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

Refer to NMFS No:
WCRO-2020-01361 (Batch Consultation Reference No.)

November 9, 2020

Michelle Walker
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 39 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 Ms. Walker:

Between May 1, 2018, and March 27, 2020, we received 39 letters from the U.S. Army Corps of Engineers, Seattle District, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 *et seq.*) for the Corps' 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 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 Corps' proposed action, to permit the 39 projects, will jeopardize the continued existence of listed Puget Sound (PS) Chinook salmon and Southern Resident killer whales (SRKW). The proposed action will also adversely modify those species' designated critical habitats. We also determined that the proposed action will not jeopardize listed PS steelhead, PS/Georgia Basin bocaccio rockfish, yelloweye rockfish, or Hood Canal Summer-run Chum salmon or adversely modify designated critical habitat for those four species.

Our 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. Twelve of the proposed projects batched in this consultation are not subject to the requirements of the RPA because their projects, as proposed, do not need to provide any additional conservation offsets to achieve the RPA's goal of avoiding jeopardy by offsetting the permanent 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 the EFH of Pacific Coast groundfish, coastal pelagic species, and Pacific Coast salmon. Therefore, we have included the results of that review in Section 3 of this document.

We look forward to working with you and your staff to assist in the implementation of the RPA and complete this consultation. Please contact Elizabeth Babcock of our North Puget Sound Branch (Elizabeth.Babcock@noaa.gov) or Jennifer Quan of our Central Puget Sound Branch (Jennifer.Quan@noaa.gov) if you have any questions concerning this consultation or if you would like additional information.

Sincerely,

Barry A. Thom
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 39 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-2020-01361

Action Agency: United States 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	Threatened	Yes	No	NA	NA
Puget Sound Chinook	Threatened	Yes	Yes	Yes	Yes
Hood Canal Summer-run Chum	Threatened	Yes	No	Yes	No
Puget Sound/Georgia Basin Yelloweye Rockfish	Threatened	Yes	No	Yes	No
Puget Sound/Georgia Basin Bocaccio	Endangered	Yes	No	Yes	No
Southern Resident Killer whale *(Orcinus area)*	Endangered	Yes	Yes	Yes	Yes
Southern Distinct Population of Sturgeon (*Acipenser medirostris*)	Threatened	No	NA	No	NA

Consultation Conducted By: National Marine Fisheries Service
West Coast Region

Issued By:

Barry A. Thom
Regional Administrator

Date: November 9, 2020

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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
COE	U.S. Army COE of Engineers
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
PST	Pacific Salmon Treaty
PSTRT	Puget Sound Technical Recovery Team
PVA	Population Viability Analyses
PVC	Polyvinyl Chloride

RCW	Revised Code of Washington
RMS	Root Mean Squared
RPA	Reasonable and Prudent Alternative
RPM	Reasonable and Prudent Measures
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
SWFSC	NOAA’s Southwest Fishery Science Center
TACT	Trouble-shooting, Action planning, Course correction, Tracking Monitoring
TRT	Technical Review Tram
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) 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 in- and overwater- new, repair and replacement 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 the pending 39 subject projects through SNNP, which is still under development at this time.

Thus, in order to bring these open consultations to conclusion, NMFS provides here a batched review of 39 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 necessary project-specific information is provided as separate attachments (when necessary) to this Opinion. Every attempt to remove applicant-identifying details and preserve this privacy have been made.

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 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 May 1, 2018, and March 20, 2020, The USACE requested consultation on its proposed authorization of 39 projects (Table 1). The proposed projects would construct new 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, PS/GB bocaccio rockfish, Hood Canal (HC) summer-run chum, 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-2018-00038	NWS-2017-796	Commercial Dock	5/1/2018
INQ-2018-00012	NWS-2017-587	Residential Bulkhead	6/8/2018
INQ-2018-00014	NWS-2018-963	Residential PRF & Dredge	11/21/2018
INQ-2018-00016	NWS-2018-229	Residential Bulkhead	12/12/2018
INQ-2018-00017	NWS-2018-465	Residential Bulkhead	12/12/2018
INQ-2018-00018	NWS-2018-53	Residential Bulkhead	12/12/2018
INQ-2019-00029	NWS-2018-636	Commercial Marina	1/30/2019
INQ-2019-00033	NWS-2017-955	Residential Bulkhead	1/31/2019
INQ-2019-00034	NWS-2018-760	Commercial Dock	1/31/2019
INQ-2019-00036	NWS-2017-840	Residential Bulkhead	7/25/2018
WCRO-2019-00196	NWS-2018-981	Commercial Marina	1/31/2019
INQ-2019-00052	NWS-2018-1143	Residential Bulkhead	5/2/2019
INQ-2019-00053	NWS-2018-570	Commercial Dock	5/2/2019
INQ-2019-00056	NSW-2018-1165	Residential OWS Home	5/2/2019
INQ-2019-00084	NWS-2017-573	Commercial Boat Ramp	5/22/2019
INQ-2019-00101	NWS-2018-382	Residential Bulkhead	6/5/2019
INQ-2019-00193	NWS-2019-207	Commercial Dock	7/11/2019
INQ-2019-00221	NWS-2019-552	Residential Bulkhead	8/8/2019
INQ-2019-00292	NWS-2019-676	Commercial Dock	10/17/2019
INQ-2019-00337	NWS-2019-526	Commercial Marina	12/17/2019
WCRO-2019-01871	NWS-2018-750	Commercial Marina	9-27-18 (original) 7-8-19 (New Date)

NMFS Consultation #	USACE Identification # (NWS #)	Project Structure Type	Consultation Request Date
WCRO-2019-01922	NWS-2018-39	Commercial Boat Ramp	9-24-18 (original) 7-24-19 (New Date)
WCRO-2019-01683	NWS-2019-491	Commercial Ramp/Float	7/3/2019
WCRO-2019-03766	NWS-2019-664	Bulkhead	1/2/2020
WCRO-2019-02497	NWS-2019-336	Commercial Dock	9/9/2019
WCRO-2019-03069	NWS-2018-525	Commercial Marina	10-17-18 (original) 10-3-19 (New Date)
WCRO-2018-01246	NWS-2018-492	Bulkhead, jetty, riprap	11-21-18 (original) 8-13-19 (New Date)
WCRO-2019-03474	NWS-2019-478	Dredging/maintain access marina and docks	11/19/2019
INQ-2020-00030	NWS-2019-956	Bulkhead	2/27/2020
INQ-2020-00034	NWS-2019-0883	Commercial pier	3/11/2020
WCRO-2020-00704	NWS-2019-728	Residential concrete steps	3/27/2020
INQ-2020-00045	NWS-2019-690	Residential boat ramp, deck piles, bulkhead	3/25/2020
INQ-2020-00072	NWS-2019-0703	Public pier/park	4/16/2020
INQ-2020-00073	NWS-2020-0204	Commercial dock, bulkhead	4/16/2020
INQ-2019-00055	NWS-2017-550	Commercial Dock	5/2/2019
INQ-2019-00114	NWS-2019-101	Commercial Dock	6/18/2019
INQ-2019-00338	NWS-2019-832	Residential PRF	12/18/2019
WCRO-2019-00642	NWS-2017-427	Moorage	6/3/2019
WCRO-2020-00074	NWS-2019-983	Boat Ramp Armoring	1/17/2020

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 reach on how to proceed with development of SSNP, NMFS redirected resources to develop a batch consultation on theses 39 nearshore projects. This was determined to be the most efficient and expedient path forward to clear the backlog of projects.

As of July 1, 2020, the consultation initiation package for only one of the projects (WCRO–2018-01246) 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 gaps in information. To complete consultation, NMFS has reviewed and made reasonable assumptions that would allow for a complete analysis for this Opinion. In this review, 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 and "X,") by proposed USACE projects.

NWS#	PS Steelhead	Critical Habitat	PS Chinook	Critical Habitat	HC S-R Chum	Critical Habitat	PS/GB bocaccio	Critical habitat	Yelloweye rockfish	Critical Habitat	SR Killer whale	Critical Habitat
NWS-2017-796	X		X	X	X	X	X	X	X	X	X	
NWS-2017-587	X		X	X			X	X	X	X	X	
NWS-2018-963	X		X	X			X	X	X	X	X	
NWS-2018-229	X		X	X			X	X	X	X	X	X
NWS-2018-465	X		X	X			X	X			X	X
NWS-2018-53	X	X	X	X	X	X	X	X	X	X	X	
NWS-2018-636	X		X	X			X	X	X		X	X
NWS-2017-955	X		X	X			X	X	X	X	X	
NWS-2018-760	X		X	X			X	X	X	X	X	X
NWS-2017-840	X		X	X			X	X	X		X	
NWS-2018-981	X		X	X			X	X	X		X	
NWS-2018-1143	X		X	X			X	X	X		X	
NWS-2018-570	X		X	X			X	X	X		X	
NSW-2018-1165	X		X	X			X	X	X		X	
NWS-2017-573	X		X	X	X	X	X	X	X		X	
NWS-2018-382	X		X	X			X	X	X		X	
NWS-2019-207	X		X	X	X	X	X	X	X		X	
NWS-2019-552	X		X	X			X	X	X		X	
NWS-2019-676	X		X	X			X	X	X		X	
NWS-2019-526	X		X	X			X	X	X		X	
NWS-2018-750	X		X	X	X		X	X	X		X	
NWS-2018-39	X		X	X	X	X	X	X	X		X	
NWS-2019-491	X		X	X			X	X	X		X	
NWS-2019-664	X		X	X			X	X	X		X	
NWS-2019-336	X		X	X			X	X	X		X	
NWS-2018-525	X		X	X			X	X	X		X	

NWS#	PS Steelhead	Critical Habitat	PS Chinook	Critical Habitat	HC S-R Chum	Critical Habitat	PS/GB bocaccio	Critical habitat	Yelloweye rockfish	Critical Habitat	SR Killer whale	Critical Habitat
NWS-2018-492	X		X	X	X		X	X	X		X	
NWS-2019-478	X		X	X	X		X	X	X		X	
NWS-2019-956	X		X	X			X	X	X		X	
NWS-2019-0883	X		X	X			X	X	X		X	
NWS-2019-728	X		X	X			X	X	X		X	
NWS-2019-690	X		X	X	X	X	X	X	X		X	
NWS-2019-0703	X		X	X			X	X	X		X	
NWS-2020-0204	X		X	X			X	X	X		X	
NWS-2017-550	X		X	X			X	X	X		X	
NWS-2019-101	X		X	X			X	X	X		X	
NWS-2019-832	X		X	X			X	X	X		X	
NWS-2017-427	X		X	X			X	X	X		X	
NWS-2019-983	X		X	X			X	X	X		X	

On May 28, 2020, NMFS transmitted a "Discussion Draft" of this Opinion that included a draft Reasonable and Prudent Alternative (RPA) to the USACE. On June 11, 2020, the USACE and NMFS met to discuss this draft and NMFS agreed to deliver a formal draft Opinion that the USACE could share with the project applicants.

On July 2, 2020, NMFS transmitted a draft of this Opinion that included a draft reasonable and prudent alternative (RPA) to the proposed action to the USACE for review.

On July 8, 2020, for the USACE's administrative ease, NMFS provided 39 project specific letters to the USACE that included summary sheets from the Nearshore Habitat Values Models (NHVM) outputs or "conservation calculators" and depicted draft debit/credit output for each project. The USACE distributed the letters and the July 2, 2020, draft Opinion to the applicants. Many applicants requested access to a working spreadsheet version the NHVM related to their project and on July 20, 2020, NMFS transmitted to the USACE project specific individual spreadsheets, which in turn the USACE transmitted to the applicants.

Between July 8, 2020, to approximately August 12, 2020, the USACE and NMFS staff met with project applicants to determine the need for project updates and review of the draft RPA in the July 2, 2020 version of the Opinion. During that timeframe, NMFS staff engaged in over 40 meetings with applicants, exchanged 100s of emails and re-ran Nearshore Habitat Values Model Calculators for all of the proposed projects.

On August 12, 2020, the USACE provided comments on the draft Opinion. This letter is included here as Appendix 1 as is it in part establishes the USACE proposed process/request for implementing the RPA that the NMFS will incorporate by reference later in this final Opinion. In response, on September 16, 2020, NMFS transmitted updated documents to the USACE that included an updated draft of the RPA, a draft Incidental Take Statement (ITS), draft Reasonable and Prudent Measures (RPMs) and draft Terms and Conditions (T&C's).

As of September 23, 2020, NMFS had received updated project information, and project amendments (additional proposed conversation offsets) from 38 of the 39 applicants. As a result of the applicant meetings, the final debit calculation, which includes offsets that have been proposed by applicants to meet the terms of the RPA, had reduced ~ 38% compared to what was calculated in the Draft Batch Opinion. In addition, the number of projects subject to the RPA has been reduced from 37 to 27. These overall reductions are largely due to:

- Project clarification: For most projects updates resulted in reduced debit output except for 5 projects that it resulted in increased credits (outlined below)
- Projects that amended the original proposed action to provided sufficient 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.

One applicant was unresponsive to the USACE and NMFS communication request and as such we have assumed there are no updates relative to their projects.

On October 1, 2020, the USACE provided comments in response to the NMFS September 16, 2020, RPA, RMP and T&C's and on Oct 16, 2020, NMFS replied to these comments. The comments and responses are attached to this Opinion as Appendix 2.

On October 23, 2020, NMFS transmitted to the USACE as second set of "Administrative Ease Letters" and enclosures that the USACE then transmitted to project applicants. Those letters described the status of each project, and included the updated NHVM calculator spreadsheet, the updated draft RPA for projects subject to the RPA, and draft RMP's and draft T&C's that would be used in conclusion of this consultation. NMFS also provided a Questions and Answer document (Appendix 3) to address many of the questions that had arisen over the course of engagement with the applicants. NMFS also provided the opportunity for applicant to meet with NMFS staff the following week (and beyond) to seek clarification on the process both before and after the Opinion was signed. The updated NHVM calculators transmitted with these letters were used to complete the analysis for this Opinion, with one exception (see below), and as such will not be attached final Opinion.

Prior to the Opinion being signed, between October 27, 2020, and October 30, 2020, NMFS met with or received response from 23 applicants to explain RPA implementation after finalization of the Opinion. Many applicants provided additional project updates. This Opinion reflects these updates where the new information informed the take surrogates. Per NMFS October 23, 2020 letter to the USACE, proposed project changes that would impact the NHVM calculator outputs are not reflected in this Opinion and will be further processed as part of RPA implementation. One project warranted an exception as it was not subject to the RPA and updated project updates would reduce the likelihood of re-initiation for this project.

During the course of this batch consultation the USACE requested four project be either withdrawn or undergo emergency consultation:

- NWS- 2019-664: On June 26, 20020, the USACE notified NMFS that this project would need to undergo emergency consultation. NMFS informed the USACE that we would continue to include this project in the consultation and that a final RPA could still apply.

- NWS-2019-690: On September 22, 2020, the USACE requested that NWS-2019-690 be withdrawn from consultation. Never-the-less, given that this project had already undergone extensive analysis, this Opinion concludes consultation on that project.

- NWS-2018-0703: On October 6, 2020, the USACE declared an emergency on a portion of NWS-2018-0703 (Pier 58). On September 13, 2020, Pier 58 collapsed. NMFS informed the USACE that we would continue to include this project in the consultation and that a final RPA could still apply.

- NWS-2019-478: On October 19, 2020, the USACE declared an emergency for NWS-2019-478. NMFS informed the USACE that we would continue to include this project in the consultation and that a final RPA could still apply.

When the emergency projects are submitted for after-the-fact consultation, NMFS will review the situation to determine if the degraded conditions of the structure would have been eligible for the 10-year useful life assumptions applied in this Opinion (see section 1.3 "Proposed Federal Action").

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 39 permits in Tables 1. The USACE permits would authorize 39 projects (Table 3) under the Clean Water Act and/or Rivers and Harbors Act. While some of the proposed projects contain new or expanded nearshore or overwater structure, a majority of the proposed projects are 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 and 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 then enactment of the Clean Water Act).
- If the USACE has previously issued a permit for the structure, that permit authorized the structure with no end date. For the structure to remain in compliance with the original USACE permit, at some point(s) during the life of the structure 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 condition[1] 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.[2] 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 explanatory graphs in Appendix 5.

Carrying this forward to the consequences of the proposed action, and based on our assumption that the existing structure 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 any positive effects that result from removing the structure for any remaining "useful life period." Second, are the effects of the proposed (replace/repaired, and often environmentally friendlier) structure. 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[3] "useful life period" for the structure, or the part of the structure being repaired or replaced, as follows:

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[2] 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 currently supports 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"—NWS-664 referenced in the consultation history is an example of this situation. 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. Any change to the 10-year assumption would be determined on a case-by-case basis. However, for this consultation we applied the 10-year assumption for all projects except as noted in the consultation history.

[3] NMFS based the assumed duration of the new "useful life periods" on SIMP, as referenced in footnote 1, as

- Over 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 5.

Two projects included replacement of stormwater outfalls or newly configured stormwater conveyance as part of their proposed action. Both projects will discharge stormwater from parking lots into the Puget Sound. For these two projects, stormwater discharged from those outfall and conveyances that would not occur "but for" the USACE action and has therefore been analyzed in this Opinion as a consequence of the proposed action.

Two projects include maintenance dredging in whole 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 it 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 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 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 are not considered a part of the proposed action.

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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 as described above.

Table 3. Abbreviated permit action description by USACE identification number (NWS #).

NWS#	Abbreviated Permit Description
NWS-2017-796	This permit includes the routine maintenance of the existing dock and mooring facilities. Repair work will be conducted over a five-year period. This work includes the replacement of deteriorated decking, decking stringers, bull rails, dock bearing pilings, dolphin pilings, and debris wall timbers in order to maintain the dock and mooring facilities in operational status. Existing structures will be replaced and no expansion of the dock and mooring facilities will occur. Impact pile driving and some in-water work will be required for the proposed project. The project includes a temporary erosion and sediment control plan, as well as other conservation measures specific to listed endangered or threatened species and water quality. The project also includes removal of 4,765 sq. ft. of derelict structures and 136 creosote piles in Glen Cove. The proposed repaired and replaced components of the structure are expected to remain in place with a new 40-year “useful life period” (i.e., not in need of another Corps for 40 years).
NWS-2017-587	Replace 110 linear foot riprap bulkhead with new larger size-rock riprap bulkhead. At the project site there is mapped kelp and documented surf smelt spawning. Project is near start of approximately 2 mile long right to left drift cell; affects approximately 1.75 miles of shoreline. Proposed conservation measures include one-time beach nourishment. The proposed repaired and replaced components of the structure are expected to remain in place with a new 50-year “useful life period” (i.e., not in need of another Corps for 50 years).
NWS-2018-963	This permit includes the replacement of an existing pier, ramp and float (PRF), maintenance dredging of the mooring area, removal of beach debris and installation of shoreline plantings. The existing PRF is 1,240 square-foot, U-shaped and solid-decked, supported by 15 creosote piles and 3 steel piles. The 1,200 square-foot, U-shaped, proposed replacement PRF consists of a 6-foot by 50-foot grated pier, a 4-foot by 50-foot grated gangway, a 4-foot by 60-foot grated finger float, a 4-foot by 65-foot grated finger float, and a 4-foot by 27-foot connecting grated float, all supported by a total of (14) 10-inch steel piles. Proposed dredging would remove 485 cubic yards of sediment from an area of 3,407-square feet, down 3 to 4 feet, within an existing, 50-foot by 100-foot dredge prism. The proposed repaired and replaced components of the structure are expected to remain in place with a new 40-year “useful life period” (i.e., not in need of another Corps for 40 years).
NWS-2018-229	The permit proposes to replace an existing 63-linear foot concrete bulkhead with a 30-linear foot rock bulkhead, install a helical anchored mooring buoy, and remove a mooring pile. Removal and replacement of a mooring buoy. Approximately 1,757 sqft of invasive and non-native vegetation will be removed and re-planted with native vegetation and shade producing trees. The proposed repaired and replaced components of the structure are expected to remain in place with a new 50-year “useful life period” (i.e., not in need of another Corps for 50 years).

NWS#	Abbreviated Permit Description
NWS-2018-465	Remove and replace 75-linear foot concrete bulkhead with 75-linear foot of angular rock bulkhead. All work will be completed from grounded barge. The work will require 14 days of work and will be done in 3 phases: (1) removing backfill behind bulkhead to prevent sedimentation in the aquatic environment; (2) removal of 75-linear foot of concrete bulkhead, and (3) installation of angular rock bulkhead, filter fabric, and quarry spalls. Additionally, 373 cubic feet of beach nourishment. The proposed repaired and replaced components of the structure are expected to remain in place with a new 50-year "useful life period" (i.e., not in need of another Corps for 50 years).
NWS-2018-53	Repair 26-foot failed section of existing 150-foot concrete bulkhead. Existing cinderblock cap on the entire length of bulkhead will be removed and replaced with a 3-foot-tall concrete lift along the entire bulkhead length. Waterward of the failed section of bulkhead, approximately 300 sq. ft. is currently potentially inundated by high tides (below HAT), providing aquatic habitat under existing conditions. A stair wing wall will also be reinforced. At project site there is mapped eelgrass, and surf smelt and Pacific herring spawning. Proposed conservation measures include one-time beach nourishment and removal of debris from failed section of bulkhead. The proposed repaired and replaced components of the structure are expected to remain in place with a new 50-year "useful life period" (i.e., not in need of another Corps for 50 years).
NWS-2018-636	Replace the existing 2,574 square foot solid-decked marina with a 2,514 square foot grated floating dock system, and to replace 15 creosote-treated piles with 15 12-inch diameter steel piles with a vibratory driver. The proposed repaired and replaced components of the structure are expected to remain in place with a new 40-year "useful life period" (i.e., not in need of another Corps for 40 years).
NWS-2017-955	Replace an existing 140 LF concrete bulkhead with a new angular rock bulkhead approximately three foot landward of removed structure. A grounded barge (in the dry) will be present from which construction equipment (i.e., excavator) will operate throughout removal and replacement activities. Approximately 150 cy of materials will be used for the replacement bulkhead. Additionally, 105 sq. ft. of solid deck and four creosote piles will be removed, 700 cubic feet of beach nourishment, and 1560 sq. ft. of RZ planting . The proposed repaired and replaced components of the structure are expected to remain in place with a new 50-year "useful life period" (i.e., not in need of another Corps for 50 years).
NWS-2018-760	Replacement of 4 piles. Replacement float will be 490 square feet with 240 square feet of grating and approximately 37% (89 square feet) open area, for an increase of 171 square feet. They will also pull 5 damaged derelict creosote piles and dispose of them off site. A second grated gangway will be installed on the western end of the southern pier face. The gangway structure will be approximately 18 feet above the water line and will be folded in when not in use. The proposed repaired and replaced components of the structure are expected to remain in place with a new 40-year "useful life period" (i.e., not in need of another Corps for 40 years).

NWS#	Abbreviated Permit Description
NWS-2017-840	Repair an existing 6.5' tall rock bulkhead. 136 lineal feet of bulkhead will be restacked. The proposed bulkhead repair will be in the same footprint as the existing bulkhead. No waterward encroachment will occur. Add 25 cubic yards of fine sand and pea gravel (50/50 mix) beach nourishment waterward of the bulkhead. The proposed repaired and replaced components of the structure are expected to remain in place with a new 50-year "useful life period" (i.e., not in need of another Corps for 50 years).
NWS-2018-981	The existing Pier and associated catwalk will be demolished. This will include the removal of (44) creosote-treated piles with a vibratory hammer. (8) 12-inch (nominal) steel piles will be driven for the South Pier and Extension. All piles will be driven with a vibratory hammer as far as possible and then proofed with an impact hammer. Pile driving will be completed from a barge. Steel pile caps will be set from the barge and welded in place using scaffolding. Timber stringers, decking, rails, and accessories will be installed atop without the need for heavy equipment. (19) 12-inch (nominal) steel piles will be driven for the Launch Floats. Three of these piles will be used to ensure that the floats remain in place, and the remaining sixteen piles will be installed beneath the corners of the floats to ensure that they do not ground at low tides. These short piles are often referred to as 'grounding posts.' All piles will be driven with a vibratory hammer as far as possible and then proofed with an impact hammer. Pile driving will be completed from a barge. Float modules will be fabricated offsite, brought in via barge, and lowered into place with the crane. An 80-foot gangway will be fabricated offsite, brought in via barge and lifted into position, connecting the pier extension to the launch floats. Gangway connections will be installed without the need for heavy equipment. The project will remove (44) 12-inch- to 16-inch-diameter creosote timber piles along with the caps, stringers, and asphalt deck. The city also proposes to remove concrete debris from the beach northwest of Eddon Boat Park. The approximately 2,000 square feet of debris was identified during the initial mitigation proposal for NWS-2016-733. Upper intertidal shading will be reduced by approximately 1,455 square feet due to the removal of the remainder of the Pier, including its caps, stringers, and asphalt deck. The proposed repaired and replaced components of the structure are expected to remain in place with a new 40-year "useful life period" (i.e., not in need of another Corps for 40 years).
NWS-2018-1143	This permit includes the replacement of 60-linear feet of concrete bulkhead with an inset, concrete stair set with an inset, large angular rock stair set, as well as 15-linear feet of wing wall at the south end of the bulkhead. The new bulkhead would be 7 feet above grade, and keyed up to 24 inches below existing grade. The bulkhead would be backfilled with quarry spall and filter fabric. The project would account for the removal of up to 40 cubic yards of material, and the placement of up to 155 cubic yards of new material. The new bulkhead would be constructed behind the existing bulkhead first, then the existing bulkhead would be removed. The project also consist of 300 cubic feet of beach nourishment. The proposed repaired and replaced components of the structure are expected to remain in place with a new 50-year "useful life period" (i.e., not in need of another Corps for 50 years).

NWS#	Abbreviated Permit Description
NWS-2018-570	This permit includes: replacement of an existing 5,273 square foot overwater structure (shellfish processing building with solid decking) with a new overwater structure that would consist of a 3,000 square foot building (1,298 square feet will be overwater, with solid decking), installation of a 2,411 square foot grated working platform (waterward), a new 60 square foot grated pier, 292 square foot grated ramp, and 142 square foot partially grated float, and a 1,160 square foot pier and platform, and a 96 square foot float. The project would also replace 388 linear feet of creosote timber bulkhead with 56 linear feet of new rockery bulkhead and the remaining 330 linear feet of the replacement would be constructed of concrete. To extend the existing breakwater by reconfiguring an adjacent 600 square foot float and two piles to attach to the existing breakwater. All piles would be driven and removed utilizing a barge mounted vibratory pile driver, operating during high tide, which would not be allowed to ground. The bulkhead removal and replacement would occur during low tides and be conducted from the uplands. Additionally, 507.5 cubic feet of beach nourishment. The proposed repaired and replaced components of the structure are expected to remain in place with a new 50-year "useful life period" (i.e., not in need of another Corps for 50 years).
NSW-2018-1165	The proposed re-development project at the subject site is to repair and replace an existing single family dwelling constructed over water. Included is replacement of decaying wooden support pilings with a foundation system consisting of prefabricated galvanized steel footings and coated galvanized steel columns and bracing. No pile driving is involved. A 115 sf solid float will be removed but other existing auxiliary dock structures will remain. There will be no increase in number of the number of dwelling units, no increase in overwater coverage, and no appreciable change in configuration. The footprint of the proposed residence is smaller than and is contained within the footprint of the existing residence. The proposed repaired and replaced components of the structure are expected to remain in place with a new 50-year "useful life period" (i.e., not in need of another Corps for 50 years).
NWS-2017-573	This permit allows the applicant to construct an elevated concrete boat ramp measuring 48 ft. wide by 264 ft. long. An 8 ft. wide float with 50% functional grating (60% open area) would extend 44 ft. waterward of the end of the boat ramp. 68 (12-inch diameter) closed-end steel piles would be used to support the ramp and six (12-inch diameter) open end piles would be used to secure the floating dock. All ramp support piles will be driven within a cofferdam, using a vibratory pile driver to refusal and then proofed with an impact hammer. Float piles will be installed with a vibratory hammer only. Most of the piles will be driven during low tide from the existing boat ramp and the remaining piles will be driven from a barge. The proposed repaired and replaced components of the structure are expected to remain in place with a new 40-year "useful life period" (i.e., not in need of another Corps for 40 years).

NWS#	Abbreviated Permit Description
NWS-2018-382	This permit is for the replacement of a 125-linear foot, failing, creosote timber bulkhead with a 125-linear foot, large angular rock bulkhead. Work would be conducted with an excavator staged from a grounded barge. The barge would be grounded to allow work to occur in dry and because steep upland conditions do not allow for upland machinery access to the project site. All 17.86 tons of removed creosote would be disposed of appropriately upland. Additionally, 300 sq. ft. of beach nourishment is proposed. To minimize impacts to ESA-listed species, work may be performed July 16 through February 15 in any year the permit is valid. Prior to commencing any work, including grounding the barge, a forage fish spawning survey will be completed by a qualified biologist with a negative result. After confirming that no forage fish spawning is occurring, the applicant will have two weeks to complete the proposed work. After two weeks, another forage fish spawning survey will be completed, with a negative result, before work may continue. The proposed repaired and replaced components of the structure are expected to remain in place with a new 50-year “useful life period” (i.e., not in need of another Corps for 50 years).
NWS-2019-207	This permit is to replace the existing 4,168 ft2 creosote-treated wood and foam solid-decked floats with 4,168 ft2 of new floats for commercial private use and recreational boat moorage. The proposed floating dock consists of (1) 8’x25’ float, 1 8’x178’11” float, and 1 8’x317’2” float. The proposed floats will have 50% grated surface and pre-stressed concrete surface. Replacement floats will use the existing piling and will not involve the installation of new or additional piling. The new floats will be attached to the existing ramp and pier using hand tools. A small boat will remove the existing floats offsite and tow in the replacement floats where they will be connected to the existing piling using hand tools. Marine Floats performs all work from a construction barge that is not allowed to ground out at any time. All floats are constructed at the Marine Floats facility in Tacoma and are comprised of 50% fiberglass grating with and 50% Recycled Plastic Decking with High Density Polycarbonate flotation drums. Dock assembly is from the water, never on land. Construction materials are transported by boat/barge via water to the project site. All materials removed from the project site will be transported to the Marine Floats facility for dismantling and taken to an approved upland disposal site. 1) All new floats will have 50% grated surface and 50% pre-stressed surface 2) Replacement floats will replace the current overwater area and will be attached to the existing steel piling. 3) All floats are designed to meet current regulatory standards. 4) Floats are manufactured at Marine Floats facility. The floats will be placed into the waterway and towed by a boat to be installed using hand tools in the marina. The proposed repaired and replaced components of the structure are expected to remain in place with a new 40-year “useful life period” (i.e., not in need of another Corps for 40 years).
NWS-2019-552	The permit is to repair the bottom portion of an existing timber bulkhead by installing approximately 237 linear feet of new timber lagging on the waterward side of the bulkhead and backfilling the void created behind with gravel. Along approximately 70 linear feet of the bulkhead, new galvanized sheet piling will be driven with a vibratory hammer along the waterward side of the bulkhead. The proposed repaired and replaced components of the structure are expected to remain in place with a new 50-year “useful life period” (i.e., not in need of another Corps for 50 years).

NWS#	Abbreviated Permit Description
NWS-2019-676	This permit is to repair 5 piles by installing polymer fiber jackets. The pile work will occur in the water body, in shallow water (9 ft. MLLW) near the seawall. One 14" diameter creosote timber pile will be removed. The proposed repaired and replaced components of the structure 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-2019-526	This permit includes removing an existing 3,476 sq. ft. solid decked marina and replacing it with 3,216 sq. ft. of grated surfaces. Removal will include (8) 10” creosote pier piles, (12) 12” creosote float piles, (2) 10” creosote float piles, and (1) 10” steel float pile. Installation will include (2) 10” steel pier piles and (10) 12” steel float piles. Total reduction in overwater coverage equals 286 sq. ft. Planting 5000 sq. ft. in the RZ is proposed. This proposed repaired and replaced component of the structure are expected to remain in place with a new 40 “useful life period” (i.e., not in need of another Corps permit for 40 years).
NWS-2018-750	Replace ninety 12 to 14-inch diameter creosote piles with ninety 12-inch diameter steel piles and replace 31,744 square feet of solid wood and concrete float systems with 31,744 square feet of 50% grated and concrete floats (69% open space), all within the existing footprint. This proposed repaired and replaced component of the structure are expected to remain in place with a new 40 “useful life period” (i.e., not in need of another Corps permit for 40 years).
NWS-2018-39	Replacement of 1,440 ft2 joint-use boat ramp within Hood Canal. Additionally, removal of approximately 600 sq. ft. of sediment from the boat ramp per year will be continued for 50 years. The boat ramp acts as a sediment barrier. The proposed repaired and replaced components of the structure 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-2019-491	Install an 18-foot wide by 63-foot long kayak launch ramp to provide for public small craft launches and an additional floating dock adjacent to the existing Port of Bellingham structure at the site. Overall a 1,292sf floating dock expansion and 1000sf launch ramp installation. The dock decking “will allow light penetration.” Construction will require a small (150 level) track hoe, a small rubber mounted loader, and a standard dump truck. This proposed repaired and replaced component of the structure are expected to remain in place with a new 40 “useful life period” (i.e., not in need of another Corps permit for 40 years).
NWS-2019-664	Repair and replace a failing bulkhead by constructing a total of 360 linear feet of new poured in placed concrete within forms at the waterward face of the existing and failing bulkhead. Construction will include digging two to three feet into beach substrate, directly abutting the existing bulkhead, and install a footer with 12 inch rebar centers to support concrete panels 8-inches thick by 4-feet wide and extending 12-feet upwards with a 16 inch thick lip at the top; two-feet of the 12-foot panel wall would be installed below grade. The concrete toe of the existing bulkhead will be removed and 66.7 cubic yards of beach nourishment be added. The proposed repaired and replaced components of the structure 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#	Abbreviated Permit Description
NWS-2019-336	Replace up to 248 fender piles over a 10-year period as conditions warrant and as the operating budget allows. A maximum of 100 fender piles will be replaced in any given year over the life of the program. This Program proposes the required repair and maintenance for all existing fender piles, as they are reaching the end of their design life or are damaged from vessel operations. This Program will remove 196 creosote-treated timber fender piles, which provides a direct benefit to the environment. It will also remove 41 damaged steel piles as needed. The proposed repaired and replaced components of the structure 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-2018-525	Replacement of 12,178 ft2 of solid deck floats, 360 ft2 pier and ramp. Remove 13 creosote piles and replace with 13 steel piles. Pier will be fully grated, floats will have 30 percent grated area. 11 timber piles (not creosote) will be removed permanently. Project located within pocket estuary and covers a significant portion of the area. The proposed repaired and replaced components of the structure 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-2018-492	This permit is to remove 842 linear feet (LF) of existing creosote timber bulkhead, 33,052 square feet (SF) of existing riprap, and 148 LF of existing breakwater. The removed riprap and structures would be replaced with 834 LF steel sheet pile bulkhead, 4,010 SF of riprap, and 148 LF of new breakwater. The proposed repaired and replaced components of the structure 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-2019-478	Remove up to 7,500 cubic yard of accumulated sediment through maintenance dredging. Maintenance dredging is proposed to the authorized depth of -13 feet mean lower low water plus 2 feet of over dredge allowance.
NWS-2019-956	Replacement of a 130 linear-foot creosote pile and timber bulkhead with a 130 linear-foot large rock riprap bulkhead. The existing bulkhead would be removed and then the new bulkhead would be placed within footprint of existing bulkhead. Due to the steep topography, all demolition and installation work will likely occur from a barge using a crane during a period of 3-5 days to complete the bulkhead removal and reconstruction. The proposed repaired and replaced components of the structure 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-2019-0883	Performance of maintenance activities on a petroleum distribution and storage terminal over the next five years as needed, including the replacement of up to 23 piles with piles of the same diameter, and in-kind replacement of up to 100 square feet of timber and concrete decking. As needed, repair and replace pile caps, replace wooden bracing with untreated wood, repair loose timber and/or damaged chains on dolphins, repair/replace fenders, repair building components like roofing and siding, and repair machinery on the dock including heating equipment, meters, valves, transfer arms, pipes and electrical equipment. The proposed repaired and replaced components of the structure 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-2019-728	Remove up to 5 feet of existing concrete steps and replace with rock steps in-kind. Additional work would include the removal of 5 cubic yards of fallen riprap and adding 324 cubic feet of WDFW specified beach nourishment. A construction barge will be used to deliver equipment and materials to the site. The proposed repaired and replaced components of the structure 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-2019-690	Remove a 552 sq. ft. concrete boat ramp and replace it with a new 200 sq. ft. concrete slab using an excavator. Replace 40 ft. of bulkhead, 35 of which are below HAT. Remaining 140 ft. of proposed log bulkhead is above HAT. Four existing creosote pilings which support an overwater deck, would be removed and replaced with four 6-inch-diameter steel pilings. 200 sq. ft. of solid deck would be replaced with 200 sq. ft. of grated deck. Additional removal of 999.75 sq. ft. of shoreline debris. The proposed repaired and replaced components of the structure 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-2019-0703	Remove the existing Pier 58 (48,320 square feet), including 490 piles (365 timber piles, 81 steel monotube piles that may be filled with concrete, and 44 steel H-piles), railings, decking, stringers, pile caps, and bracing. An unknown number of remnant piles and debris from previous pier configurations will also be removed. Replacement pier will be 48,200 square feet and will include installation of 186 permanent 36-inch steel piles. The decking will consist of both pre-cast concrete panels and a cast-in-place concrete deck slab. Grating will be installed along the western edge of the pier (500 square feet) and along the southern corner of the pier at the nearshore (500 square feet). The proposed repaired and replaced components of the structure 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). Existing pier 63 (35,108 square feet) will be removed, including removal of 900 timber piles that are approximately 14 inches in diameter. An unknown number of remnant piles and debris from previous pier configurations will be removed. Replacement pier will be 26,436 square feet (net reduction in overwater cover of 30 square feet) and will include the installation of 170 permanent 36-inch steel piles, concrete pile caps, and concrete deck planks. Remove approximately 8,672 square feet of the pier, 60 linear feet from the seawall, to create an area of open water to provide natural lighting of the intertidal habitat near the shore (located at approximately -10 feet mean lower low water (MLLW)). Approximately 2,000 square feet of the open water habitat area was previously permitted to be grating as part of the Pier 62 Reconstruction Project (USACE Reference No. NWS-2016-296-WRD). Total net increase of open water habitat area at Pier 63 will be approximately 6,672 square feet for this project. The proposed repaired and replaced components of the structure 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-2020-0204	Install fiberglass or high-density polyethylene (HDPE) jackets on up to 218 corroded steel pipe piles, repair or replace steel float covers, timber fender panels, recoating steel pile caps and braces, wales, brackets, and non-skid wearing surfaces, and repairs to the 330 ft. bulkhead. The proposed repaired and replaced components of the structure 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-2017-550	This permit allows the applicant to hire a waterfront contractor to use a barge-mounted crane and pile-driving equipment to remove 200 14-inch creosote-treated piles and replace up to 200 12-inch steel piling located no more than approximately 450 feet from the shoreline. The replacement piling would be installed beneath the dock in waters down to -55 Mean Lower Low Water (MLLW) or approximately 65 feet of water. This allows for barge and ship draft depths up to the needed 43 feet at the face of the dock. This project provides continued safe mooring for ships and barges transporting materials for Alon Asphalt. Norwest Engineering provided inspection support to determine pile size, location, condition, and replacement recommendation. A vibratory hammer would be used to vibrate the old piles out and the new piles into the substrate; the 12-inch steel pile will be driven to a maximum depth of -75 feet MLLW, 20 feet into the substrate. The piling will be installed plumb below the dock. The overall project installation would occur between July 15 through December 31 and January 1 through February 15 over the course of the 10-year permit. The proposed repaired and replaced components of the structure 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-2019-101	This permit involves maintenance and repairs to the wharf substructure, including piling, bracing, girts, sash, and firewalls. Proposed work also includes superstructure elements including pile caps, stringers, decking, railing, and fender chains. Approximately 149 piles require repair. All top of pile repairs will occur above the waterline. Cathodic protection system components will be replaced. The proposed repaired and replaced components of the structure 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-2019-832	This permit is for the replacement of an existing pier and float, and the replacement and expansion of an existing boat ramp. The existing pier and float consist of a solid-decked, five-foot by 95-foot pier and a solid-decked 12-foot by 22-foot float, supported by 23 creosote piles. The proposed structure consists of a four-foot by 56-foot, 100-percent grated pier, a 3-foot by 40-foot, 100-percent grated ramp, and a 12-foot by 22-foot, 50-percent grated float, supported by eight 8-inch galvanized steel piles. The existing boat ramp is 35 feet by 12 feet (156 square feet waterward of Mean Higher High Water (MHHW)). The replacement boat ramp would be 75 feet by 12 feet (528 square feet waterward of MHHW) and would be constructed of precast concrete panels. Excavation to a maximum depth 6 inches would occur prior to placing the panels. On-site compensatory mitigation includes removal of 23 creosote piles, removal of intertidal debris including brick and tires from a 2,075 square foot area, and placement of 25 cubic yards of spawning sediment over 1,400 square feet. The proposed repaired and replaced components of the structure 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-2017-427	This permit is to replace two concrete float anchors with a 36-inch diameter steel pile. The proposed repaired and replaced components of the structure 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-2019-983	This permit includes: LWD placement as habitat enhancement, beach nourishment, installation of coir lifts along the eroded area for stability and reduction of erosion, installation of drainage system to collect runoff prior to reaching the bank and convey runoff to Hogum Bay at a localized outfall, and articulated concrete mats will be placed around the existing boat ramp. For habitat improvements and offsets, 27 piles from a previously removed pier are to be removed. The piles are located south of the existing boat ramp. The proposed repaired and replaced components of the structure 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).

For the proposed permits, the USACE has proposed 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 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, to reduce 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 project that include impact or vibratory pile driving which will exceed harmful noise levels (120dbRMS) will have a NOAA-approved Marine Mammal Monitoring Plan (MMMP) in place before any work can commence in waters of the U.S.[4] The MMMP must meet the requirements of NOAA's guidance for MMMPs found on NOAA's website: http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/monitoring_plan_g uidance.html

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

a. Projects for which this BMP would apply:

NWS-2018-963
NWS-2018-636
NWS-2018-760
NWS-2018-981
NWS-2018-570
NWS-2017-573
NWS-2019-552
NWS-2019-526
NWS-2018-750
NWS-2019-336
NWS-2018-525
NWS-2019-0883
NWS-2019-0703
NWS-2017-550
NWS-2019-101
NWS-2019-832
NWS-2017-427
NWS-2018-492
NWS-2017-796

Additionally some of the projects have proposed minimization and conservation measure to offset impacts of the projects authorized under the 30 permits. They are summarized in Table 4.

Table 4. Minimization and Conservation Proposed by Permit

Summary Project Totals (where relevant)

	13	**4**	**12**	**6**	**1**	**25**
	Minimization/Conservation Proposed					
NWS#	**Debris Removal**	**Boat Ramp Removal**	**Beach Nourish**	**Planting**	**Manmade Groin Removal**	**Creosote Removal**
NWS-2017-796	x					x
NWS-2017-587			x	x		
NWS-2018-963	x	x		x	x	x
NWS-2018-229				x		x
NWS-2018-465			x			
NWS-2018-53	x		x	x		
NWS-2018-636						x
NWS-2017-955			x	x		x
NWS-2018-760						x
NWS-2017-840			x			
NWS-2018-981	x					x
NWS-2018-1143			x			
NWS-2018-570	x		x			x
NSW-2018-1165						x
NWS-2017-573		x				
NWS-2018-382			x			x
NWS-2019-207						x
NWS-2019-552	x					
NWS-2019-676						x
NWS-2019-526				x		x
NWS-2018-750						x

Summary Project Totals (where relevant)

NWS-2018-39		x				
NWS-2019-491						
NWS-2019-664			x			
NWS-2019-336						x
NWS-2018-525						x
NWS-2018-492	x					x
NWS-2019-478						
NWS-2019-956						x
NWS-2019-0883						x
NWS-2019-728	x		x			
NWS-2019-690	x	x				x
NWS-2019-0703	x					x
NWS-2020-0204						
NWS-2017-550						x
NWS-2019-101						x
NWS-2019-832	x		x			x
NWS-2017-427	x					
NWS-2019-983	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 such as pier, dock, float, ramp, wharf, or marinas would cause recreational and/or commercial boat use to continue at current levels or increase. Twenty-six of the projects included in this Opinion are either residential commercial or industrial structures that support motorized boating that extend through Puget Sound (discussed further below).

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 39 projects (Table 1). The proposed action would cause a range of effects, as described in Section 2.4, Effects of the Action, including:

Temporary effects related to construction:

1. underwater sound from pile installation and removal,
2. generation of suspended sediment, and
3. noise from the operation of construction vessels such as barges.

Enduring effects including related to the proposed structures:

1. creation of overwater shade that increases predation and suppresses aquatic vegetation,
2. migration delays,
3. interruption of habitat forming processes from shoreline stabilization, and
4. interruption of drift cell formation.

Intermittent effects caused by marine vessels that use the proposed structures:

1. noise,
2. propeller wash, and
3. degradation of water quality through the introduction of a small amount of contaminants (i.e., fuel).

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. in review, 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. in review, 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. in review, 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. in review found that 67% 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 many of the 39 projects. The purpose of many of these structures, such as residential pier, ramp, and floats, marinas, and commercial wharfs, 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 vessels 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. 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, we expect the vessel use to be well spread out through the Puget Sound. Notable landmarks or location indicators and expected vessel use, if applicable, is indicated in Table 5.

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 east of Deception Pass and to the south and east of Admiralty Head-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-2017-796	Port Townsend	Commercial and Industrial Vessels
NWS-2017-587	Peale Passage	NA - Bulkhead
NWS-2018-963	Gig Harbor	Recreational Vessel
NWS-2018-229	Burien	NA - Bulkhead
NWS-2018-465	Gig Harbor	NA - Bulkhead
NWS-2018-53	Hood Canal	NA - Bulkhead
NWS-2018-636	Gig Harbor	Commercial and Recreational Vessels
NWS-2017-955	Lakebay	NA - Bulkhead
NWS-2018-760	Pier 69	Commercial and Industrial Vessels
NWS-2017-840	Burien	NA - Bulkhead
NWS-2018-981	Bellingham	Commercial and Recreational Vessels

NWS#	Notable Land Mark Indicator (City, Island, etc.)	Vessel Use
NWS-2018-1143	Pitt Passage	NA - Bulkhead
NWS-2018-570	Shelton	Commercial and Industrial Vessels
NSW-2018-1165	Seattle	NA - Bulkhead
NWS-2017-573	Hood Canal	Commercial and Recreational Vessels
NWS-2018-382	Case Inlet	NA - Bulkhead
NWS-2019-207	Shaw Island	Commercial and Recreational Vessels
NWS-2019-552	Ferndale	NA - Bulkhead
NWS-2019-676	Seattle, PS waterfront	Commercial and Industrial Vessels
NWS-2019-526	Gig Harbor	Commercial and Recreational Vessels
NWS-2018-750	Indian Island	Commercial and Recreational Vessels
NWS-2018-39	Tahuya	Commercial and Recreational Vessels
NWS-2019-491	Squalicum	Commercial and Recreational Vessels
NWS-2019-664	Anacortes	NA - Bulkhead
NWS-2019-336	Harbor Island	Commercial and Industrial Vessels
NWS-2018-525	Indian Cove	Commercial and Recreational Vessels
NWS-2018-492	Des Moines	Commercial and Recreational Vessels
NWS-2019-478	Des Moines	Commercial and Recreational Vessels
NWS-2019-956	Fox Island	NA - Bulkhead
NWS-2019-0883	Foss Waterway/ Tacoma	Commercial and Industrial Vessels
NWS-2019-728	Seattle, PS waterfront	Recreational Vessel
NWS-2019-690	Discovery Bay	NA - Bulkhead
NWS-2019-0703	Seattle, PS waterfront	Commercial and Recreational Vessels
NWS-2020-0204	Bellingham	Commercial and Industrial Vessels
NWS-2017-550	Point Wells	Commercial and Industrial Vessels
NWS-2019-101	Anacortes	Commercial and Industrial Vessels
NWS-2019-832	Vaughn	Recreational Vessel

NWS#	Notable Land Mark Indicator (City, Island, etc.)	Vessel Use
NWS-2017-427	Shelton	Commercial and Industrial Vessels
NWS-2019-983	Nisqually Reach	Recreational Vessel

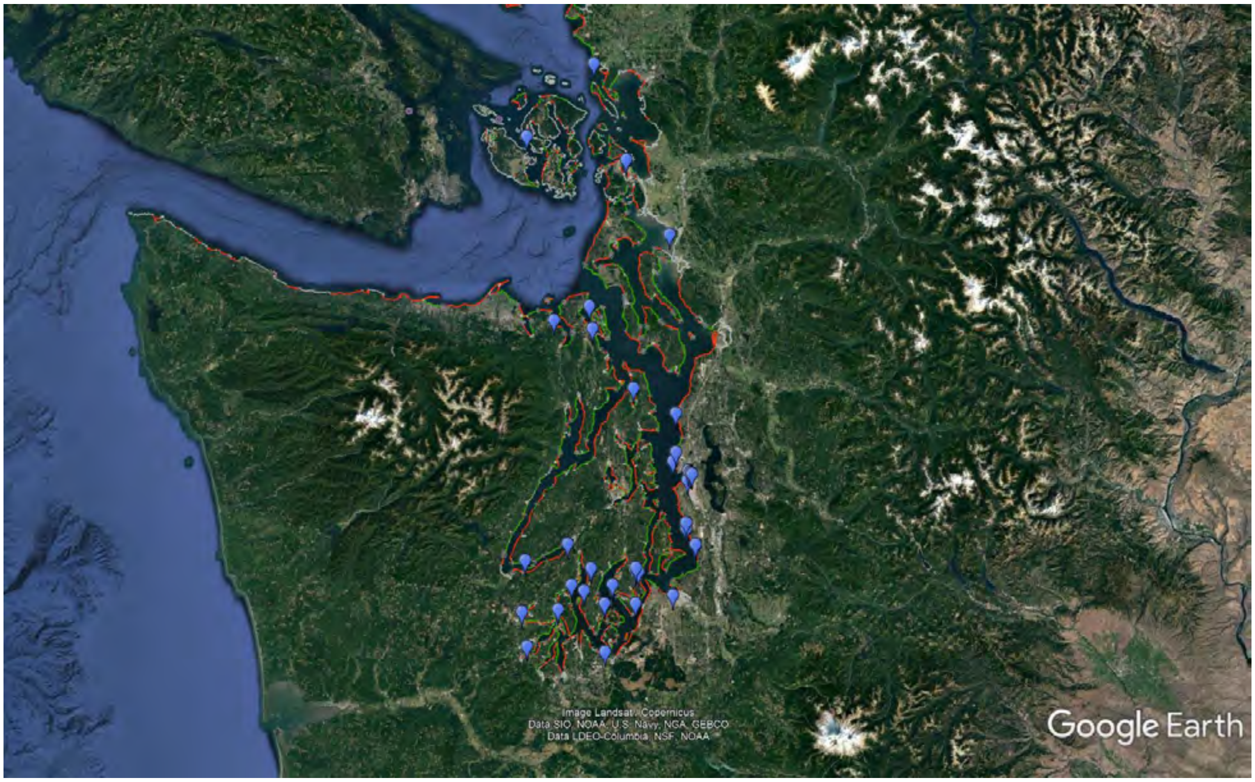

Figure 1. Image of Puget Sound with Approximate Project Locations

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 ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

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 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 using a Habitat Equivalency Analysis (HEA)[5] and the Puget Sound Nearshore Habitat Values Model (NHVM) that we adapted from Ehinger et al. 2015. We developed an input calculator ("conservation calculator") that serves as a user-friendly 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 are fully offset by the services gained from a conservation activity. In this case, we use this approach to calculate the "cost" and "benefit" of the proposed actions, as well as the impacts of the existing environmental baseline, using the NHVM.

The NHVM includes a debit/credit factor of two applied 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). To rephrase, 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, or function. Debits (-) on the other hand indicate a loss of nearshore habitat quality, quantity, 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, that assume that some function has already been lost from the existing structure. In sum, outputs from the NHVM accounts 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 the remaining "useful life period";

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[5] 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 (Milon and Dodge 2001; Cacela et al. 2 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 CH.

- 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), in the Effects of the Action (Section 2.4), and in Appendix 5. Specific project outputs from each proposed project are included with this Opinion are included as 39 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. Following the summary sheets are detailed model output that describe how 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.

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. Note—the NHVM only assess the temporal impacts critical habitat impacts. The shorter-term effects like elevated suspended sediments and re-suspended contaminants are addressed qualitatively in the Effect of the Action in Section 2.4 below.

The model's accounting includes a selection of applicable SAV conditions prior to dredging and no SAV after impact, and a 2-year impact to prey base from disrupted sediment and substrate. Additionally, a reduction in migratory corridor function of 4 years is assumed. Further, the impact assessment is based on assuming linear recovery of migratory corridor function and prey base over the respective time horizons.

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).

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).

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 resulted in 3.5-5.3°C increases in Columbia Basin streams and a peak temperature of 26°C 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).

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).

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).

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 1.0-3.7°C 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).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. A 38 percent 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 likely 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 (NWFSC 2015). 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).

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.

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 six 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; 'P' means proposed for listing or designation.

Species	Listing Status	Critical Habitat
Chinook salmon ***(Oncorhynchus tshawytscha)***		
Puget Sound	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630
Chum salmon ***(O. keta)***		
Hood Canal summer-run	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630
Steelhead **(*O. mykiss*)**		
Puget Sound	T 5/11/07; 72 FR 26722	2/24/16; 81 FR 9252
Yelloweye Rockfish ***(Sebastes ruberrimus)***		
Puget Sound/Georgia Basin	T 4/28/10; 75 FR 22276	2/11/15; 79 FR 68041
Bocaccio **(S. *paucispinis)***		
Puget Sound/Georgia Basin	T 4/28/10; 75 FR 22276	2/11/15; 79 FR 68041
Killer Whale ***(Orcus orcinus)***		
Southern Resident	11/18/2005; 70 FR 69903	11/29/06; 79 FR 69054

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). 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.

Spatial Structure and Diversity. The Puget Sound 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 ESU also includes the progeny of numerous artificial propagation programs (NWFSC 2015). 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).

Between 1990 and 2014, the proportion of natural-origin spawners has trended downward across the ESU, with the Whidbey Basin the only MPG with consistently high fractions of natural-origin spawner abundance. All other MPG have either variable or declining spawning populations with high proportions of hatchery-origin spawners (NWFSC 2015).

Table 7. Extant PS Chinook salmon populations in each biogeographic region and the 2-year trend (2012-2014) (Ruckelshaus et al. 2002, NWFSC 2015)

Biogeographic Region	Population (Watershed)	Population trend (% change)
Strait of Georgia	North Fork Nooksack River	Negative (-30)
	South Fork Nooksack River	Positive (+8)
Strait of Juan de Fuca	Elwha River	Positive (+93)
	Dungeness River	Negative (-6)
Hood Canal	Skokomish River	Positive (+34)
	Mid Hood Canal River	Positive (+257)
Whidbey Basin	Skykomish River	Negative (-31)
	Snoqualmie River	Negative (-42)
	North Fork Stillaguamish River	Negative (-1)
	South Fork Stillaguamish River	Negative (-15)
	Upper Skagit River	Negative (-32)
	Lower Skagit River	Negative (-35)
	Upper Sauk River	Positive (+67)
	Lower Sauk River	Negative (-24)
	Suiattle River	Positive (+38)
	Upper Cascade River	Positive (+1)
Central/South Puget Sound Basin	Cedar River	Positive (+31)
	North Lake Washington/ Sammamish River	Negative (-16)
	Green/Duwamish River	Negative (-32)
	Puyallup River	Negative (-41)
	White River	Negative (-35)
	Nisqually River	Positive (+31)

Abundance and Productivity. Available data on total abundance since 1980 indicate that although abundance trends have fluctuated between positive and negative for individual populations, there are widespread negative trends in natural-origin Chinook salmon spawner abundance across the ESU (NWFSC 2015). 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 past 7 to 10 years. Further, escapement levels for all populations remain well below the TRT planning ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the TRT as consistent with recovery (NWFSC 2015).

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;
- Aggressive 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.[6]

Status of Hood Canal Summer-run Chum Salmon

We adopted a recovery plan for Hood Canal summer-run (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

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[6] 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)

- 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 ESU populations that are based on two assumptions about productivity and environmental response (Table 8).

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).

Table 8. Hood Canal summer-run chum ESU abundance and productivity recovery goals (Sands et al. 2009).

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

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

Spatial structure and diversity measures for the HCSR chum recovery program have included the reintroduction and sustaining of natural-origin spawning in multiple small streams where summer chum spawning aggregates had been extirpated. Supplementation programs have been very successful in both increasing natural spawning abundance in 6 of 8 extant streams (Salmon, Big Quilcene, Lilliwaup, Hamma Hamma, Jimmycomelately, and Union) and increasing spatial structure due to reintroducing spawning aggregations to three streams (Big Beef, Tahuya, and Chimacum). Spawning aggregations are present and persistent within five of the six major ecological diversity groups identified by the PS TRT (Table 9). 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 9. Seven ecological diversity groups as proposed by the PSTRT for the Hood Canal Summer Chum ESU by geographic region and associated spawning aggregation**.**

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

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

Trends in population productivity, estimated as the log of the smoothed natural spawning abundance in year t minus the smoothed natural spawning abundance in year (t-4), have increasing over the past five years, and were above replacement rates in the 2012 and 2013. However, productivity rates have been 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 most recent 8 years. Productivity of individual spawning aggregates shows only two of eight aggregates have viable performance. (NWFSC 2015).

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 Hood Canal summer-run 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 Hood Canal summer-run 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 Hood Canal summer-run 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 TRT produced viability criteria, including population viability analyses (PVAs), for 20 of 32 demographically independent populations (DIPs) and three major population groups (MPGs) in the DPS (Hard et al. 2015). It also completed a report identifying historical populations of the DPS (Myers et al. 2015). The DIPs are based on genetic, environmental, and life history characteristics. Populations display winter, summer, or summer/winter run timing (Myers et al. 2015). The TRT concludes that the DPS is currently at "very low" viability, with most of the 32 DIPs and all three MPGs at "low" viability.

The designation of the DPS as "threatened" is based upon the extinction risk of the component populations. Hard 2015, identify several criteria for the viability of the DPS, including that a minimum of 40 percent of summer-run and 40 percent of winter-run populations historically present within each of the MPGs must be considered viable using the VSP-based criteria. For a DIP to be considered viable, it must have at least an 85 percent probability of meeting the viability criteria, as calculated by Hard et al. (2015).

On December 27, 2019, we published a final recovery plan for PS steelhead (84 FR 71379) (NMFS 2019a). The plan indicates that within each of the three MPGs, at least fifty percent of the populations must achieve viability, *and* specific DIPs must also be viable:

- Central and South Puget Sound MPG: 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.

- Hood Canal and Strait of Juan de Fuca MPG: Elwha River Winter/Summer-Run; Skokomish River Winter-Run; One from the remaining Hood Canal populations: West Hood Canal Tributaries WinterRun, East Hood Canal Tributaries Winter-Run, or South Hood Canal Tributaries WinterRun; 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.

- North Cascades MPG: Of the eleven DIPs with winter or winter/summer runs, five must be viable: One from the Nooksack River Winter-Run; One from the 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.

Of the five summer-run DIPs in this MPG, three must be viable representing in each of the three major watersheds containing summer-run populations (Nooksack, Stillaguamish, Snohomish Rivers); 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)

Spatial Structure and Diversity**.** The PS steelhead DPS is the anadromous form of *O. mykiss* that occur in rivers, below natural barriers to migration, in northwestern Washington State that drain to Puget Sound, Hood Canal, and the Strait of Juan de Fuca between the U.S./Canada border and the Elwha River, inclusive. The DPS also includes six hatchery stocks that are considered no more than moderately diverged from their associated natural-origin counterparts: Green River natural winter-run; Hamma Hamma winter-run; White River winter-run; Dewatto River winter-run; Duckabush River winter-run; and Elwha River native winter-run (USDC 2014, 79 FR 20802). Steelhead are the anadromous form of *Oncorhynchus mykiss* that occur in rivers, below natural barriers to migration, in northwestern Washington State (Ford 2011). 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).

DIPs can 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). Most DIPs have low viability criteria scores for diversity and spatial structure, largely because of extensive hatchery influence, low breeding population sizes, and freshwater habitat fragmentation or loss (Hard et al. 2007). In the Central and South Puget Sound and Hood Canal and Strait of Juan de Fuca MPGs, nearly all DIPs are not viable (Hard et al. 2015). More information on PS steelhead spatial structure and diversity can be found in NMFS’ technical report (Hard et al. 2015).

Abundance and Productivity. Abundance of adult steelhead returning to nearly all Puget Sound rivers has fallen substantially since estimates began for many populations in the late 1970s and early 1980s. Smoothed trends in abundance indicate modest increases since 2009 for 13 of the 22 DIPs. Between the two most recent five-year periods (2005-2009 and 2010-2014), the geometric mean of estimated abundance increased by an average of 5.4 percent. For seven populations in the Northern Cascades MPG, the increase was 3 percent; for five populations in the Central & South Puget Sound MPG, the increase was 10 percent; and for six populations in the Hood Canal & Strait of Juan de Fuca MPG, the increase was 4.5 percent. However, several of these upward trends are not statistically different from neutral, and most populations remain small. Inspection of geometric means of total spawner abundance from 2010 to 2014 indicates that 9 of 20 populations evaluated had geometric mean abundances fewer than 250 adults and 12 of 20 had fewer than 500 adults. Between the most recent two five-year periods (2005-2009 and 2010-2014), several populations showed increases in abundance between 10 and 100 percent, but about half have remained in decline. Long-term (15-year) trends in natural spawners are predominantly negative (Table 10, NWFSC 2015).

There are some signs of modest improvement in steelhead productivity since the 2011 review, at least for some populations, especially in the Hood Canal & 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 & South Puget Sound MPG (NWFSC 2015).

Little or no data is available on summer-run populations to evaluate extinction risk or abundance trends. Because of their small population size and the complexity of monitoring fish in headwater holding areas, summer steelhead have not been broadly monitored.

<u>Limiting factors.</u> 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 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.

Table 10. Extant PS Steelhead populations in each biogeographic region and the percent change 1990-2014 (Ruckelshaus et al. 2002, NWFSC 2015)

Biogeographic Region	Population (Watershed)	Population trend (% change)
Hood Canal and Strait of Juan de Fuca	East Hood Canal Tribs	Negative (-3)
	Sequim/Discovery Bay Tribs	Positive (+12)
	Elwha River	-
	Dungeness River	-
	Skokomish River	Positive (+65)
	South Hood Canal Tribs	Negative (-43)
	West Hood Canal Tribs	Negative (-50)
	Strait of Juan de Fuca Tribs	Negative (-40)
Northern Cascades	Snohomish/Skykomish River	Negative (-70)
	Snoqualmie River	Negative (-46)
	Stillaguamish River	Positive (+20)
	Nooksack River	-
	Skagit River	Positive (+7)
	Pilchuck River	Positive (+3)
	Sammish/Bellingham Bay Tribs	Positive (+58)
	Tolt River	Positive (44)
Central/South Puget Sound Basin	Cedar River	Negative (-67)
	North Lake Washington/ Sammamish River	-
	Green River	Negative (-23)
	Puyallup/Carbon River	Negative (-42)
	White River	Positive (+136)
	Nisqually River	Positive (+18)

PS steelhead Recovery Plan. Juvenile Puget Sound 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. Puget Sound 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 Puget Sound 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 estimates of historic or present-day abundance of yelloweye rockfish, or PS/GB bocaccio across the full DPSs area. In 2013, the WDFW published abundance estimates from a remotely operated vehicle 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).

Further, data 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. Therefore, long-term population growth rate for the listed species was likely even lower (more negative) than that for total rockfish. Finally, there is little to no evidence of recent recovery of total rockfish abundance to recent protective measures.

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 with size. 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. However, the generality of maternal effects in Sebastes suggests that some level of age or size influence on reproduction is likely for all species.

Larval rockfish rely on nearshore habitat. The nearshore is generally defined as habitats contiguous with the shoreline from extreme high water out to a depth no greater than 98 feet (30 m) relative to mean lower low water. This area generally coincides with the maximum depth of the photic zone and can contain 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 (Simenstad et al. 2011). 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 and 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). 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 juvenile bocaccio occur on shallow rocky reefs and nearshore areas (Moser 1967; Anderson 1983; Kendall and Lenarz 1986; Carr 1991; Love et al. 1991; Love 1996; Murphy et al. 2000; Love et al. 2002). Young bocaccio associate with macroalgae, especially kelps (Laminariales), and sandy areas that support seagrasses. 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 rockfish juveniles offer a beneficial mix of warmer temperatures, food, and refuge from predators (Love et al. 1991). Habitat formed by kelp provides structure for feeding, refuge from predators, and reduced currents that enable energy conservation for juvenile bocaccio.

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 understood. Some areas around Puget Sound have shown a large decrease in kelp. 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. Although loss of nearshore habitat quality is a threat to rockfish, the recovery plan for this species list the severity of this threat as low (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. 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 Central and South Sound (Greene and Godersky 2012).

Status of PS/GB Bocaccio

The PS/GB bocaccio distinct population segment (DPS) was listed as endangered on April 28, 2010 (75 FR 22276). In April 2016, we completed a 5-year status review that recommended the DPS retain its endangered classification (Tonnes et al. 2016), and we released a recovery plan in October 2017 (NMFS 2017a). Though PS/GB bocaccio were never a predominant segment of the multi-species rockfish population within the Puget Sound/Georgia Basin, their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Most PS/GB bocaccio within the DPS may have been historically spatially limited to several basins within the DPS. They were apparently historically most abundant in the Central and South Sound with no documented occurrences in the San Juan Basin until 2008. The apparent reduction of populations of PS/GB bocaccio in the Main Basin[7] and South Sound represents a further reduction in the historically spatially limited distribution of PS/GB bocaccio, and adds significant risk to the 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.

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[7] 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).

<u>General Life History:</u> The life history of PS/GB bocaccio includes a larval/pelagic juvenile stage that is followed by a juvenile stage, and 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 likely result in most larvae staying within the basin where they are released rather than being broadly dispersed (Drake et al. 2010).

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 with 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.

<u>Spatial Structure and Diversity:</u> The PS/GB bocaccio DPS includes all PS/GB bocaccio from inland marine waters east of the central Strait of Juan de Fuca and south of the northern Strait of Georgia. 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, (4) South Sound, and (4) Hood Canal. The fifth basin consists of Canadian waters east and north of the San Juan Basin into the Straights 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.

<u>Abundance and Productivity:</u> 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). 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:

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

Status of PS/GB Yelloweye Rockfish

Spatial Structure PS/GB 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 Distinct Population Segment (DPS) (75 Fed. Reg. 22276). The Puget Sound/Georgia Basin DPS of yelloweye rockfish was listed as "threatened" under the ESA on April 28, 2010 (75 FR 22276). The DPSs include all yelloweye rockfish a found in waters of Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca east of Victoria Sill. Critical habitat was designated for all species of listed rockfish in 2014 under section 4(a)(3)(A) of the ESA (79 FR 68041, November 13, 2014).

Diversity New collection and analysis of PS/GB yelloweye rockfish tissue samples reveal significant genetic differentiation between the inland (DPS) and coastal samples. These new data are consistent with and further support the existence of a population of Puget Sound/Georgia Basin yelloweye rockfish that is discrete from coastal populations (Ford 2015; Tonnes et al. 2016). In addition, yelloweye rockfish from Hood Canal were genetically differentiated from other Puget Sound/Georgia Basin, indicating a previously unknown degree of population differentiation within the DPS (Ford 2015; Tonnes et al. 2016). 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 Puget Sound/Georgia Basin DPS.

Abundance Yelloweye rockfish within the Puget Sound/Georgia Basin (in U.S. waters) are very likely the most abundant within the San Juan Basin of the DPS. Yelloweye rockfish spatial structure and connectivity is threatened by the apparent reduction of fish within each of the basins of the DPS. 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 Puget Sound/Georgia Basin.

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 2016 concluded that SRKWs should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2016b). NMFS considers SRKWs to be currently among eight of the most at-risk species as part of the Species in the Spotlight initiative[8] 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 killer whale populations that have generally been increasing since the 1970s (Carretta et al. 2019).

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 PFMC SRKW Ad Hoc Workgroup's report (PFMC 2020a), as well as newly available data.

Abundance, Productivity, and Trends

Killer whales—including SRKWs—are a long-lived species and sexual maturity can occur at age 10 (review in NMFS (2008a)). Females produce a small 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

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

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 have 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 2). As of April 2020, the population is 72 whales (one whale is missing and presumed dead since the 2019 summer census), including 22 whales in J pod, 17 whales in K pod, and 33 whales in L pod. Two new calves were born to J pod in September 2020. 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.

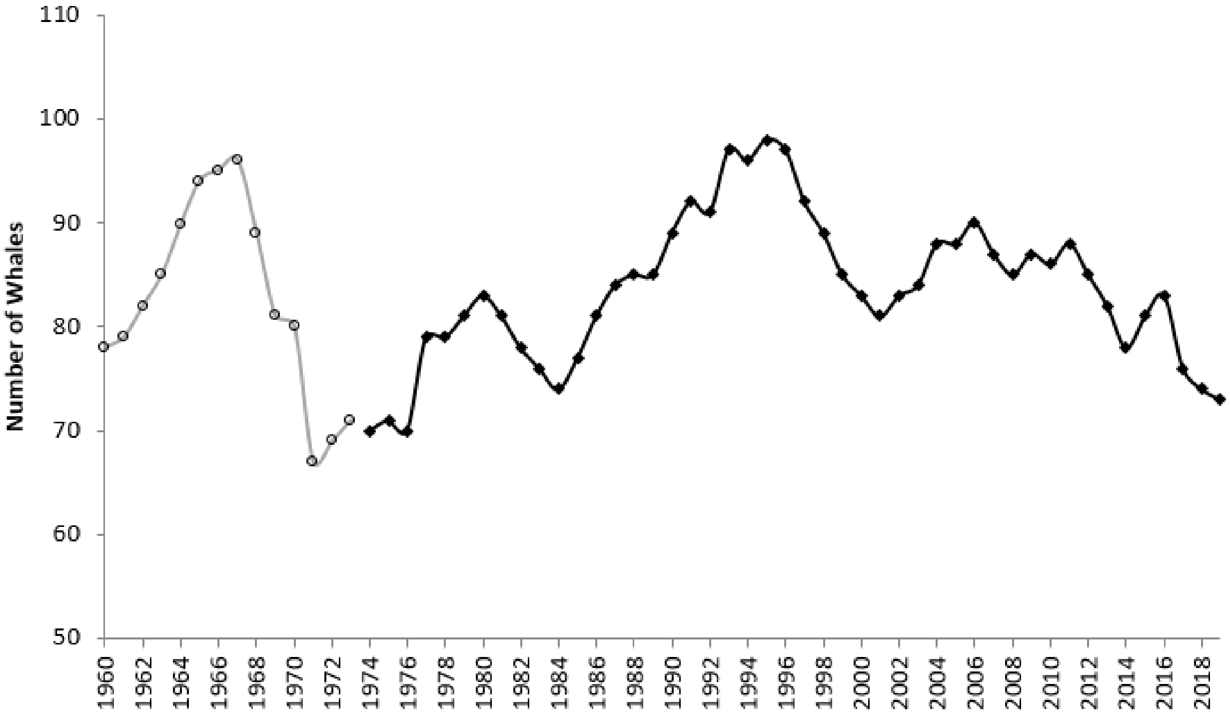

Figure 2. Population size and trend of Southern Resident killer whales, 1960-2019. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk et al. (1990). Data from 1974-2019 (diamonds, black line) were obtained through photo-identification surveys of the 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.

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 neonate 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 (CWR unpublished data). Stranding rates are higher in winter and spring for all killer whale forms in Washington and Oregon (Norman et al. 2004).

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). According to the updated analysis, the model results now suggests a downward trend in population size projected over the next 50 years. As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates. 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 (2011-2016), the population will decline faster as shown in Figure 3 (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 (review in NMFS 2016b).

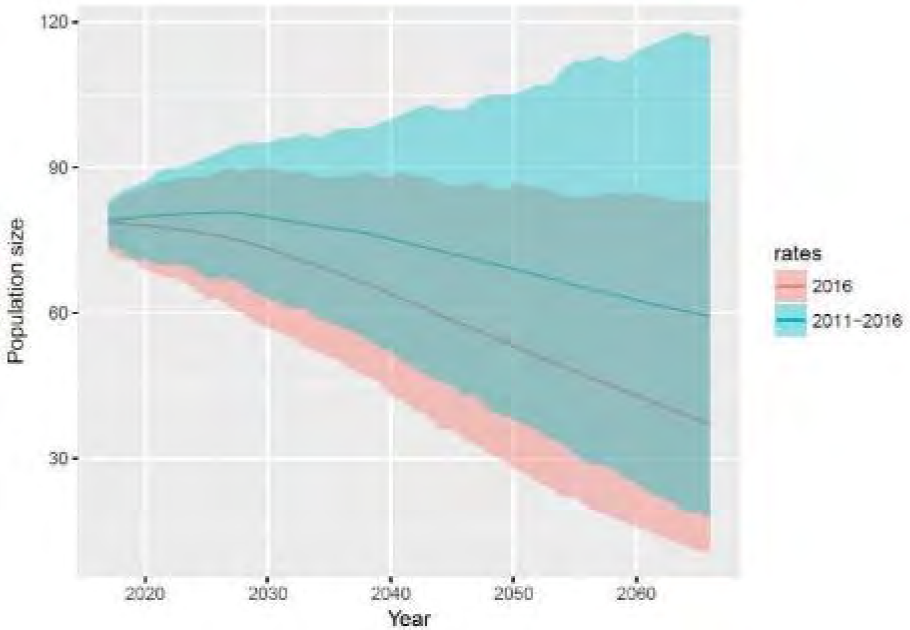

Figure 3. Southern Resident killer whale population size projections from 2016 to 2066 using two scenarios: (1) projections using demographic rates held at 2016 levels, and (2) projections using demographic rates from 2011 to 2016. The pink line represents the projection assuming future rates are similar to those in 2016, whereas the blue represents the scenario with future rates being similar to 2011 to 2016 (Figure 2, 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 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, from 2010 through July 2019, only 15 of the 28 reproductive aged females successfully reproduced, resulting in 16 calves. There were an additional 10 documented non-viable calves, and likely more undocumented, born during this period (CWR unpubl. data). A recent study indicated pregnancy hormones (progesterone and testosterone) can be detected in SRKW feces and have indicated several miscarriages, particularly in late pregnancy (Wasser et al. 2017). The fecal hormone data have shown that up to 69 percent of the detected pregnancies do not produce a documented calf (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. 2017).

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. 2019; Ford et al. 2017) (Figure 4). 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).

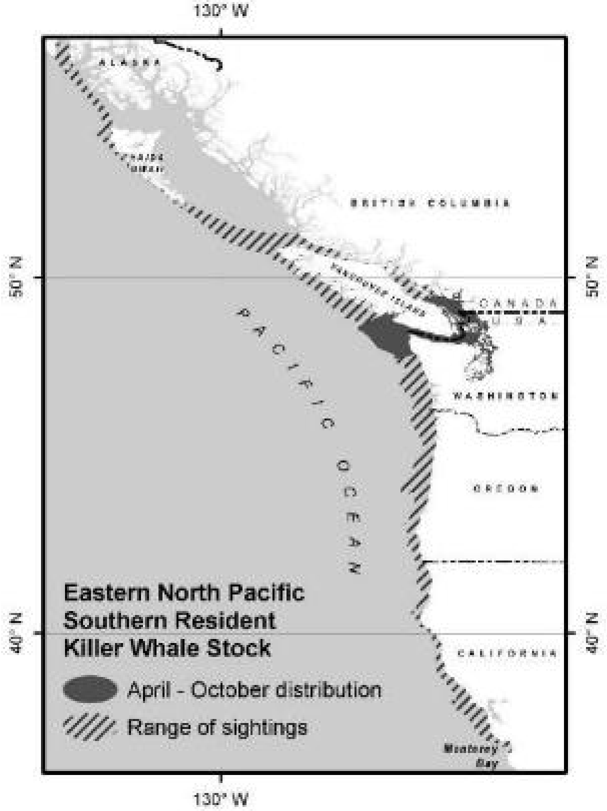

Figure 4. Approximate April–October distribution of Southern Resident killer whales (shaded area) and range of sightings (diagonal lines) (reprinted from Carretta et al. (2019)).

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 satellite tagging resulted in data range of duration days, from 3 days to 96 days depending on the tag, of monitoring with deployment durations from late

December to mid-May (Table 11). 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). 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 5). 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 6) (Hanson et al. 2017, 2018). The tagging data provide general information on the home range and overlap of each pod from 2012 to 2016.

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. Most locations were in waters less than 100m in depth.

Table 11. Satellite-linked tags deployed on Southern resident killer whales 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

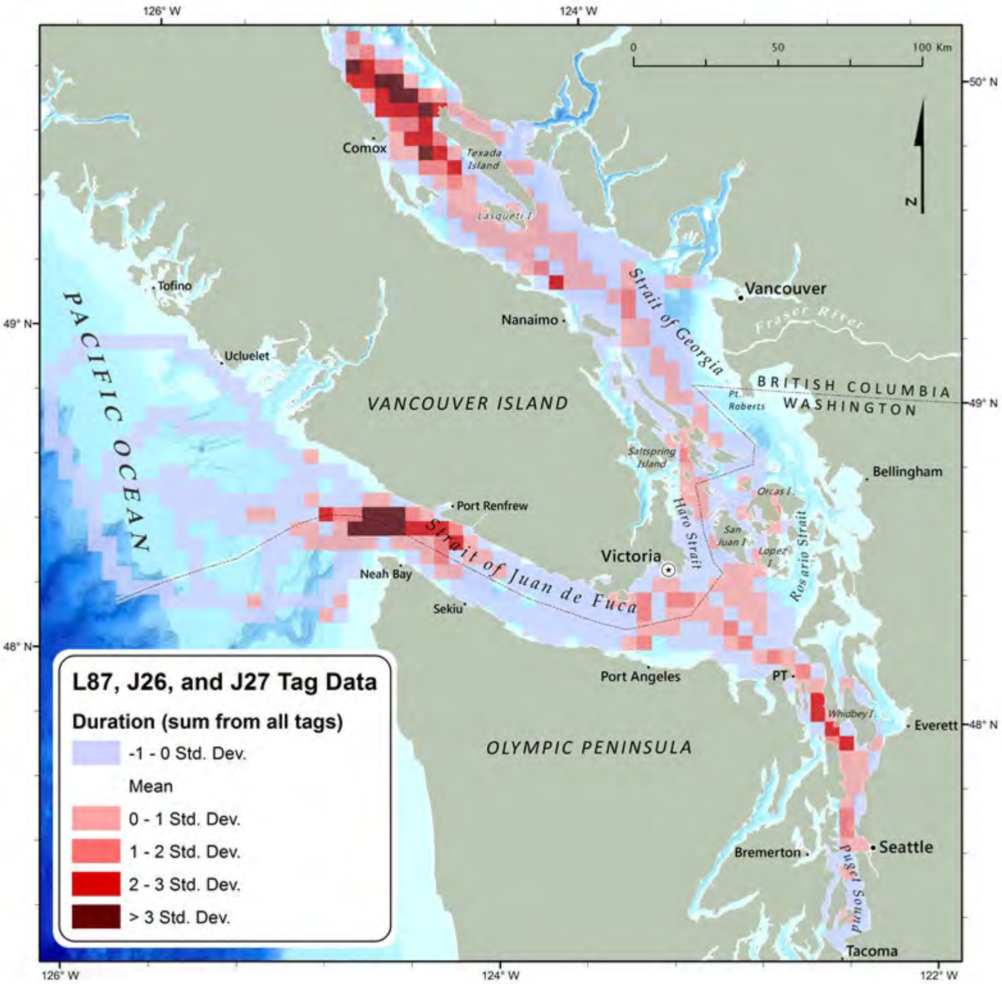

Figure 5. Duration of occurrence model output for J pod tag deployments (Hanson et al. 2017). "High use areas" are illustrated by the 0 to > 3 standard deviation pixels.

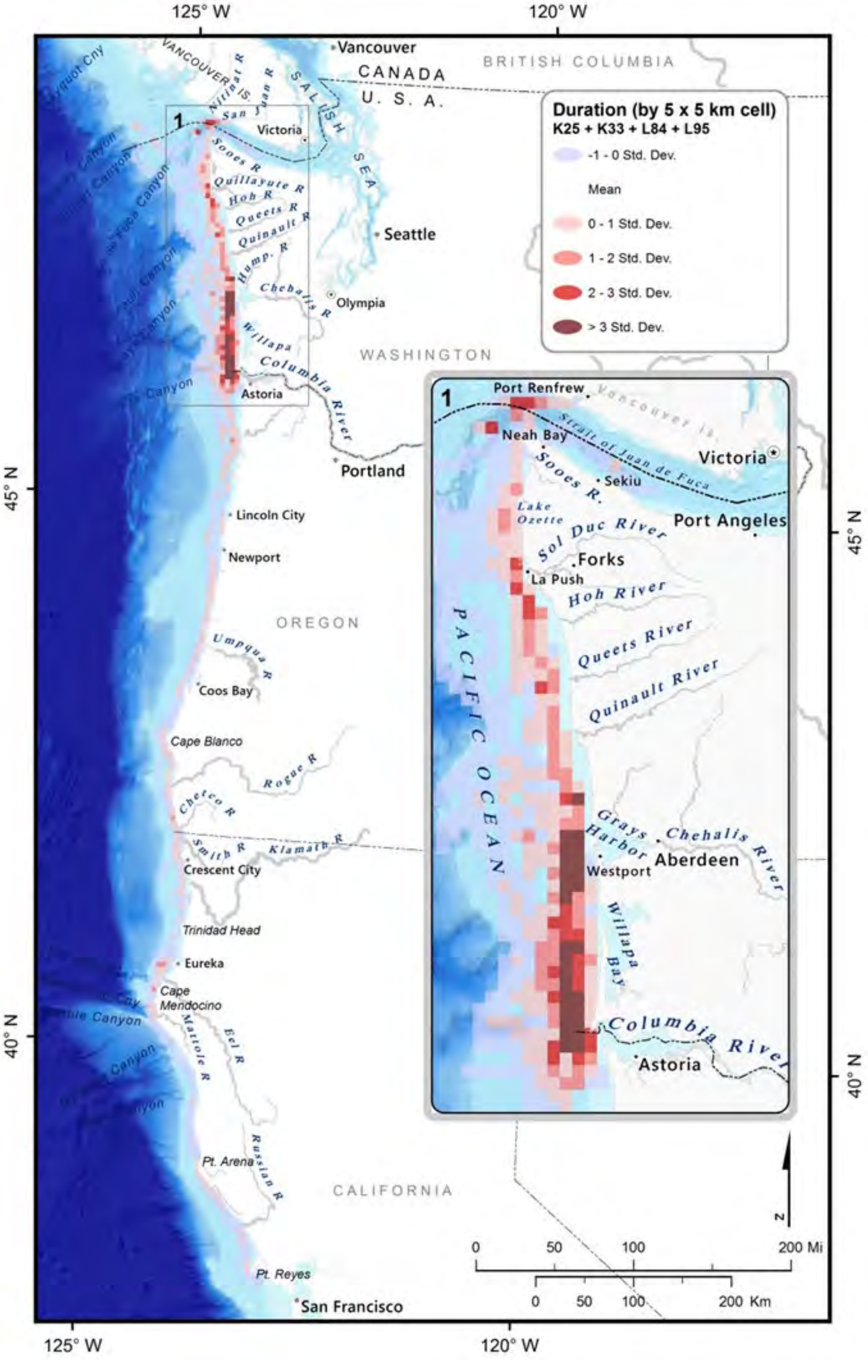

Figure 6. Duration of occurrence model for all unique K and L pod tag deployments (Hanson et al. 2017). "High use areas" are illustrated by the 0 to > 3 standard deviation pixels.

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 (EARs) 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 (Figure 7; 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 8), 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 9), 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).

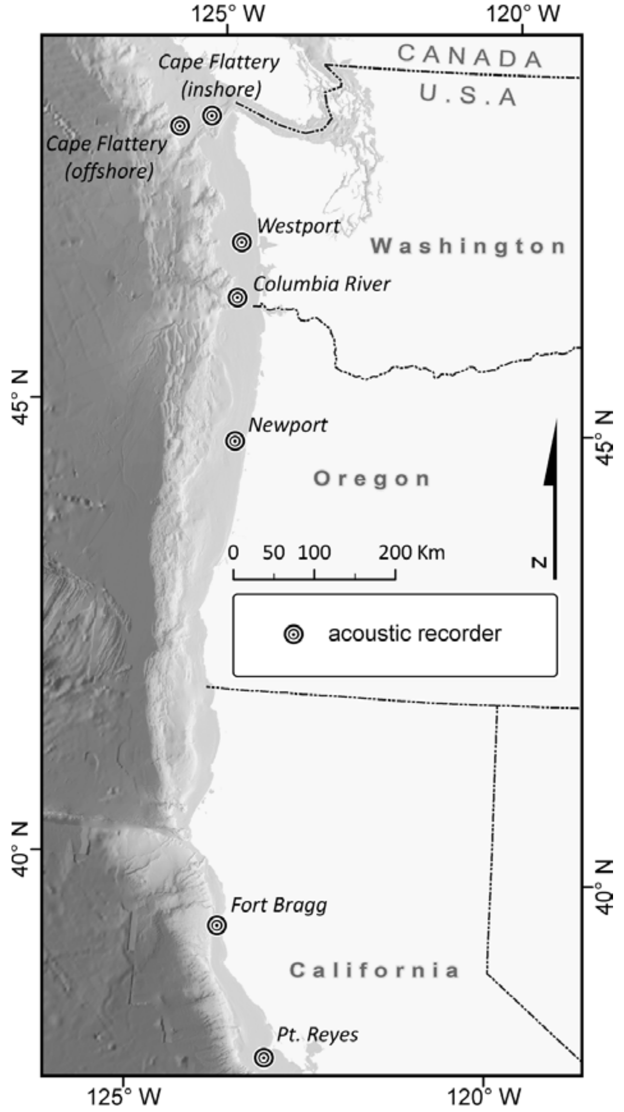

Figure 7. Deployment locations of acoustic recorders on the U.S. west coast from 2006 to 2011 (Hanson et al. 2013).

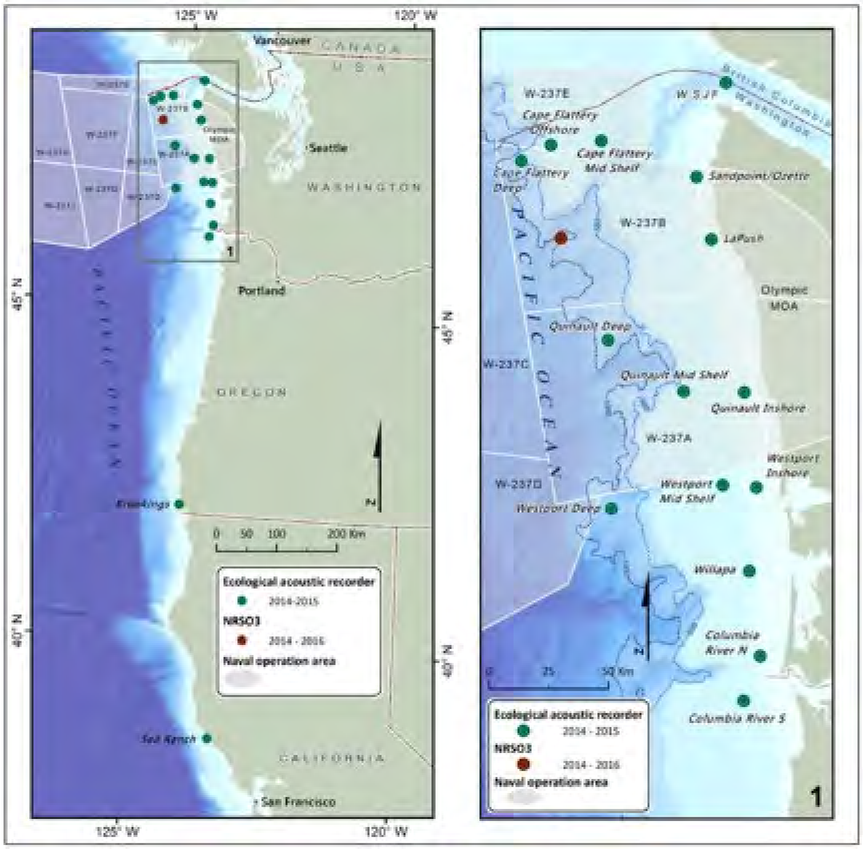

Figure 8. Locations of passive acoustic recorders deployed beginning in the fall of 2014 (Hanson et al. 2017).

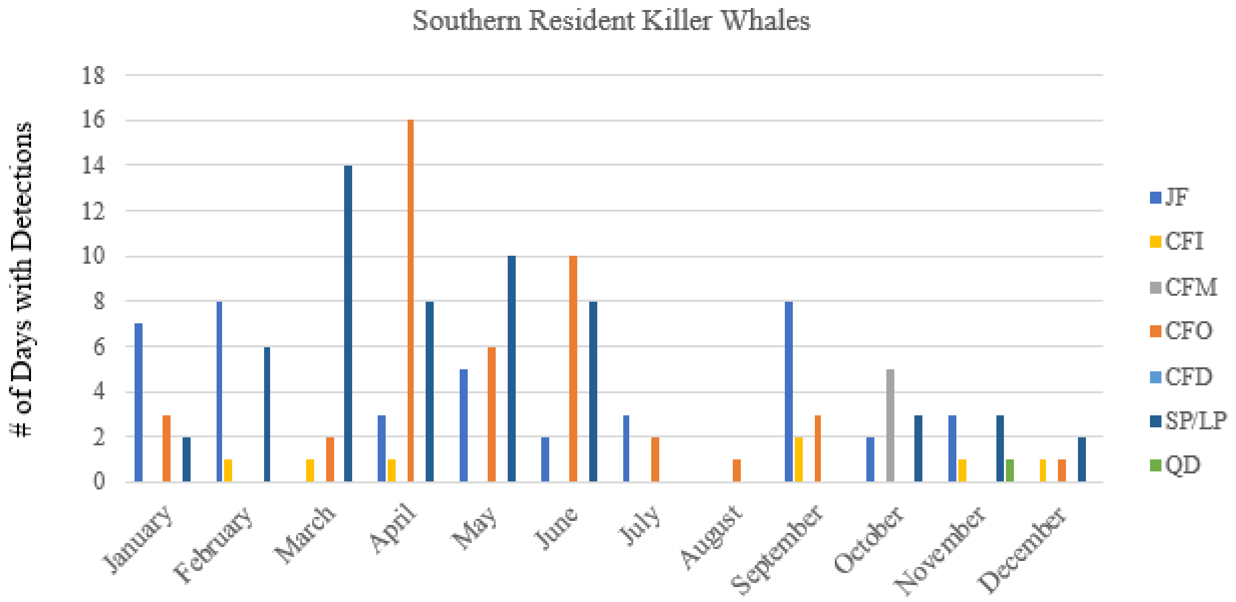

Figure 9. Counts of detections at each northern recorder site by month from 2014-2017 (Emmons et al. 2019). Areas include Juan de Fuca (JF); Cape Flattery Inshore (CFI); Cape Flattery Mid Shelf (CFM); Cape Flattery Offshelf (CFO); Cape Flattery Deep(CFD); Sand Point and La Push (SP/LP); and Quinault Deep (QD).

In a recent study, 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 10 (Riera et al. 2019). SRKW were detected on 163 days with 175 encounters (see Figure 11 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).

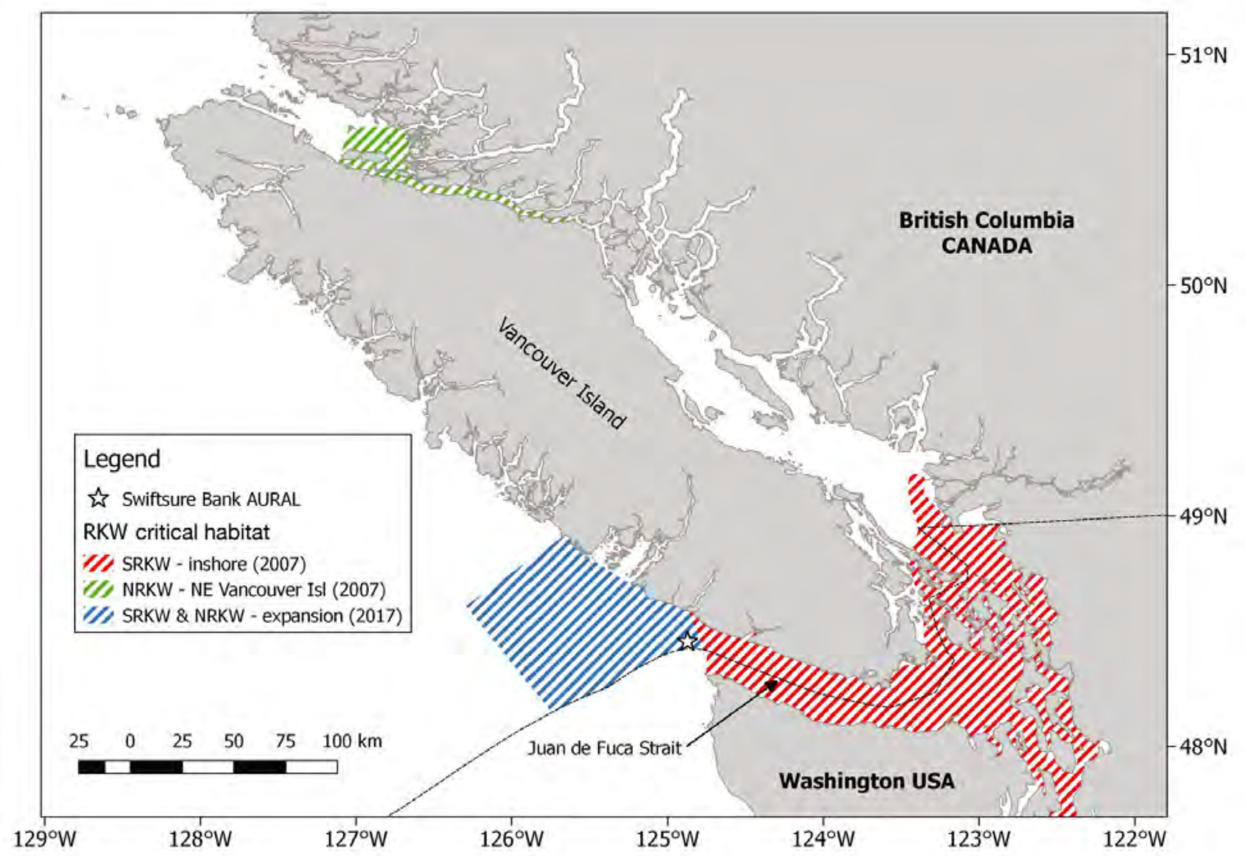

Figure 10. Swiftsure Bank study site off the coast of British Columbia, Canada in relation to the 2007 Northern Resident critical habitat (NE Vancouver Island) and 2007 Southern Resident killer whale critical habitat (inshore waters) and the 2017 Northern Resident and Southern Resident expansion of critical habitat (Riera et al. 2019).

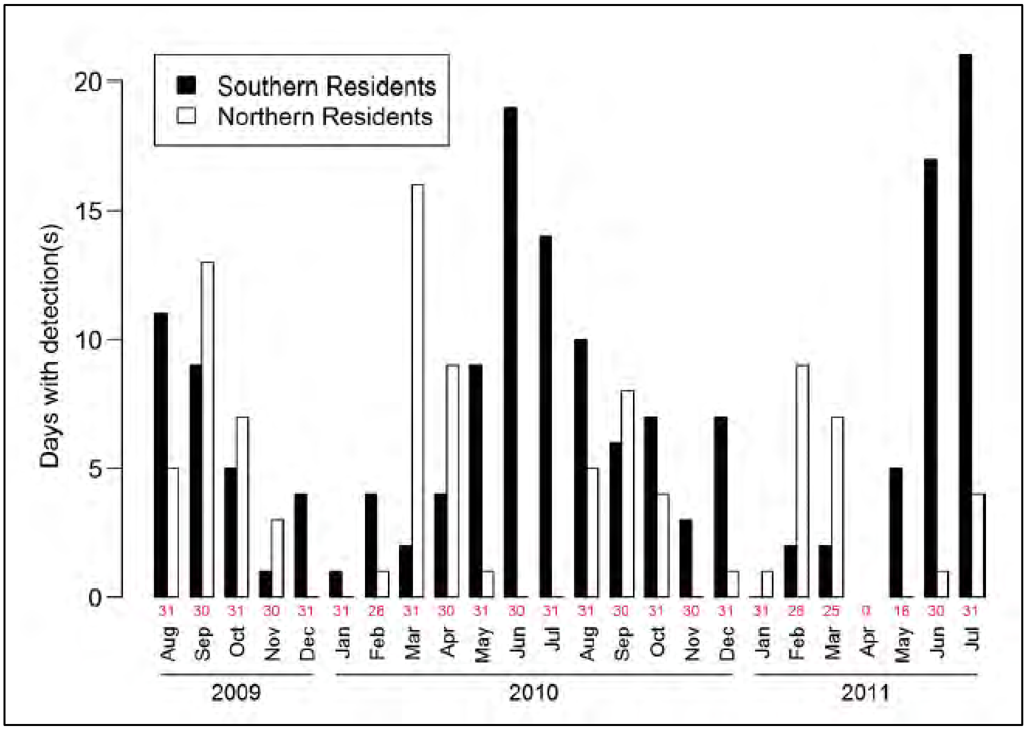

Figure 11. Number of days with acoustic detections of SRKWs at Swiftsure Bank from August 2009–July 2011. Red numbers indicate days of effort. (Riera et al. 2019).

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. SRKWs are the subject of ongoing research, the majority of which has occurred in inland waters of Washington State and British Columbia, Canada during summer months and includes direct observation, scale and tissue sampling of prey remains, and fecal sampling. The diet data suggest that SRKWs are consuming mostly larger (i.e., generally age 3 and up) Chinook salmon (Ford and Ellis 2006). Chinook salmon is their primary prey despite the much lower abundance in comparison to other salmonids in some areas and during certain time periods (Ford and Ellis 2006). Factors of potential importance include the species' large size, high fat and energy content, and year-round occurrence in the SRKW's geographic range. Chinook salmon have the highest value of total energy content compared to other salmonids because of their larger body size and higher energy density (kilocalorie/kilogram (kcal/kg)) (O'Neill et al. 2014). For example, in order for a SRKW to obtain the total energy value of one adult Chinook salmon, they would need to consume approximately 2.7 coho, 3.1 chum, 3.1 sockeye, or 6.4 pink salmon (O'Neill et al. 2014). Research suggests that SRKWs are capable of detecting, localizing, and recognizing Chinook salmon through their ability to distinguish Chinook echo structure as different from other salmon (Au et al. 2010). The degree to which killer whales are able to or willing to switch to non-preferred prey sources (i.e., prey other than Chinook salmon) is also largely unknown, and likely variable depending on the time and location.

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 northern resident killer whale populations given the northern migrations of Chinook salmon stocks in the ocean and this competition may be limiting the growth of the SRKW population.

May–September

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

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

October–December

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

January–April

Observations of SRKWs overlapping with salmon runs (Wiles 2004; Zamon et al. 2007) and collection of prey and fecal samples have also occurred in coastal waters in the winter and spring months. Although fewer predation events have been observed and fewer fecal samples collected in coastal waters, recent data indicate that salmon, and Chinook salmon in particular, remains an important dietary component when the SRKWs occur in outer coastal waters during these timeframes. Prior to 2013, only three prey samples for SRKW on the U.S. outer coast had been collected (Hanson et al. in prep). From 2013 to 2016, satellite tags were used to locate and follow the whales to obtain predation and fecal samples. A total of 55 samples were collected from northern California to northern Washington (Figure 12). Results of the 55 available prey samples indicate that, as is the case in inland waters, Chinook are the primary species detected in diet samples on the outer coast, although steelhead, chum, lingcod, and halibut were also detected in samples. Despite J pod utilizing much of the Salish Sea—including the Strait of Georgia—in winter months (Hanson et al. 2018), few diet samples have been collected in this region in winter.

The occurrence of K and L pods off the Columbia River in March suggests the importance of Columbia River spring runs of Chinook salmon in their diet (Hanson et al. 2013). Chinook genetic stock identification from samples collected in winter and spring in coastal waters from California through Washington included 12 U.S. west coast stocks, and showed that over half the Chinook salmon consumed originated in the Columbia River (Hanson et al. in prep). Columbia River, Central Valley, Puget Sound, and Fraser River Chinook salmon collectively comprised over 90 percent of the 55 diet samples collected for SRKW's in coastal areas.

As noted, most of the Chinook prey samples opportunistically collected in coastal waters were determined to have originated from the Columbia River basin, including Lower Columbia Spring, Middle Columbia Tule, and Upper Columbia Summer/Fall. In general, we would expect to find these stocks given the diet sample locations (Figure 12) However, the Chinook stocks included fish from as far north as the Taku River (Alaska and British Columbia stocks) and as far south as the Central Valley California.

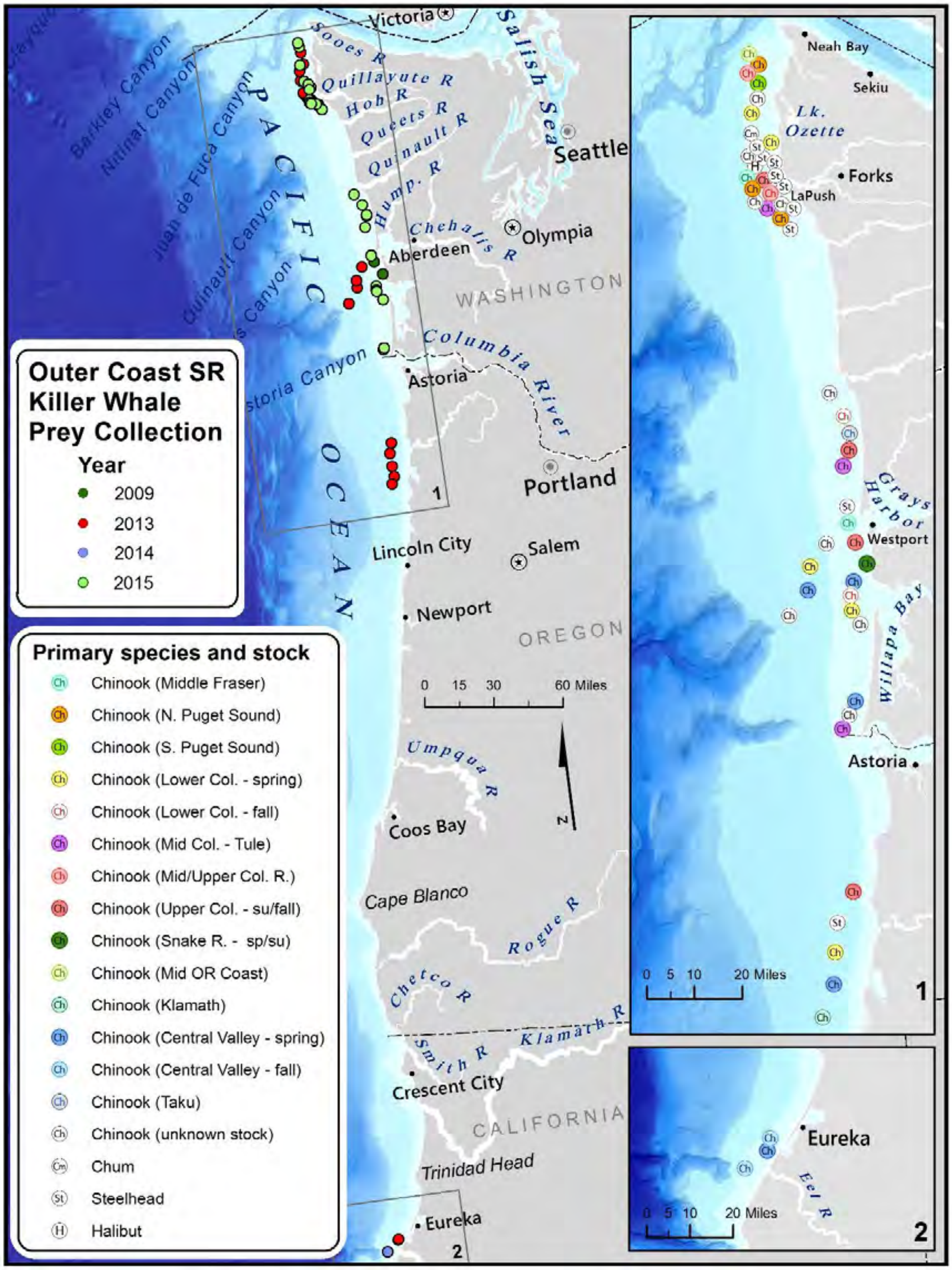

Figure 12. Location and species for scale/tissue samples collected from Southern Resident killer whale predation events in outer coastal waters (NMFS 2019b).

In an effort to prioritize recovery efforts such as habitat restoration and help inform efforts to use fish hatcheries to increase the whales' prey base, NMFS and WDFW developed a report identifying Chinook salmon stocks thought to be of high importance to SRKW along the West Coast (NOAA and WDFW 2018).[9] 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 Southeast Alaska (SEAK) to California (CA). Puget Sound Chinook salmon are considered a top priority prey stock.

Hatchery production is a significant component of the salmon prey base returning to watersheds within the range of SRKWs (Barnett-Johnson et al. 2007; NMFS 2008a). The release of hatchery fish has not been identified as a threat to the survival or persistence of SRKWs and there is no evidence to suggest the whales prefer wild salmon over hatchery salmon. Increased Chinook abundance, including hatchery fish, benefit this endangered population of whales by enhancing prey availability to SRKWs and hatchery fish often contribute significantly to the salmon stocks consumed (Hanson et al. 2010, Hanson et al. in prep). Currently, hatchery fish play a mitigation role of helping sustain Chinook salmon numbers while other, longer term, recovery actions for natural fish are underway. Although hatchery production has contributed some offset of the historical declines in the abundance of natural-origin salmon within the range of the whales, hatcheries also pose risks to natural-origin salmon populations (Nickelson et al. 1986; Ford 2002; Levin and Williams 2002; Naish et al. 2007). Healthy natural-origin salmon populations are important to the long-term maintenance of prey populations available to Southern Residents because it is uncertain whether a hatchery dominated mix of stocks is sustainable indefinitely and because hatchery fish can differ, relative to natural-origin Chinook salmon, for example, in size and hence caloric value and in availability/migration location and timing.

Nutritional Limitation and Body Condition

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

Since 2008, NOAA’s Southwest Fishery Science Center (SWFSC) have used aerial photogrammetry to assess the body condition and health of SRKWs, initially in collaboration

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

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[10]. In fall 2016 another young adult male, J34, was found dead in the northern Georgia Strait (Carretta et al. 2019). The necropsy indicated that the whale died of blunt force trauma to the head and the source of trauma is still under investigation.

Previous scientific review investigating nutritional stress as a cause of poor body condition for SRKWs concluded "Unless a large fraction of the population experienced poor condition in a particular year, and there was ancillary information suggesting a shortage of prey in that same year, malnutrition remains only one of several possible causes of poor condition" (Hilborn et al. 2012). Body condition in whales can be influenced by a number of factors, including prey availability or limitation, increased energy demands, disease, physiological or life history status, and variability over seasons or across years. Body condition data collected to date has documented declines in condition for some animals in some pods and these occurrences have been scattered across demographic and social groups (Fearnbach et al. 2018).

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

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

Toxic Chemicals

Various adverse health effects in humans, laboratory animals, and wildlife have been associated with exposures to persistent pollutants. These pollutants have the ability to cause endocrine disruption, reproductive disruption or failure, immunotoxicity, neurotoxicity, neurobehavioral disruption, and cancer (Reijnders 1986; Subramanian et al. 1987; de Swart et al. 1996; Bonefeld-Jørgensen et al. 2001; Reddy et al. 2001; Schwacke et al. 2002; Darnerud 2003; Legler and Brouwer 2003; Viberg et al. 2003; Ylitalo et al. 2005; Fonnum et al. 2006; Darnerud 2008; Legler 2008). SRKWs are exposed to a mixture of pollutants, some of which may interact synergistically and enhance toxicity, influencing their health, and reproduction. Relatively high levels of these pollutants have been measured in blubber biopsy samples from SRKWs compared to other resident killer whales in the North Pacific (Ross et al. 2000; Krahn et al. 2007; Krahn et al. 2009; Lawson et al. 2020), and more recently, these pollutants were measured in fecal samples collected from SRKWs providing another potential opportunity to evaluate exposure to these pollutants (Lundin et al. 2016a; Lundin et al. 2016b).

Southern Resident killer whales are exposed to persistent pollutants primarily through their diet. For example, Chinook salmon contain higher levels of some persistent pollutants than other salmon species, but only limited information is available for pollutant levels in Chinook salmon (Krahn et al. 2007; O'Neill and West 2009; Veldhoen et al. 2010; Mongillo et al. 2016). These harmful pollutants, through consumption of prey species that contain these pollutants, are stored in the 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 Southern Resident killer whale 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 Southern Resident killer whale 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).

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

In addition to vessels, underwater sound can be generated by a variety of other human activities, such as dredging, drilling, construction, seismic testing, and sonar (Richardson et al. 1995; Gordon and Moscrop. 1996; National Research Council 2003). Impacts from these sources can range from serious injury and mortality to changes in behavior. In other cetaceans, hormonal changes indicative of stress have been recorded in response to intense sound exposure (Romano et al. 2003). Chronic stress is known to induce harmful physiological conditions including lowered immune function, in terrestrial mammals and likely does so in cetaceans (Gordon and Moscrop. 1996).

Oil Spills

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

Repeated ingestion of petroleum hydrocarbons by killer whales likely causes adverse effects; however, long-term consequences are poorly understood. In marine mammals, acute exposure to petroleum products can cause changes in behavior and reduced activity, inflammation of the mucous membranes, lung congestion and disease, pneumonia, liver disorders, neurological damage, adrenal toxicity, reduced reproductive rates, and changes in immune function (Schwacke et al. 2013; Venn-Watson et al. 2015; de Guise et al. 2017; Kellar et al. 2017), potentially death and long-term effects on population viability (Matkin et al. 2008; Ziccardi et al. 2015). For example, 122 cetaceans stranded or were reported dead within 5 months following the Deepwater Horizon spill in the Gulf of Mexico (Ziccardi et al. 2015). An additional 785 cetaceans were found stranded from November 2010 to June 2013, which was declared an Unusual Mortality Event (Ziccardi et al. 2015). Previous polycyclic aromatic hydrocarbons (PAH) exposure estimates suggested SRKWs can be occasionally exposed to concerning levels (Lachmuth et al. 2011). More recently, Lundin et al. (2018) measured PAHs in whale fecal samples collected in inland waters of Washington between 2010 and 2013 and found low concentrations of the measured PAHs (<10 parts per billion (ppb), wet weight). However, PAHs were as high as 104 ppb in the first year of their study (2010) compared to the subsequent years. Although it is unclear the cause of this trend, higher levels were observed prior to the 2011 vessel regulations that increased the distance vessels could approach the whales. In addition, oil spills have the potential to adversely impact habitat and prey populations, and, therefore, may adversely affect SRKWs by reducing food availability.

Climate change and other ecosystem effects

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% of cetaceans would be affected by climate change, with 47% 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).

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 and Steelhead 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.[11] 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 12). These features are essential to conservation because without them the species cannot successfully spawn and produce offspring. The physical or biological features of freshwater migration corridors associated with spawning and incubation sites include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

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[11] 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).

Table 12. Primary constituent elements (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 and steelhead, determine whether those areas contained PCEs essential for the conservation of those species and whether unoccupied areas existed within the historical range of the listed salmon and steelhead that are also essential for conservation. The CHARTs assigned a 0 to 3 point score for the PCEs in each HUC_5 watershed for:

Factor 1. Quantity,
Factor 2. Quality—Current Condition,
Factor 3. Quality—Potential Condition,
Factor 4. Support of Rarity Importance,
Factor 5. Support of Abundant Populations, 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 (HCSRC). 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 Sounds. 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 13). 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 in estuarine and nearshore areas. Designated critical habitat for PS steelhead does not include nearshore areas, as this species does not make extensive use of these areas during juvenile life stage.

The following discussion is general to salmon and steelhead critical habitat in the Puget Sound basin. More specific information for each individual species' critical habitat is presented after the general discussion.

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).

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).

In summary, critical habitat for salmon and steelhead throughout the Puget Sound basin has been 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.

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 13).

Table 13. **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
Hamma Hamma River (803)	CK/CM	1/2	1/2
Lower West Hood Canal Frontal (802)	CK/CM	0/2	0/1
Skokomish River (701)	CK/CM	1/0	2/1
Duckabush River (804)	CK/CM	1	2
Upper West Hood Canal Frontal (807)	CM	1	2
Big Quilcene River (806)	CK/CM	1	1/2
Deschutes Prairie-1 (601) & Prairie-2 (602)	CK	1	1
West Kitsap (808)	CK/CM	1	1
Kitsap – Prairie-3 (902)	CK	1	1
Port Ludlow/Chimacum Creek (908)	CM	1	1
Kitsap – Puget (901)	CK	0	1
Kitsap – Puget Sound/East Passage (904)	CK	0	0
Strait of Juan de Fuca Olympic #1711002xxx			
Dungeness River (003)	CK/CM	2/1	1/2
Discovery Bay (001) & Sequim Bay (002)	CM	1	2
Elwha River (007)	CK	1	2
Port Angeles Harbor (004)	CK	1	1

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 United States 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.

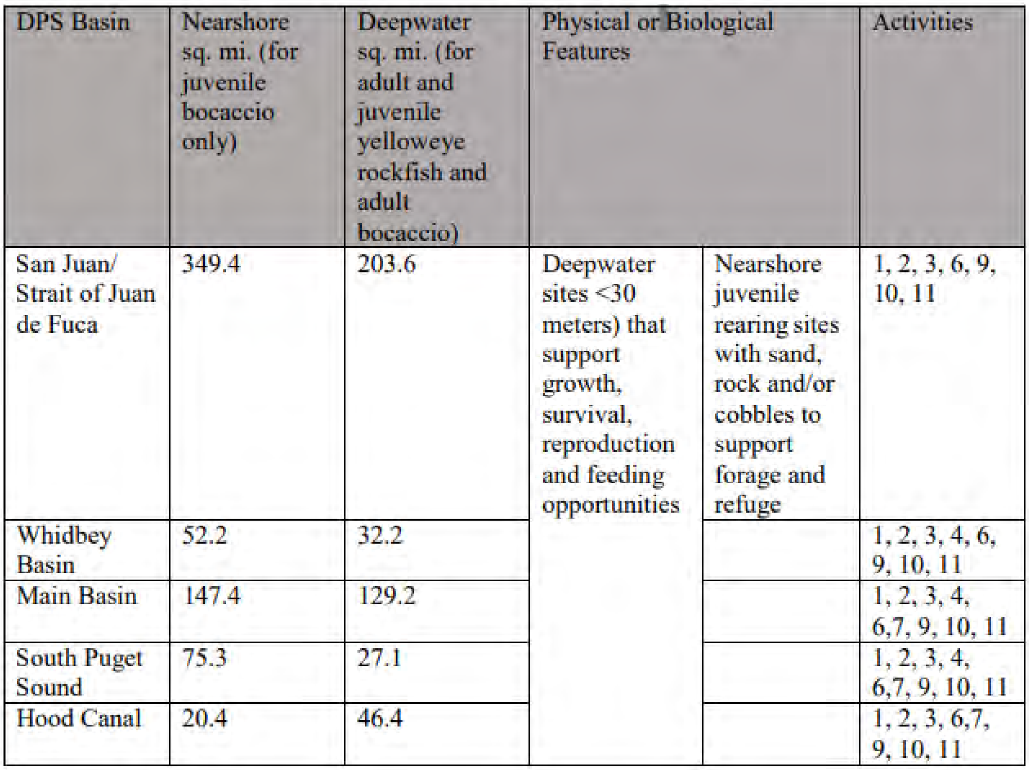
We have determined that approximately 644.7 square miles (1,669.8 sq km) of nearshore habitat for juvenile PS/GB bocaccio and 438.5 square miles (1,135.7 sq km) of deepwater habitat for PS/GB yelloweye rockfish and PS/GB bocaccio meet the definition of critical habitat.Critical habitat for adult PS/GB 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 supports 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). 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 13. Image of a table indicating 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 Southern Resident killer whale 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 September 19, 2019, NMFS proposed to revise the critical habitat designation for the SRKW DPS under the ESA by designating six new areas along the U.S. West Coast (84 FR 49214). Specific new areas proposed along the U.S. West Coast include 15,626.6 square miles (mi^2) (40,472.7 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 proposed rule (84 FR 49214), NMFS states that the "proposed 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 – 2017 (WDOE 2017).

Prey Quantity, Quality, and Availability

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.

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

Passage

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

Nearshore habitat in Hood Canal, a historically fragile area, 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 Hood Canal nearshore (Garono et al. 2002). Daubenberger et al. 2017 document that Port Gamble Bay, Port Ludlow, and Kilisut Harbor are relatively shallow and enclosed, within the greater Hood Canal system. These shallow areas permit for 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 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).

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.

Recent studies have estimated the loss of nearshore habitat in Puget Sound at close to 85 percent or more (Brophy et al. 2019). 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. 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. An analyses conducted in 2011 though the Puget Sound Nearshore Ecosystem Restoration Project (Fresh et al, 2011; Simenstad et al 2011) found that since 1850, of the approximately 2,470 miles of Puget Sound shoreline:

- Shoreline armoring has been installed on 27 percent of Puget Sound shores (Table 14).
- 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 15).
- There has been a 93 percent loss of freshwater tidal and brackish marshes. The Duwamish and Puyallup rivers have lost nearly all of this type of habitat.
- A net decline in shoreline length of 15 percent as the naturally convoluted and complex shorelines were straightened and simplified. This represents a loss of 1,062 km or 660 miles of overall shoreline length.
- Elimination of small coastal embayments has led to a decline of 46 percent in shoreline length in these areas.
- A 27 percent decline in shoreline length in the deltas of the 16 largest rivers and a 56 percent loss of tidal wetlands in the deltas of these rivers.

Table 14. Total area of over water structures by sub-basin observed in aerial photo review between 2013 and 2016 (Beechie et al. 2017).

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

The distribution and sizes of over water structures (OWS) in the nearshore[12] are detailed further in Schlenger et al. (2011) and (Simenstad et al. 2011).

Table 15. 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. 2003; Duffy and Beauchamp 2011). 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). Smolt-to-adult survival rates for hatchery-reared sub-yearling Chinook Salmon within Puget Sound have averaged less than 1% over the past three decades (Kilduff et al. 2014).

There is also evidence that loss of nearshore habitat quality may be eliminating PS Chinook salmon life history strategies that make use of nearshore areas during the early life stages. Campbell et al. (2017) found < 3 % of adults returning to the Green and Puyallup to exhibit the

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

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 ~ 50 % of the estuary remained in a natural state (Beechie et al. 2017) and 36 and 24 % 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 the 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.[13] 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)[14] have been reached (Puget Sound Partnership 2018). 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.

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[13] Shoreline Permitting Through TACT (Spring 2015) (TACT is an acronym for: Trouble-Shooting, Action Planning, Course Correction, and Tracking and Monitoring).

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

- Shoreline armoring: Stable between 2011 and 2014. No recent net increase, restoration actions balance out increase from private shoreline armoring. However, this could be related to poor economic conditions. More years of data are needed to determine trend.
- 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.
- 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[15] 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, in the Puget Sound nearshore.

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[15] 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.

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 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.

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 to 2014, maintenance dredging resulted in at least 25 million cubic yards of sediment removed from nearshore environments and disposed in multi-user disposal by Puget Sound harbors and waterways by various dredgers (Table 16). These included private developers and public entities (e.g., federal and state agencies, ports, and local governments) responsible for funding and undertaking dredging projects.

Table 16. Multiuser Disposal Site Volumes by Year (in cubic yards)

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

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 October 21, 2020.

These dredging activities are generally limited to the nearshore environments. Regular dredging maintenance result in periodic short-term water quality degradation suspending sediments above background levels and and re-suspended contaminants. This also results in periodic removal of sediment that support invertebrate prey and forage species for salmon and rockfish (Jones and Stokes 1998, McCabe et al 1998). Usually, a dredged area recolonizes within a maximum of 2 years (Boese et al 2009, Dethier and Schoch 2005). Maintenance dredging increases depth and maintains increased depth. This results in a reduction of shallow habitat and obstruction of the migratory corridor for rearing and migrating juvenile salmonids.

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 that for SRKW, vessel disturbance imposes an energetic cost on surface active behaviors and vocal effort (Williams et al. 2006; Noren et al. 2012; Noren et al. 2013; Holt et al. 2015). For example, Williams et al. (2006) estimated that changes in activity budgets in Northern Resident killer whales in inland waters in the presence of vessels result in an approximate 3% increase in energy expenditure compared to when vessels are not present. However, this increased energy expenditure may be less important than the reduced time spent feeding and the resulting potential reduction in prey consumption (Ferrara et al. 2017). Southern Resident killer whales spent 17 to 21% 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., 2015, 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 general 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 in inland waters and were responsible for 13% of the incidents inconsistent with the Be Whale Wise Guidelines and non-compliant with federal regulations in 2019 (Shedd 2019). 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 300-400 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 and 2019 due to decreased viewing effort on SRKWs by commercial whale watching vessels, with an average of 10 and 9 vessels with the whales at any given time, respectively (Shedd 2020).

Stormwater

Mackenzie et al. 2017 found that stormwater is the most important pathway to Puget Sound for most toxic contaminants, transporting more than half of the Sound's total known toxic load (Ecology & King County 2011). During a robust Puget Sound monitoring study, toxic chemicals were detected more frequently and at higher concentrations during storm events compared with baseflow for diverse land covers, pointing to stormwater pollution (Ecology 2011). The Puget Sound basin has over 4,500 unnatural surface water and stormwater outfalls, 2,121 of which discharge directly into the Sound (WDNR 2015).

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

- 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 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 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.* 2006).

When considered at the landscape scale, the baseline condition of Puget Sound nearshore habitat is a degraded state overall, with reduced water quality, reduced forage and prey availability, reduced quality of forage and prey communities, reduced amount of estuarine habitat, reduced quality of nearshore and estuarine habitat, and reduced condition of migration habitat due to structures noise and vessel perturbations. Each of these conditions of the baseline exerts downward pressure on all cohorts of all populations of each 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 its potential for serving recovery of these species. Overall, the nearshore is impacted in many areas by the degradation from coastal development and pollution. The status of deep water habitat is impacted by remaining derelict fishing gear and degraded water quality among other factors. The input of pollutants affects water quality, sediment quality, and food resources in the nearshore and deep-water areas of critical habitat.

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

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

The environmental baseline would also include the projected effects of climate change for the time period commensurate with the effects of the proposed actions. 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). Using the criteria of Morrison et al. (2015) for scoring, PS Chinook salmon, HC 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).

Fisheries

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 South East Alaska (SEAK), those off the coast of British Columbia, the Washington and Oregon coasts, and the Columbia River. Canadian and SEAK salmon fisheries impact salmon stocks from the states of Washington, Oregon, and Idaho as well as salmon originating in SEAK and Canadian waters. Fisheries off the coast of Washington and Oregon and in inland waters, such as the Puget Sound, harvest salmon originating in U.S. West Coast and Canadian river systems. The PST provides a framework for the management of salmon fisheries in these U.S. and Canada waters that fall within the PST's geographical scope. The overall purpose of the fishing regimens, is to accomplish the conservation, production, and harvest allocation objectives set forth in the PST (https://www.psc.org/publications/pacific-salmon-treaty/). The PST provides for the U.S. and Canada to each manage their own fisheries to achieve domestic conservation and allocation priorities, while remaining within the overall limits agreed to under the PST. 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 populations are agreed by the State and tribes, in coordination with NMFS. In recent years, NMFS has consulted with the BIA 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 and SRKW. The most recent opinion was issued in May 2020 concluded the fisheries were not likely to jeopardize Puget Sound Chinook or SRKW, and not likely to adversely modify their critical habitat.

The new PST Agreement includes reductions in harvest impacts for all Chinook fisheries within its scope and refines the management of 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. The level of reduction depends on the Chinook abundance in a particular year. This comes on top of the reductions of 15 and 30 percent for those same fisheries that occurred as a result of the prior 10-year agreement (2009 through 2018). Harvest rates on Chinook salmon stocks caught in southern British Columbia and U.S. salmon fisheries, including those under the jurisdiction of the PFMC are reduced by up to 15% from the previous agreement (2009 through 2018). Beginning in January 2020 this will result in an increased proportion of abundances of Chinook salmon migrating to waters more southerly. 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 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. The beneficial effects of these activities (i.e., increases in the abundance of Chinook salmon available as prey to SRKW, hatchery conservation programs to support critical Puget Sound Chinook populations, and improved habitat conditions for those populations) are expected to begin in the next 3-5 years. Subsequent specific actions (i.e., hatchery production programs) will 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.

Hatcheries

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

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

(7) fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds.

Beginning in the 1990s, state and tribal co-managers took steps to reduce risks identified for Puget Sound hatchery programs as better information about their effects became available (PSIT and WDFW 2004), in response to reviews of hatchery programs (e.g., Busack and Currens (1995), HSRG (2000), 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 reforms proposed are to ensure that existing natural salmonid populations are preserved, and that hatchery-induced genetic and ecological effects on natural populations are minimized.

About one-third 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 41 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 re-introduction programs are in operation for early Chinook in the South Fork Nooksack River, fall Chinook in the South Fork Stillaguamish River (Tynan 2010) and spring and late-fall Chinook in the Skokomish River (Redhorse 2014; Speaks 2017).

Conservation hatchery programs, under the PST critical stock program, are currently operating in the Nooksack, Dungeness, and Stillaguamish rivers. A new program is being developed for Mid-

Hood Canal. A programmatic consultation on the PST funding initiative was included in the consultation on SEAK fisheries (NMFS 2019d) and the 2020 funding already appropriated 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 2016c; 2019e). Review of the Nooksack program and development of the Mid-Hood Canal program is currently ongoing. The latter two programs will be subject to further consultation once the site specific details are fully described. Modifications to the Dungeness and Stillaguamish programs could trigger reinitiation of those site specific consultations. Consistent with the programmatic consultation on the PST funding initiative, the likely effects of these programs are described in general terms here.

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, there are new initiatives to increase hatchery production to further enhance the SRKW's prey base. As described above and in the 2019 biological Opinion on domestic actions associated with implementation of the new PST agreement (NMFS 2019f), additional hatchery production of Chinook funded through the PST funding initiative is expected to result in increased available prey throughout the SRKW's geographic range. The increases in the abundance of Chinook salmon available as prey to SRKW as a result from the funded hatchery production are expected to occur in the next 3–5 years as adult Chinook return to the action area As site-specific actions under the PST funding initiative are identified, the effects will be analyzed through subsequent section 7 consultations, unless the activities and effects have already been analyzed through an existing consultation.

In the programmatic assessment of the PST funding initiative NMFS (2019d), 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 et al. 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. We estimated accomplishing this would require the release of 20 million smolts from hatcheries located in Puget Sound, the Columbia River, and coastal Washington areas.

2.3.2 Distinguishing Baseline from Effects of the Action

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 extends the life of the part of the structure being repaired or replaced. The impacts 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. Further, to facilitate the existence of a permitted and structurally intact structure into perpetuity, regular maintenance will be necessary. 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 39 permits that form the basis of this consultation. *See* Appendix 1 at 3 (explaining that if the applicants request the Corps 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”).

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. Limiting NMFS’s analysis of the impacts of a structure to incremental periods, helps solve a practical problem too: NMFS cannot reasonably predict all future effects of a structure in perpetuity but it can predict effects during the useful life of a structure as described next.

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 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. Here, 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 the 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 actions generally result in some reduction of impacts during the remaining useful life that would not occur but for the proposed actions. 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 impacts, such as construction related activities, that are a direct result 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 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 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), also see Appendix 5) 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 more below in Section 2.4. Also, more detailed information on this particular credit as it applies to each proposed project is found in the attachments designated by USACE identification number at the end of this Opinion.

During the preparation of this Opinion, the USACE and some applicants have asserted that NMFS should also consider potential effects associated with the 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 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- and/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 useable 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 that overtime 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 (and at the very least state and 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 39 nine 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, NMFS has assumed that is reasonably likely that regular maintenance will occur before complete degradation. Moreover, granting the requested permits is within the Corps’ discretionary authority (Appendix 1) and therefore the consequences of the issuance of these permits—namely, impacts associated with a prolonged life of structures in a usable state 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, 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 actions 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 39 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). Figure 14 and 15 illustrate this approach and also depict 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 5 further describes how the model calculates the effects of the action in light of the environmental baseline). Table 17 summarizes the quantitative, project-specific credits and any debits the model generated for the projects as currently proposed.

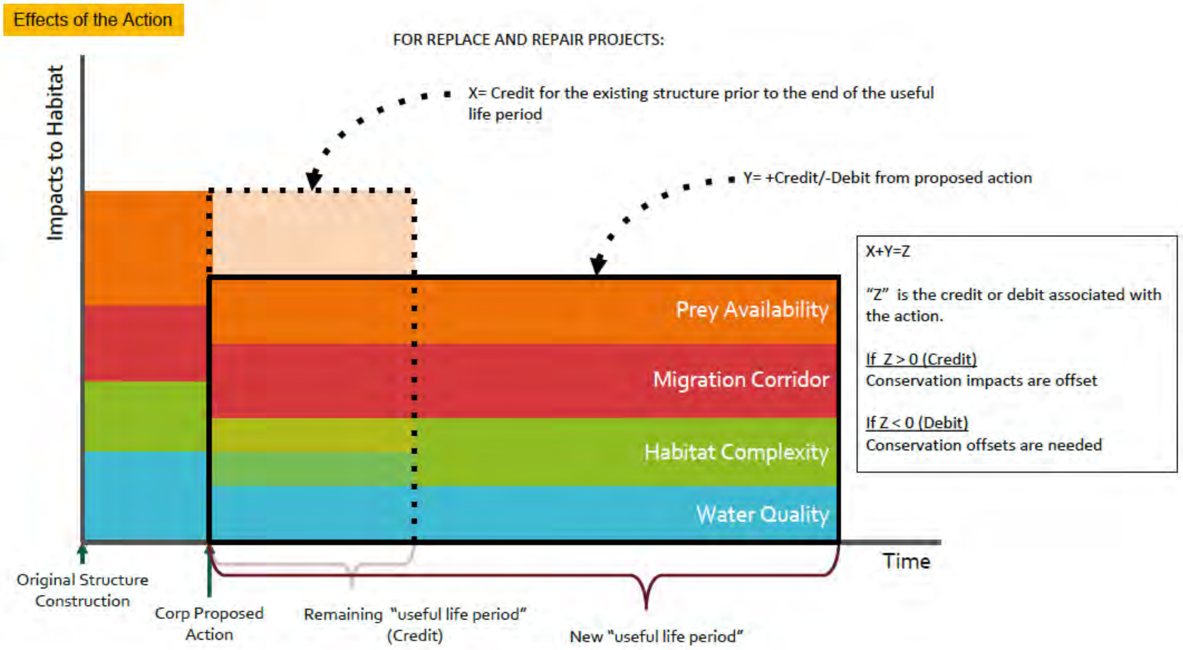
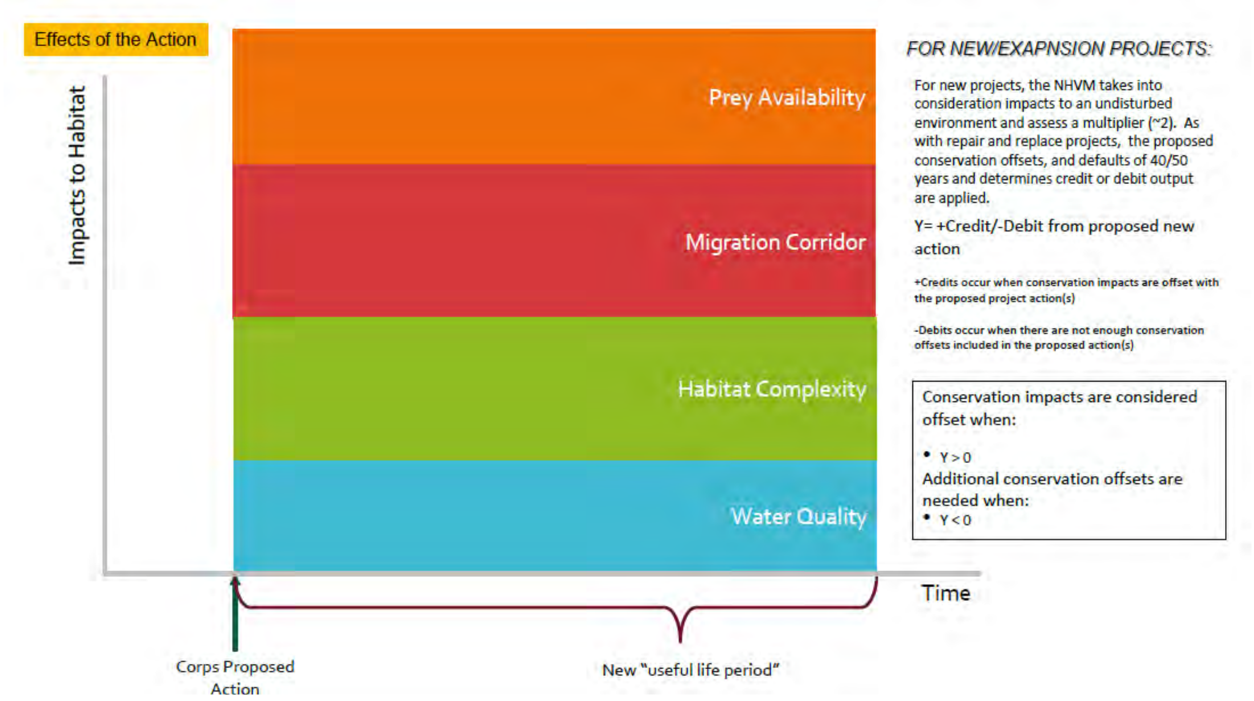


Figure 14 Effects of the Action: Illustration depicts “credit” for early removal of and existing structure plus effects of a proposed replacement structure. Note the scale of time for original structure is condensed for the sake of readability.



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

Figure 15. Effects of the Action: Illustration depicts debits for a new or expanded component of a nearshore structure.

Table 17. 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 Oct 23, 2020, for each project.

NWS#	Proposed Conservation Credits (10-yr 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-2017-796	831.2	-252.1
NWS-2017-587	103.3	-131.6
NWS-2018-963	103.6	23.2
NWS-2018-229	91.6	1.8
NWS-2018-465	64.1	-82.3
NWS-2018-53	140.4	-352.3
NWS-2018-636	62.7	-20.8
NWS-2017-955	107.9	-101.8
NWS-2018-760	16.9	-54.4
NWS-2017-840	54.5	-87.1
NWS-2018-981	84.8	-1.9
NWS-2018-1143	79.6	3
NWS-2018-570	724.3	-329.2
NSW-2018-1165	30	16.4
NWS-2017-573	45.8	-1045.2
NWS-2018-382	91.8	-39.6
NWS-2019-207	211.7	-80.7
NWS-2019-552	2	-374.8
NWS-2019-676	3.5	0
NWS-2019-526	169.3	15.5
NWS-2018-750	559.9	-146.2
NWS-2018-39	13.4	-28.3
NWS-2019-491	0	-260.7
NWS-2019-664	51.6	-550.1
NWS-2019-336	634.7	-530.5
NWS-2018-525	271.5	-202.3
NWS-2018-492	2351.1	-2043.14
NWS-2019-478	0	-9.3
NWS-2019-956	154.6	-212.05
NWS-2019-0883	39.5	14.3
NWS-2019-728	14.6	7.8
NWS-2019-690	62.8	-37.7

NWS#	**Proposed Conservation Credits (10-yr 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-2019-0703	4017.6	957.4
NWS-2020-0204	0	-1185.6
NWS-2017-550	557.1	440.2
NWS-2019-101	319.1	208.8
NWS-2019-832	65.3	30
NWS-2017-427	0.1	-2.1
NWS-2019-983	152	78.6
Total	12283.9	-6364.79

All of the proposed actions have similar project 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 18 summarizes respective project components.

Table 18. The components of the proposed actions that were relevant to the effects analysis by USACE project.

Project totals:	**22**	**22**	**2**	**6**	**2**	**26**	**16**	**2**
	Components of the proposed actions relative to the effect analysis							
NWS #	**Installed Piling**	**Removed Piling**	**Installed Mooring Buoy(s)**	**Boat Ramp Installed**	**Dredging**	**OWS, New/ Removed & Replaced/Installed**	**Bulkhead New Removed/ Replaced**	**Stormwater outfall or conveyance**
NWS-2017-796	x	x	x			x		
NWS-2017-587							x	
NWS-2018-963	x	x			x	x		
NWS-2018-229							x	
NWS-2018-465							x	
NWS-2018-53							x	
NWS-2018-636	x	x				x		
NWS-2017-955		x				x	x	
NWS-2018-760	x	x				x		
NWS-2017-840							x	
NWS-2018-981	x	x				x		
NWS-2018-1143							x	
NWS-2018-570	x	x				x	x	
NSW-2018-1165	x	x				x		
NWS-2017-573	x			x		x		
NWS-2018-382							x	
NWS-2019-207						x		
NWS-2019-552	x						x	
NWS-2019-676		x				x		
NWS-2019-526	x	x				x		
NWS-2018-750	x	x				x		
NWS-2018-39				x		x		
NWS-2019-491				x		x		
NWS-2019-664							x	
NWS-2019-336	x	x				x		
NWS-2018-525	x	x				x		
NWS-2018-492	x	x					x	x

Project totals:	**22**	**22**	**2**	**6**	**2**	**26**	**16**	**2**
	Components of the proposed actions relative to the effect analysis							
NWS #	**Installed Piling**	**Removed Piling**	**Installed Mooring Buoy(s)**	**Boat Ramp Installed**	**Dredging**	**OWS, New/ Removed & Replaced/Installed**	**Bulkhead New Removed/ Replaced**	**Stormwater outfall or conveyance**
NWS-2019-478					x			
NWS-2019-956							x	
NWS-2019-0883	x	x				x		
NWS-2019-728							x	
NWS-2019-690	x	x		x		x	x	
NWS-2019-0703	x	x				x		
NWS-2020-0204	x					x	x	
NWS-2017-550	x	x				x		
NWS-2019-101	x	x				x		
NWS-2019-832	x	x		x		x		
NWS-2017-427	x	x	x			x		
NWS-2019-983		x		x		x		x

The effects analyses in this section will include both an overarching description of effects caused by the construction and presence of over- and in-water structures as well as a specific analyses of the effects we expect as a result of each proposed project. Table 19 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 19. Summary of effect by USACE project.

Project Totals	**34**	**32**	**26**	**4**	**8**	**5**	**18**	**15**	**18**
	Effects/Disruptions to listed species and critcal habitat								
NWS#	**Noise (Pile Driving, construction vessel noise)**	**Water Quality (Suspended Sediments & Contaminant, Stormwater, Vessel Discharge)**	**Nearshore migration corridors (OWS)**	**Feeder Bluff**	**Estuary**	**Pocket Estuary**	**Forage Fish Spawning**	**Submerged Aquatic Vegetation (SAV)**	**Drift Cell**
NWS-2017-796	x	x	x						x
NWS-2017-587		x				x	x	x	
NWS-2018-963	x		x			x		x	
NWS-2018-229	x	x					x		x
NWS-2018-465	x	x							x
NWS-2018-53	x				x		x		x
NWS-2018-636	x	x	x					x	
NWS-2017-955	x	x	x						x
NWS-2018-760	x	x	x		x				
NWS-2017-840	x	x				x			x
NWS-2018-981	x	x	x						
NWS-2018-1143	x	x							
NWS-2018-570	x	x	x						x
NSW-2018-1165	x	x	x		x				
NWS-2017-573	x	x	x			x	x	x	x
NWS-2018-382	x	x							
NWS-2019-207	x		x			x	x	x	
NWS-2019-552	x	x	x				x		x
NWS-2019-676	x	x	x						x
NWS-2019-526	x	x	x				x	x	
NWS-2018-750	x	x	x					x	
NWS-2018-39			x				x	x	x

Project Totals	**34**	**32**	**26**	**4**	**8**	**5**	**18**	**15**	**18**
	Effects/Disruptions to listed species and critcal habitat								
NWS#	**Noise (Pile Driving, construction vessel noise)**	**Water Quality (Suspended Sediments & Contaminant, Stormwater, Vessel Discharge)**	**Nearshore migration corridors (OWS)**	**Feeder Bluff**	**Estuary**	**Pocket Estuary**	**Forage Fish Spawning**	**Submerged Aquatic Vegetation (SAV)**	**Drift Cell**
NWS-2019-491		x	x		x				x
NWS-2019-664				x					x
NWS-2019-336	x	x	x		x		x		
NWS-2018-525	x	x	x				x		
NWS-2018-492	x	x	x						
NWS-2019-478	x							x	
NWS-2019-956	x	x		x			x		x
NWS-2019-0883	x	x	x		x				
NWS-2019-728	x	x		x			x	x	x
NWS-2019-690		x	x		x				
NWS-2019-0703	x	x	x					x	
NWS-2020-0204	x	x	x				x	x	x
NWS-2017-550	x	x	x				x	x	
NWS-2019-101	x	x	x				x	x	
NWS-2019-832	x	x	x				x		
NWS-2017-427	x						x		x
NWS-2019-983	x	x		x	x		x	x	x

In addition to the positive effects accounted for as credits in Table 17, this effects section also takes into account beneficial effects that will occur as a result of the removal of creosote pilings. A total of 25 proposed projects will remove 3,693 tons of creosote (Table 20). While the short-term effects of removing creosote is adverse (resuspension of containments), the removal will result in improved benthic conditions in the long run and is discussed further below.

Table 20. USACE projects that propose to remove creosote piles and number of creosote piles removed.

Total	**3693**
NWS#	**Estimated Tons of Creosote Removed**
NWS-2017-796	148
NWS-2018-963	11
NWS-2018-229	1
NWS-2018-636	15
NWS-2017-955	1
NWS-2018-760	1
NWS-2018-981	22
NWS-2018-570	179
NWS-2018-1165	10
NWS-2018-382	18
NWS-2019-207	20
NWS-2019-676	1
NWS-2019-526	22
NWS-2018-750	120
NWS-2019-336	196
NWS-2018-525	13
NWS-2018-492	198
NWS-2019-956	15
NSW-2019-0883	11
NWS-2019-690	4
NWS-2019-0703	2232
NWS-2017-550	272
NWS-2019-101	167
NWS-2019-832	12
NWS-2019-983	5

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 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 and dredging projects. 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-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. 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 were contaminants are present increase contaminant concentrations by re-suspending particulates, thereby allowing more contaminants to advect into the water column. Consequently, in these cases elevated water column contaminant concentration occur in the vicinity of the (upstream and downstream or upstream from) dredging, depending on the tidal stage during the dredging activity. For dredging activities that occur estuary environments, Washington state water quality regulations (WAC173-201A-400) establish a 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. For dredging activities it is expected that during the days that dredging occurs, elevated suspended sediment levels within this area.

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 dredging 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 could have contemporaneous reduction in dissolved oxygen within the same affected area.

For non-dredging activities, as with suspended sediments, reduced DO is not expected to exceed the 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 dredging activities, as with suspended sediments, reduced DO is not expected to exceed 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.

Re-suspended Contaminants

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 some of the projects, removal of creosote timber piles will reduce leaching of chemical compounds into nearshore and marine sediments, which can cause toxic conditions for organisms that use these areas (DNR 2014).

Barges and tugs will be used to construct many of the projects as well as some work associated with the 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 are likely to have 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 hydrocarbans (PAHs)[16] 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.

For non-dredging activities, as with suspended sediments, re-suspended contaminants are not expected to be detectable beyond background levels beyond the establish a mixing zone of 200 feet plus the depth of water over the discharge port(s) as measured during mean lower low water.

Often, dredge sites in the Puget Sound occur in highly industrialized environments that have known hazardous substances in and near the dredge sites. Contaminants in sediments and dissolved in water can have varying levels of toxicity, most often occurring as sub-lethal effects. Some of these chemicals of concern 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. For dredging activities, as with suspended sediments, re-suspended contaminants are not expected to be detectable beyond 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.

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[16] 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.

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.

Pile Driving. Pile driving can cause high levels of underwater sound; the use of a confined or unconfined bubble curtain results in only a 10dB reduction. 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. 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.

Twenty of the proposed projects include pile driving activities (Table 21). Some projects proposed multiple pile types and diameter sizes, and proposed either vibratory of impacts 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 22 provides the assumptions used in the practical spreading model for each project.

Table 21. 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	Pile Installation Method	Bubble Curtain proposed	Maximum Pilings/Day	Maximum (Impact) Strikes/Pile	Maximum Pile (Impact) Strikes/Day	Minutes/Pile (Vibratory)	Minutes/Day (Vibratory)
NWS-2017-796	83	Steel	14	Impact	No	6	500	3000	0	0
NWS-2018-963	14	Steel	10	Vibratory	No	14	0	0	20	280
NWS-2018-636	15	Steel	12	Vibratory	No	7	0	0	20	140
NWS-2018-760	4	Steel	24	Vibratory	No	4	0	0	20	80
NSW-2018-981	27	Steel	12	Impact and Vibratory Combo	No	8	500	4000	20	160
NWS-2018-570	54	Steel	16	Vibratory	No	8	0	0	20	160
NWS-2017-573	52	Steel	12	Impact and Vibratory Combo	Yes	4	100	400	14	160
NWS-2019-552	29	Steel sheet pile (3.2 sf footprint)	NA	Vibratory	No	5	0	0	20	100
NWS-2019-526	12	Steel	12	Vibratory	No	8	0	0	20	160
NWS-2018-750	90	Steel	12	Vibratory	No	2	0	0	20	160
NWS-2019-336	248	Steel	30	Vibratory	No	8	0	0	20	160
NWS-2018-525	13	Steel	14	Vibratory	Yes	8	0	0	20	160
NWS-2018-492	188	Steel sheet pile (850 lf); steel pipe pile	30	Vibratory for steel sheet pile and impact for steel piles	Yes	5	4500	22500	20	100
NWS-2019-0883	23	Steel	14	Vibratory, impact if necessary	Yes	4	25	100	10	40

NWS#	Total Piles	Pile Type	Largest Pile Diameter	Pile Installation Method	Bubble Curtain proposed	Maximum Pilings/Day	Maximum (Impact) Strikes/Pile	Maximum Pile (Impact) Strikes/Day	Minutes/Pile (Vibratory)	Minutes/Day (Vibratory)
NWS-2019-0703	295	Steel	36	Vibratory with impact proofing	No	9	1200	10800	45	405
NWS-2017-550	200	Steel	12	Vibratory with impact proofing	Yes (or wood/Micarta block)	7	35	245	20	140
NWS-2019-101	127	ACZA	16	Vibratory with impact proofing	No	8	500	4000	10	80
NWS-2019-832	8	Steel	8	Vibratory	Yes	8			20	160
NWS-2019-690	4	Steel	6	Hand Dug	No	6	NA	NA	NA	NA
NWS-2017-427	1	Steel	36	Impact and Vibratory Combo	Yes	1	600	600	20	20

Given the assumptions above, underwater sound from the piles driving could exceed behavioral and injury thresholds. Table 22 details this for each project that will pile drive for each sound threshold.

Table 22. Fish and marine mammal behavioral responses to proposed pile driving.

NWS#	Pile Driving Response: Behavioral for fish (150dBRMS) (meters)	Pile Driving Response: Injury Fish ≥ 2g (187dBcumSEL) (meters)	Pile Driving Response: Injury Fish < 2g (183dBcumSEL) (meters)	Vibratory Pile Driving Response: Behavioral for SRKW and (120dBRMS) (km)	Impact Pile Driving Response: Behavioral for SRKW and (160dBRMS) (meters)	Vibratory Pile Driving Injury for mid-frequency SRKW (198cumSEL) (meters)	Impact Pile Driving Injury for mid-frequency SRKW (185cumSEL) (meters)
NWS-2017-796	1848	283	398	NA	398	NA	18.6
NWS-2018-963	NA	NA	NA	1.8	NA	0.7	NA
NWS-2018-636	NA	NA	NA	2.2	NA	0.4	NA
NWS-2018-760	NA	NA	NA	4.6	NA	0.6	NA
NWS-2018-981	631	117	136	2.2	136	0.5	7.7
NWS-2018-570	NA	NA	NA	2.2	NA	0.5	NA
NWS-2017-573	136	16	29	2.2	29	0.5	0.4
NWS-2019-552	NA	NA	NA	10	NA	1.6	NA
NWS-2019-526	NA	NA	NA	2.2	NA	0.5	NA
NWS-2018-750	NA	NA	NA	2.2	NA	0.5	NA
NWS-2019-336	NA	NA	NA	10	NA	2.2	NA
NWS-2018-525	NA	NA	NA	2.2	NA	0.5	NA
NWS-2018-492	1000	136	136	10	22	1.6	178.6
NWS-2019-0883	398	6	12	2.2	1000	0.2	0.4
NWS-2019-0703	4642	1000	1000	21.5	46	8.6	109.5
NWS-2017-550	136	6	11	2.2	5	0.4	0.4
NWS-2019-101	215	40	46	3.4	7	0.5	2.6
NWS-2019-832	NA	NA	NA	2.2	NA	0.5	NA
NWS-2017-427	1585	83	153	21.5	341	1.2	5.4

Construction vessels. Barges and tugs will be used to construct many of the proposed projects and are 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 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 for salmon, 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 total number of salmon steelhead or rockfish entrained is expected to be low.

2.4.2 Intermittent Effects From Use and Maintenance

The 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 39 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, co-extensive 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 repairs 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 causes reduction in water quality stemming from vessels and/or unmanaged stormwater from upland areas as follows. A single proposed project would use ACZA-treated wood piles. These piles contribute small amounts of PAHs and metals to the surrounding waters throughout the life of the structure. The water quality impacts, caused by migration of wood preservatives, are a subset of those described, below, for stormwater. 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 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 pollutant due to hydromodification.

(Buckler and Granato 1999; Colman et al. 2001; Driscoll et al. 1990; Kayhanian et al. 2003; Van Metre et al. 2005). Those 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 from new or replacement impervious surface or replacement of stormwater outfalls. Effects caused by these projects are considered intermittent as stormwater runs 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 is 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 matters from runoff. Lead may occur either as sorbed 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.

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 Boat and Ship Operation

During consultation, NMFS identified boat use associated with 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 boat use will occur in association with new structures of these types.

Similar to what is described in the section on boat noise from construction vessels, above, underwater sound from boat motors 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 (minutes) 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 actions, 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 also experience repeated disruption of benthic prey communities, suppressing this forage source. Consistent with our analytical approach in this Opinion, these impacts are considered co-extensive 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

Most of the projects included in the proposed action install, expand, repair and replace over-or in water or nearshore structures (Table 18 and Table 23).

Table 23. Summary of Installed and replaced in- and overwater and nearshore structures resulting from the proposed action.

	Enduring Effects - Totals		
	# of projects	Installed (new)/Replaced	New "Useful life Period"
Bulkhead (Linear Feet)	16	3,125	50 Years
Overwater Structure (Square Feet)	24	215,182	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. (2006) researched the effects of grating in residential floats on eelgrass. They reported a statistically significant decline in eelgrass shoot density underneath six of the 11 studied floats in northern Puget Sound. We could not find studies examining the effect of OWS on SAV other than eelgrass and kelp (Mumford 2007). 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). 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 migrate along shallow nearshore habitats, and OWS's will disrupt their migration and increase their predation risk. Every juvenile Chinook and juvenile HCSR chum will encounter 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, adult and juvenile steelhead, and adult chum, 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). 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 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 (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 salmon 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).

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 mortality. Steelhead are not nearshore dependent and thus the presence of these structures is unlikely to affect their behavior.

Disrupted Shore Processes

A total of 16 projects will result in a new 50-year useful life for ~3,125 linear feet of bulkhead (Table 18 and Table 23) throughout Puget Sound. The effects that these structures exert on habitat features and functions also will persist for the same duration. The impacts of hard armor along shorelines are well documented.[17] Armoring of the nearshore can reduce or eliminate shallow water habitats through the disruption of sediment sources and sediment transport. Bulkheads, whether new, repaired, or replacement are expected to result in a higher rate of beach erosion water ward 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

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[17] Marine Shoreline Design Guidelines at 2-1.

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).

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. 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 (Rice 2006; Parks et al. 2013), which are both important prey species of PS Chinook salmon. 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). This would be expected to cause a reduction in potential spawning habitat (i.e., eelgrass) for Pacific herring, another forage species of Chinook salmon. A total of 18 projects (Table 19) are expected impact forage fish spawning areas.

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). 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. 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. This energy can lower the beach, make it steeper, and wash away fine sediments. Dikes and fill reduce estuarine wetlands and other habitat for salmon, forage fish, and eelgrass.

When the physical processes are altered, there is also a shift in the biological communities. 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. Shoreline armoring can also physically bury forage fish spawning beaches when structures are placed in or too close to the intertidal zone. 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). 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.

Armoring of the nearshore can reduce or eliminate shallow water habitats via two distinct mechanisms. First, bulkheads cause a higher rate of beach erosion waterward of the armoring because there is higher wave energy, compared to a natural shoreline. This leads to beach lowering, coarsening of substrates, increases in sediment temperature, 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). As a result of deepening of the intertidal zone adjacent to the bulkhead, as well as increased wave energy, bulkheads also reduce SAV (Patrick et al. 2014). We expect reduced SAV to cause a reduction in potential spawning habitat (i.e., eelgrass) for Pacific herring, another forage species of Chinook salmon and juvenile PS/GB bocaccio. Reduced SAV also diminishes habitat for larval rockfish, which in their pelagic stage rely on SAV for prey and cover for several months. Second, 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.

In addition to loss of shallow areas through higher rates of beach erosion and substrate coarsening by increased wave energy, bulkheads also prevent the input of sediment from sources landward of the bulkhead to the beach, further diminishing the supply of fine sediment. 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 (Rice 2006; Parks et al. 2013), which are both important prey species of PS Chinook salmon, and juvenile PS/GB bocaccio, both of which depend on nearshore areas for forage. As a result of deepening of the intertidal zone adjacent to the bulkhead, as well as increased wave energy, the new, repaired or replaced bulkhead would also be expected to reduce SAV (Patrick et al. 2014). This would be expected to cause a reduction in potential spawning habitat (i.e., eelgrass) for Pacific herring, another forage species of Chinook salmon and juvenile PS/GB bocaccio. 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. Both salmonids and juvenile bocaccio are affected the loss of prey communities. Larval rockfish of both species—PS/GB bocaccio and PS/GB yelloweye—are affected by the loss of SAV.

2.4.4 Effects on Critical Habitat

Critical habitat for PS chinook, Hood Canal Summer Run Chum, PS/GB Bocaccio and PS/GB Yelloweye Rockfish, and Southern Resident Killer Whales 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 Puget Sound 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 19 summarizes by projects the adverse effects to these functions, while Table 23 quantifies the aerial extent 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, chum, PS/GB bocaccio, yelloweye, and SRKW habitats).

The *temporary water quality reductions from increased turbidity and corollary decrease in dissolved Oxygen (DO), and re-suspended contaminants*—are both expected to persist with the in-water work period of each project, and then to return to baseline within hours (turbidity) to days (DO) after work ceases. Based on these factors, the temporary turbidity 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, and other contaminants will be widely dispersed, and can have detrimental effect at very low levels of exposure either directly or indirectly through the consumption of prey contaminated by their own exposure in the water column. This 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 intermittent 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, chum, 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, chum, 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 causes 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 would reduce quality and quantity of prey including juvenile chinook. 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 these fish are likely to have latent health effects that slightly reduce adult abundance, and also reduce the quality of adult fish that do return and serve as prey, due to bioaccumulated contaminant.

Given the total quantity of prey available to Southern Resident killer whales 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 Southern Resident killer whales. However, episodic and enduring declines of SRKW's prey as a result of the proposed actions are 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 from between 1 and 4 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 dBRMS, 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; access to forage and shallow water habitat upland of the structures is prevented during high tides.

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 40–50 year useful life period of the projects, reduces available nearshore feeding, rearing and safe migration for juvenile salmon impacting juvenile salmon survival rates, limiting the life-history's (fry contribution to returning adults Chinook) (Beechie et al. 2017), and ultimately contribute to low adults salmon returns. This would reduce the potential for recovery of PS Chinook salmon that would likely lead to nutritional stress that results 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 direct 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

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 presence from mid-February through mid-July, but does not fully avoid exposure in January through the first half of February. Additionally, a percentage of Chinook salmon rear in Puget Sound without migrating to ocean areas.

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 15through 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 rock fish 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 a 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. In late winter, juvenile chum 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, 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 (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. Juvenile Chinook salmon are however, have the longest period in which they are nearshore oriented (Fresh 2006) and thus, although numbers are expected to be low at any given time, individuals of this species are likely more often per individual to encounter the intertidal and nearshore area where construction and enduring structure effects are anticipated.

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% 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 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 is 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, during a construction action or over the a proposed structure's useful life.

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 15. As discussed in the Status section, the whales' seasonal movements are only somewhat predictable because there can be large inter-annual variability in arrival time and days present in inland waters from spring through fall. Late arrivals and fewer days present in inland waters have been observed 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 the 30 projects, the area of elevated turbidity and TSS levels during construction could extend up to 200 feet radially from each project location (~1.6 acre/ projects and ~48 acres total) during construction, and would return to background levels shortly after the end of construction (hours to days). Two 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 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 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 39 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

Fish Species Response

For non-dredging projects, the area (~30 acres total) in which benthic forage base is temporarily diminished by disturbed substrate is very small, and because benthic prey recruits from adjacent area 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 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.

SRKW Response

The reduction in prey (PS Chinook salmon) from the temporary construction effects of the proposed actions is extremely small even when considered across all 39 action areas, 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. 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. 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, NMFS anticipates that the short-term reduction of Chinook salmon during construction would have little effect on Southern Resident killer whales.

Response to noise in aquatic habitat from pile driving and construction vessels

Fish Species Response

A total of 22 projects (Table 22) 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 response 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 will be used to attenuate 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 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. 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.

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.

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).

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 will have the most exposure due to their extensive use of nearshore habitats. Juvenile chum also depend on estuarine and nearshore habitats, but they migrate more rapidly out of Puget Sound. Adult Chinook, adult and juvenile steelhead, and adult chum 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 15 to February 15), all exposed PS Chinook salmon, PS steelhead, and adult HCSR chum 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

Southern Resident killer whales 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 in Section 1.3 the following permits are assumed to have a Marine Mammal Monitoring Plan (MMPA) that would detect listed marine mammals before they would come into a zone on behavioral impact.

NWS-2018-963
NWS-2018-636
NWS-2018-760
NWS-2018-981
NWS-2018-570
NWS-2017-573
NWS-2019-552
NWS-2019-526
NWS-2018-750
NWS-2019-336
NWS-2018-525
NWS-2019-0883
NWS-2019-0703
NWS-2017-550
NWS-2019-101
NWS-2019-832
NWS-2017-427
NWS-2018-492
NWS-2017-796

Species Response to Enduring Effects

As was detailed 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 40-50 year useful life period. Thus, multiple cohorts of the multiple populations of PS Chinook salmon, PS steelhead, Hood Canal Summer run Chum, 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 26 (Table 5) projects will support vessels 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 co-extensive 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 will 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, 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

Fish Species Response

Increased stormwater discharge. For two projects (Table 18), polluted stormwater will be discharged to the Puget Sound from parking lots (~ 1.9 acres 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 of individual PS Chinook (juvenile and adult), and PS/GB bocaccio and yelloweye (larval, juvenile, and adult) within this action area. The increased levels of stormwater discharged from the two projects during rain and run-off events. All stormwater discharge is expected to contain concentration levels of constituents and chemical mixtures that are toxic to fish and aquatic life (NMFS 2012). 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) such as 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 that they will being to dilute as they enter the pointe of discharge into the Puget Sound. The effects of the dilution will be such that they 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 and zinc. Higher concentrations are also expected to occur between March and October in any given year—as there will be more dry periods during rain 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 received the most rain.

In an examination of effect on juvenile salmon, McIntyre et al (2015) exposed sub yearling Coho salmon to urban stormwater. 100% 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 100% 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.

We cannot estimate the number of individuals that will experience adverse effects from exposure to stormwater 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 individuals PS Chinook (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 experience reduced growth, impairment of essential behaviors related to successful rearing and migration, cellular trauma, physiological trauma, reproductive failure, and mortality.

Cresote. A total of 25 proposed projects (Table 20) 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 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 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 the intensity of 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 each of 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 with each cohort of each species will be exposed annually via exhaust and incidental introduction of fuels and oils from vessels. These impacts are considered co-extensive 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 their own exposure to reduced water quality. For example, Chinook salmon contain higher levels of some persistent pollutants than other salmon species, but only limited information is available for pollutant levels in Chinook salmon (Krahn et al. 2007; O'Neill and West 2009; Veldhoen et al. 2010; Mongillo et al. 2016). These harmful pollutants, through consumption of prey species that contain these pollutants, are stored in the killer whale's blubber and can later be released; when the pollutants are released, they are redistributed to other tissues when the whales metabolize the blubber in response to food shortages or reduced acquisition of food energy that could occur for a variety of other reasons. The release of pollutants can also occur during gestation or lactation. Once the pollutants mobilize in to circulation, they have the potential to cause a toxic response. Therefore, nutritional stress from reduced Chinook salmon populations may act synergistically with high pollutant levels in Southern Residents and result in adverse health effects.

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 contaminates through the proposed actions 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 Southern Resident killer whales have blubber concentrations that are currently 2 to 3.6 times higher than the established health-effects threshold (Krahn et al. 2009).

Since the contaminate exposure is considered to be a chronic and on-going, it is also expected a SRKW 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 only further exacerbates their current susceptibility to adverse health effects.

Response to Noise in Aquatic Habitat from Vessels

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, 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 vessel. 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 have dissipated to ambient 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 (minutes up to one hour) 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.

<u>SRKW Response</u>

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 that is within the range of the SRWK, 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 tanker-type traffic.

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 300-400 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.[18]

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;

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

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 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 can disrupt juvenile migration in the Puget Sound nearshore.

Juvenile Chinook and juvenile HCSR chum migrate along shallow nearshore habitats, and OWSs will disrupt their migration and increase their predation risk. Every juvenile Chinook and juvenile HCSR chum will encounter OWSs during their out-migration, and because the projects in this consultation are across Puget Sound, these structures will continue to be part of that migration disruption for fish in every year that they are present in the marine environment. Adult Chinook, adult and juvenile steelhead, adult chum, and juvenile PS/GB bocaccio do not migrate along shallow nearshore habitats. Therefore, OWS will not obstruct their movements. Impacts to SAV and epibenthic forage at these structures will affect both adult and juvenile Chinook, chum steelhead, and juvenile PS/GB bocaccio, however, by reducing forage at each site.

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 mortality.

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, HCSR chum salmon, PS steelhead, and juvenile PS/GB bocaccio. Bax et al. (1978) determined the abundance of chum 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. (2006) researched the effects of grating in residential floats on eelgrass, a substrate for herring spawning, 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. We could not find studies examining the effect of OWS on SAV other than eelgrass and kelp (Mumford 2007). 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, 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. As these species, particularly 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 1,581 acres of overwater structure in the nearshore of Puget Sound. The authorization for a new 40- to 50- 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 40–50 years (new useful life period), and larval and juvenile PS/GB bocaccio for the same time frame.

Species Response to Shoreline Armoring

Fish Species Response

Juvenile Chinook and juvenile HCSR chum migrate along shallow nearshore habitats, and bulkheads will degrade nearshore habitats and increase their predation risk. Every juvenile Chinook and juvenile HCSR chum 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, adult and juvenile steelhead, adult chum, 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, chum steelhead, and juvenile PS/GB bocaccio by available reducing forage. To the degree that rockfish spawn depends on SAV, their survival will also be reduced.

Species Response to Forage Reduction

Fish Species Response

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.

SRKW Response

When prey is scarce, 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.

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 uncertain whether hatchery-only stocks could be sustained indefinitely. The loss of this Chinook salmon population would also 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 to find 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 whales. 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.

Effects on Population Viability

Fish Species Response

We assess the importance of effects in the action area to the Evolutionarily Significant Units (ESUs)/Distinct Population Segments (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.

Abundance. While numbers cannot be ascertained, it is certain that at each site, there will be temporary, episodic and enduring effects that diminish water quality, forage base, and safe migration, as habitat effects, as well as sound and entrainment 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 reductions 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 utilize resources within the action area.

Because nearshore areas are not relied on to the same degree by PS steelhead, Hood Canal summer-run Chum salmon, or yelloweye rockfish, while effects will be chronic and adverse and will cause some detriments in survival, we do not expect their declines in abundance to occur at a level that will impair productivity.

SRKW Response

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 = 22, K pod = 17, L pod =33) as of July 1st, 2020. 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. (2019), 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 population viability assessment (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 Pacific Fisheries Management Council (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 long-term effects of the action include the suppression of productivity among (i.e., reduced survival of juvenile) PS Chinook populations during a 40-50 year time period, and spatial and temporal depletions in Chinook presence. This in turn limits the number of adult PS Chinook 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 speciesrelies on published correlations using outdated data, assumes the correlations represent a causative relationship, and models SRKW demographic trajectories assuming that the relationship is constant over time. These assumptions (correlation represent causation, etc.) were previously criticized by a panel of experts and they cautioned against overreliance on correlative studies (Hilborn et al. 2012). 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 Pacific Fisheries Management Council (PFMC 2020). The small population size limits the ability to detect a relationship to input into a PVA and the relationships are not constant over time (NMFS 2020).

These are consistent with several factors identified in the final recovery plan for Southern Resident killer whales 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 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 Southern Resident killer whale DPS is an average growth rate of 2.3% for 28 years (NMFS 2008). In light of the current average annual growth rate of 0.1%, 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 likely 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 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 likely to affect the action area include reductions in water quality, water quantity, and sediment transport. Future actions in the tributary watersheds whose effects are likely 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 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 likely 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.

The human population in the PS region increased from about 1.29 million people in 1950 to about 3.84 million in 2014, is expected to reach 4.17 million by 2020, and nearly 5 million by 2040 (Puget Sound Regional Council 2020). As of the date of this biological opinion, human population in the Puget Sound Region is 4.2 million, slightly exceeding projections. Thus, future private and public development actions are very likely 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 likely 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 likely 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.

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 Recovery Plan. Several not for profit organizations and state and federal agencies are implementing recovery actions identified in these recovery plans.

For the inland waters of Washington, federal rules on vessel traffic to protect SRKW from vessel effects were adopted in 2011 (76 FR 20870). Outreach and enforcement of these regulations will reduce the vessel effects (as described in Ferrara et al. (2017)) of recreational and commercial whale watching vessels in U.S. waters of the action area. There is currently a voluntary ¼ mile "Whalewatch Exclusion Zone" along the west side of San Juan Island from Mitchell Bay to Eagle Point (and ½ mile around Lime Kiln) as part of the San Juan County Marine Resources Committee Marine Stewardship Area; these are key summer foraging areas for the whales. San Juan County expanded this area to include a ¼ mile no vessel zone to Cattle Point starting in 2018 and WDFW has been increasing education and outreach regarding this area, including with the fishing community.

On March 14, 2018, WA Governor's Executive Order 18-02 was signed and it orders 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 need for Southern Resident killer whale recovery. The Task Force provided recommendations in a final Year 1 report in November 2018.[19] In 2019, a new state law was signed that increases vessel viewing

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[19] Available at: https://www.governor.wa.gov/sites/default/files/OrcaTaskForce_reportandrecommendations_11.16.18.pdf, last

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. NMFS initiated scoping in 2019 to evaluate the need to revise existing federal regulations.

On November 8, 2019, the task force released its Year 2 report[20] 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). Hatcheries are in the midst of enumerating the spring 2020 releases, but the planned production associated with this legislative action is a release of an additional 13.5 million Chinook salmon (approximately 6.4 million from Puget Sound facilities, approximately 5.6 million from Washington coastal facilities, and approximately 1.5 million from Columbia River facilities). A similar level of Chinook production funded by this legislative action is anticipated in the spring of 2021. The released smolts would return as adults and be part of the prey base 3–5 years later.

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 likely to have ongoing adverse effects on all the listed species populations addressed in this Opinion salmon and abundance and productivity that outpace the effects of restoration activities. 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.

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visited May 26, 2019.

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

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 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 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 a high importance for conservation of the species, based largely on its restoration potential. Loss of freshwater and nearshore critical habitat quality is 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 proposed in certain areas outside Puget Sound. Only the designated area will be affected by the proposed actions. 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 actions 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 more of the critical habitat for this species remains in good condition. 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, only 31 percent of Puget Sound’s shorelines remain undeveloped.

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 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 causes adverse 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 reduces juvenile survival and in some cases, has eliminated PS Chinook salmon life history strategies that rely on rearing in nearshore areas during early life history. Under the current environmental baseline, critical habitat for PS Chinook salmon is not able to support survival and recovery of this species.

These impacts on the survival of juvenile PS Chinook salmon translate to reduction of adult PS Chinook salmon, the prey PBF for SRKW critical habitat. As observed during recent years, the SRKW's population has declined. 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 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 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 20).
- 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 water ward 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 critical habitat quality over time, see Table 17. As explained in Section 2.4 *Effects of the Action*, authorization of the construction of new structures degrades the quality of PBFs as described above. The proposed authorization of replacement structures would ameliorate some effects as compared to the baseline condition and result in a decrease of 0.25 acres of nearshore area covered by overwater structures. However, because the USACE intends that these structures are maintained in perpetuity, the future consequences of the proposed actions 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, HCSR chum salmon, PS/GB bocaccio, and SRKWs. Additionally, under the proposed actions, there is a net increase in the amount of shoreline armoring, with 2237 feet of bulkhead proposed for removal and 3208 feet proposed for installation.

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 conversation 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 3 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 conversation value of critical habitat for HCSR chum salmon.

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 of the prey PBF of critical 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 critical habitat PBFs 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, 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 facilitates. 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. A noted throughout this Opinion, future effects of climate change on habitat quality throughout Puget Sound are expected to be negative.

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 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 actions are added to the environmental baseline and cumulative effects, the proposed actions are 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 species*, 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.[21]

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[21] 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.

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 eight 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 killer whale populations that have generally been increasing since the 1970s (Carretta et al. 2019). 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 actions 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 resulted in decreased survival at early life history stages and lower population abundance and productivity. The effect on nearshore habitat used by HCSR chum salmon is similar, but more 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. Currently, it is estimated that the loss of nearshore habitat in Puget Sound at close to 85 percent or more (Brophy et al. 2019).

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 causes adverse 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 reduces juvenile survival and in some cases, has eliminated PS Chinook salmon life history strategies that rely on rearing in nearshore areas during early life history. Under the current environmental baseline, nearshore habitat is not able to support juvenile survival of PS Chinook salmon such that populations of this ESU can become viable.

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 risk of 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 list 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 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.
- 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 water ward 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 proposed authorization of replacement structures would ameliorate some effects as compared to the baseline condition and result in a decrease of 0.25 acres of nearshore area covered by overwater structures. However, the future consequences of the proposed actions include adverse effects caused by the replacement structures that extend beyond 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, 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 are may be in project areas during construction and 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 conversation 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 three projects that occur in areas that would affect this species' habitat in 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, that 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 others 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 facilitates. 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. A noted throughout this Opinion, future effects of climate change on habitat quality throughout Puget Sound are expected to be negative.

In summary, PS Chinook 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 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 actions are added to the environmental baseline and cumulative effects, the proposed actions 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 would 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 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 (NMFS 2007).

Additionally, the quality of nearshore 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 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 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 a RPA target of no-net-loss of critical habitat functions. NMFS has determined that this proposed action would result in habitat loss equivalent to -8,158.79 debits (Table 25). 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 has determined that twelve (12) of the proposed permits (Table24) 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, projects listed in Table 24 are not subject to the requirements of this RPA. We reach this conclusion based on the expectation that those projects will complete their action and proposed offsets as documented.

Table 24. USACE Permits not subject to the RPA

NWS#	Credits
NWS-2018-963	23.2
NWS-2018-229	1.8
NSW-2018-1165	16.4
NWS-2019-676	0
NWS-2019-526	15.5
NWS-2019-0883	14.3
NWS-2019-728	7.8
NWS-2019-0703	957.4
NWS-2017-550	440.2
NWS-2019-101	208.8
NWS-2019-832	30
NWS-2019-983	19.8

The remaining twenty-seven (27) projects considered under this consultation, as currently designed, have a combined total of -8158.79 debits (Table 25). NMFS has determined that those remaining 27 projects are subject to the RPA to avoid jeopardizing the continued existence of PS Chinook salmon and SRKW, and destroying or adverse modifying those species' designated critical habitat.

Table 25. Projects Subject to the RPA

NWS#	Debits
NWS-2017-796	-252.1
NWS-2017-587	-131.6
NWS-2018-465	-82.3
NWS-2018-53	-352.3
NWS-2018-636	-20.8
NWS-2017-955	-101.8
NWS-2018-760	-54.4
NWS-2017-840	-87.1
NWS-2018-981	-1.9
NWS-2018-1143	3
NWS-2018-570	-329.2
NWS-2017-573	-1045.2
NWS-2018-382	-39.6
NWS-2019-207	-80.7
NWS-2019-552	-374.8
NWS-2018-750	-146.2
NWS-2018-39	-28.3
NWS-2019-491	-260.7
NWS-2019-664	-550.1
NWS-2019-336	-530.5
NWS-2018-525	-202.3
NWS-2018-492	-2043.14
NWS-2019-478	-9.3
NWS-2019-956	-212.05
NWS-2019-690	-37.7
NWS-2020-0204	-1185.6
NWS-2017-427	-2.1
Total	-8158.79

Pursuant to 50 CFR 402.14(g)(5), NMFS must discuss with the USACE and the applicants the availability of RPA(s) that can be taken to avoid violation of USACE' ESA section 7(a)(2) responsibilities. Between July 2, 2020 and October 30, 2020, NMFS staff and the applicants conducted over 60 meetings to discuss and refine the RPA. This section presents the USACE and the project applicants with an RPA that can be implemented to avoid jeopardy to species and adverse modification of critical habitat, while meeting each of the other requirements identified in the first paragraph of this section above.

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 purposed (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.

This RPA is both technologically and economically feasible. As of signing, 12 of the proposed projects (Table 24) have already provided sufficient conservation credits through project design or additionally proposed conservations offsets such that they are not subject to this RPA. As mentioned above, pursuant to 50 CFR 402.14(g)(5), between July 2, 2020 and October 30, 2020, NMFS staff and the applicants conducted over 60 meetings to discuss and refine the RPA. As of October 20, 2020, approximately90% of the applicants had identified an RPA option they could pursue. NMFS has 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 Councils In-Lieu-Fee program for projects in Hood Canal (this option can be relevant to NWS-2017-573, NWS-2018-39, NWS-2018-53) 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 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 25 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 vessels or 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-a-lone 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 of the High Tide Line (HTL) and preferably above 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

   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);
      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.

General Provisions

For any part of this RPA that requires updated NHVM calculator outputs, NMFS will respond to a request for technical assistance within 15 day of any such request.

The implementation of RPA's 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[22] and NWR 2007/08287[23]), or future, separate 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 16). "Out-of-marine basin" or "out-of-service area" credits will not meet the requirements of this RPA. The only 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.

The number of debits and credits required for each project, as currently designed, is also identified in individual attachments (Attachments 1-39).

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[22] 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).

[23] 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 16. 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, and 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 does 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 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 and 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)[24].

The precise restoration activities associated 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:

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

Table 26. Estimated days associated with construction of RPA conservation offset projects relative to conservation credits.

Conservation Credits	Days to Construct Conservation Offset Projects
1 to 200	10 days
201 to 500	20 days
501 to 1000	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 HTL or HAT, relocation away from a pocket estuary, reduction in size of structure) in 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 do not continue to drop below the existing 1-2% percent juvenile survival rates (Kilduff et al. 2014, Campbell et al. 2017) and in turn will not further reduce available SRKW prey. 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% functioning, fry out-migrants made up at least 30% of the returning adults, compared to the 3% in watersheds like the Puyallup and the Green Rivers, where 95% 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 then 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[25] 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 reduced harvest levels that are aimed at stemming the near-term population decline of Chinook and help ensure an immediate prey supply for SRKW. The conservation hatchery efforts for PS Chinook and reduced harvest levels will continue to help maintain current population levels of Chinook 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 all adverse effects of the proposed projects on the quality of Puget Sound 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

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[25] 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.

salmon and the PBFs of PS Chinook 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[26]; 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 Southern Resident Killer Whales 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 27, 28, 29, and 30 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.

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 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

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[26] 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.

synonymous with the defined in-water work window and number of in-water workdays identified in Table 27. The only exception to this is the days associated with pile installation and removal listed in Table 28. 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 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 Table 27 and 28. 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 Table 27 and 28.

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 28).

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 suspended sediments and re-suspended contaminants (specifically PAH's from creosote structures) in the sediments during 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 27.

The suspended sediments and re-suspended contaminants will occur contemporaneously—these action 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.

For non-dredging activities

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 re-suspended 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 footprint, where construction will suspend sediments and re-suspend contaminants. Elevated suspended sediment levels beyond 200-foot buffer would indicate exceedance of take. The 200-foot buffer extent of take surrogate also applies projects that implement RPA 1.1, 1.2, and 1.5.

For dredging activities

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 estuary environments, Washington state water quality regulations (WAC173-201A-400) establish a 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 re-suspended 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 footprint, where construction will suspend sediments and re-suspend contaminants. Elevated suspended sediment levels beyond 300-foot buffer would indicate exceedance of take.

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-2018-963 and NWS-2019-478)

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 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 27. 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-2017-796	July 16 - February 15	5	86/20	200/200	148	NA	NA
NWS-2017-587	July 16 - February 15	1	30/20	200/200	NA	NA	NA
NWS-2018-963	July 16 - February 15	1	30/NA	NA	11	300	713
NWS-2018-229	July 16 - February 15	1	30/NA	200/NA	1	NA	NA
NWS-2018-465	July 16 - February 15	1	14/10	200/200	NA	NA	NA
NWS-2018-53	July 16 - February 15	1	30/20	NA/200	NA	NA	NA
NWS-2018-636	July 16 - February 15	1	30/10	200/200	15	NA	NA
NWS-2017-955	July 16 - February 15	1	14/10	200/200	1	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-2018-760	July 16 - February 15	1	3/10	200/200	1	NA	NA
NWS-2017-840	July 16 - February 15	1	30/10	200/200	NA	NA	NA
NWS-2018-981	July 16 - February 15	1	30/10	200/200	22	NA	NA
NWS-2018-1143	July 16 - February 15	1	14/10	200/200	NA	NA	NA
NWS-2018-570	July 2 – March 2	1	30/20	200/200	179	NA	NA
NSW-2018-1165	July 16 - February 15	1	30/NA	200/NA	10	NA	NA
NWS-2017-573	July 16 - October 14	1	30/30	200/200	NA	NA	NA
NWS-2018-382	July 16 - January 15	1	30/10	200/200	18	NA	NA
NWS-2019-207	July 16 - February 15	1	1/10	NA/200	20	NA	NA
NWS-2019-552	August 1- January 31	1	15/20	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-2019-676	July 16 - February 15	1	7/NA	200/NA	1	NA	NA
NWS-2019-526	July 16 - February 15	1	30/NA	200/NA	22	NA	NA
NWS-2018-750	July 16 - February 15	4	60/10	200/200	120	NA	NA
NWS-2018-39	July 16 - February 15	1	2/10	NA/200	NA	NA	NA
NWS-2019-491	July 16 - February 15	1	8/20	200/200	NA	NA	NA
NWS-2019-664	July 16 - February 15	1	30/30	NA/200	NA	NA	NA
NWS-2019-336	July 16 - February 15	10	31/30	200/200	196	NA	NA
NWS-2018-525	July 16 - February 15	1	30/20	200/200	13	NA	NA
NWS-2018-492	July 16 - February 15	3	60/30	200/200	198	NA	NA
NWS-2019-478	July 16 - February 15	1	20/10	NA	NA	300	7,500

	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-2019-956	July 16 - February 15	1	30/20	200/200	15	NA	NA
NWS-2019-0883	July 16 - February 15	1	30/NA	200/NA	11	NA	NA
NWS-2019-728	August 1 - February 15	1	2/NA	200/NA	NA	NA	NA
NWS-2019-690	July 16 - January 15	1	30/10	200/200	4	NA	NA
NWS-2019-0703	September 1- February 15	5	119/NA	200/200	2,232	NA	NA
NWS-2020-0204	July 16 - February 15	2	100/30	200/200	NA	NA	NA
NWS-2017-550	July 16 - October 14	10	90/NA	200/NA	272	NA	NA
NWS-2019-101	August 1- January 31	5	30/NA	200/NA	167	NA	NA
NWS-2019-832	July 16 - February 15	1	30/NA	200/NA	12	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-2017-427	July 16 - October 14	1	5/10	NA	NA	NA	NA
NWS-2019-983	July 16 - February 15	1	30/NA	200/NA	5	NA	NA

Table 28. 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#	# of days of pile removal/install work	# of work windows	Max Impact Strikes/Day	Max Minutes Vibratory Hammer work/Day
NWS-2017-796	86	5	3,000	0
NWS-2018-963	2	1	0	280
NWS-2018-636	7	1	0	140
NWS-2018-760	2	1	0	80
NSW-2018-981	4	1	4,000	160
NWS-2018-570	8	1	0	160
NWS-2017-573	14	1	400	160
NWS-2019-552	6	1	0	100
NWS-2019-526	2	1	0	160
NWS-2018-750	60	4	0	160
NWS-2019-336	31	10	0	160
NWS-2018-525	2	1	0	160
NWS-2018-492	60	3	22,500	100
NWS-2019-0883	25	1	100	40
NWS-2019-0703	119	5	10,800	405
NWS-2017-550	90	10	245	140
NWS-2019-101	20	5	4,000	80
NWS-2019-832	7	1	0	160
NWS-2017-427	1	1	NA	NA

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 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 are summarized below in Table 29.

For In-Water and Over-Water Structures, Including Mooring Buoys

The physical size (sq feet) of an in- or over-water structure is the best available surrogates 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 structures 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 increase 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 Section 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 high tide line (HTL) and highest astronomical tide (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 sediments sources 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 juveniles PS Chinook 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 HTL and HAT. As the length and width of a bulkhead increases so does impacts to sediment inputs. Structures that are placed below the HTL and HAT directly eliminate forage fish habitat and feeding habitat for listed species. The further a structure is placed below HTL and 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 29. 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 Footage**	**Length (lf)**	**Average Elevation of Substrate at Toe of Armoring**
NWS-2017-796	49,800	NA	NA
NWS-2017-587	NA	110	MHHW
NWS-2018-963	1,173	NA	NA
NWS-2018-229	NA	33	10 ft MLLW
NWS-2018-465	NA	75	2 ft below MHHW
NWS-2018-53	NA	26/124	5 ft below MHHW
NWS-2018-636	2,514	NA	NA
NWS-2017-955	NA	140	1.5 ft below MHHW
NWS-2018-760	1,460	NA	NA
NWS-2017-840	NA	136	1 ft below MHHW
NWS-2018-981	2,722	NA	NA
NWS-2018-1143	NA	60	1 ft below MHHW
NWS-2018-570	5,469	386	2 ft below MHHW
NSW-2018-1165	690	NA	NA
NWS-2017-573	8,138	NA	NA
NWS-2018-382	NA	125	MHHW
NWS-2019-207	4,168	NA	NA
NWS-2019-552	NA	307	2 feet below MHHW
NWS-2019-676	64	NA	NA
NWS-2019-526	3,615	NA	NA
NWS-2018-750	31,744	NA	NA
NWS-2018-39	NA	NA	NA
NWS-2019-491	2,292	NA	NA
NWS-2019-664	NA	360	MHHW
NWS-2019-336	240	NA	NA
NWS-2018-525	12,778	NA	NA
NWS-2018-492	NA	834	12 feet below MHHW
NWS-2019-478	NA	NA	NA
NWS-2019-956	NA	117/13	MHHW
NWS-2019-0883	1,000	NA	NA

	In-water and Over-water Structure	**Bulkhead and Shoreline Armoring**	
USACE Project #	**Square Footage**	**Length (lf)**	**Average Elevation of Substrate at Toe of Armoring**
NWS-2019-728	NA	4	MHHW
NWS-2019-690	220	35	1 ft below MHHW
NWS-2019-0703	74,636	NA	NA
NWS-2020-0204	4,124	330	3 ft below MHHW
NWS-2017-550	1,883	NA	NA
NWS-2019-101	1,139	NA	NA
NWS-2019-832	948	NA	NA
NWS-2017-427	7	NA	NA
NWS-2019-983	704	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 2 projects. The take associated with these impacts are summarized below in Table 30.

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. 2005; 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 meaningful reinitiation trigger.

Table 30. Pollutions Generating Surface from projects involving stormwater

	Stormwater Runoff
NWS#	Pollutions Generating Surface (sq ft)
NWS-2018-492	73,000
NWS-2019-983	8,269

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 implement monitoring and reporting programs to confirm that the RPA and RPM's 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 27)
   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 27)
   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 27)
   b. To minimize incidental take from suspending sediment and re-suspended contaminants 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 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.
        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:
    a. Before work begins, all contractors working on site must receive a complete list of the USACE permit special conditions, 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 that construction has commenced: This notification should be sent to projectreports.wcr@noaa.gov and include:
        i. Email subject line: "NOTIFICATION OF START DATE **WCRO-2020-01361"**
        ii. Date project construction began
        iii. USACE NWS project number
    c. RPA implementation:
        i. 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:
            (1) Provide verification that on-site habitat improvement projects were implemented as proposed. At a minimum this verification should include:
            (2) A description of the final design, and
            (3) Before and after photographs.
            (4) Upload project details that describe completed habitat improvements into the Puget Sound Info database found here: https://www.pugetsoundinfo.wa.gov/
        ii. 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:
            (1) Provide verification 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) Upload project details that describe completed habitat improvements into the Puget Sound Info database found here: https://www.pugetsoundinfo.wa.gov/

    iii. 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.
    iv. 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
    v. For applicants using RPA 1.5 to meet all or part of their RPA requirements, applicants shall implement any project modifications concurrent with the specifications of USACE permit.
    vi. 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.

d. 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 200f buffer (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 HTL and 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

<u>Submit Reports</u>. 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.

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 39 projects on critical habitat is 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 39 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.

2.12 Reinitiation of Consultation

This concludes formal consultation for the USACE' proposal to authorize 39 in-water, overwater, or nearshore activities in Puget Sound.

If any of the applicants fail to implement the portion of the RPA applicable to their individual project, that project will not be 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. 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 39 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 NMFS Regional Office, Oregon Washington Coastal Offices, 7600 Sand Point Way NE, Seattle, WA 98115.

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

Section 305(b) of the MSA directs federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the USACE and descriptions of EFH for Pacific coast groundfish (PFMC 2005), coastal pelagic species (PFMC 1998), Pacific coast salmon (PFMC 2014) contained in the fishery management plans developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The entire action area fully overlaps with identified EFH for Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species. Designated EFH for groundfish and coastal pelagic species encompasses all waters along the coasts of Washington, Oregon, and California that are seaward from the mean high water line, including the upriver extent of saltwater intrusion in river mouths to the boundary of the U. S. economic zone, approximately 230 miles (370.4 km) offshore (PFMC 1998a,b). Designated EFH for 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 1999). Groundfish, coastal pelagic, and salmonid fish species that could have designated EFH in the action area are listed in Table 31.

Additionally, Puget Sound is a Habitat Area of Particular Concern (HAPC), based on importance of the ecological function provided by the habitat. The environmental effects of the proposed project may adversely affect EFH for Pacific coast groundfish, coastal pelagic species, and Pacific coast salmon in the HAPC for these species.

Table 31. EFH species potentially 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 elongatus
curlfin sole	Pleuronichthys decurrens	longnose skate	Raja rhina
darkblotch rockfish	Sebastes crameri	Pacific cod	Gadus macrocephalus
Dover sole	Microstomus pacificus	Pacific ocean perch	Sebastes alutus
Pacific sanddab	Ctlharichthys sordidus	shortspine thornyhea	Sebastolobus alascanus
petrale sole	E opsetta jordani	spiny dogfish	Squalus acanthias
quillback rockfish	Sebastes maliger	splitnose rockfish	Sebastes diploproa
ratfish	Hydrolagus colliei	starry flounder	Platichthys stellatus
redbanded rockfish	Sebastes babcocki	stripetail rockfish	Sebastes saxicola
redstripe rockfish	Sebastes proriger	tiger rockfish	Sebastes nigrocinctus
rex sole	Glyptocephalus zachirus	vermilion rockfish	Sebastes miniatus
rock sole	Lepidopsetta bilineata	yelloweye rockfish	Sebastes ruberrimus
rosethorn rockfish	Sebastes helvomaculatus	yellowtail rockfish	Sebastes llavidus
Coastal Pelagic			
Common Name	**Scientific Name**		
market squid	Latigo opalescens		
northern anchovy	Engraulis mordax		
jack mackerel	Trachurus symmetricus		
Pacific mackerel	Scomber japonicus		
Pacific sardine	Sardinops sagax		
Salmonid Species			
Common Name	**Scientific Name**		
Chinook salmon	Oncorhynchus tshawytscha		
coho salmon	Oncorhynchus kisutch		
pink salmon	Oncorhynchus gorbuscha		

3.2 Adverse Effects on Essential Fish Habitat

The effects of the proposed project on ESA-listed species are described in section 2.4., above. The same mechanisms of effect are likely to affect all Pacific coast groundfish, coastal pelagic species, and Pacific coast salmon to varying degrees. These adverse effects include:

1. Water quality – both temporary (during construction) and permanent (during project operations). Examples include sound, turbidity, enduring PAHs, dissolved oxygen, and pollutants.

2. Forage reduction – disturbance and shading of SAV and resulting reduction in SAV density and abundance, and related primary production. Designated EFH will experience temporary, episodic, and enduring declines in forage or prey communities.

3. Migration and passage - Designated salmon EFH 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.

4. 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.

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 life stages (larval and juvenile) for multiple species within the action area.

3.3 Essential Fish Habitat Conservation Recommendations

Fully implementing these EFH Conservation Recommendations (CRs) would protect, by avoiding or minimizing the adverse effects described in Section 3.2, above.

1. Adhere to the work window of July 15 to February 15.

2. Utilize vibratory pile driving whenever sediment conditions allow.

3. Utilize sound attenuation measure(s) (double walled piled, wooden block, bubble curtain, etc.) for all steel impact pile driving activities to keep source sound levels below the following thresholds at 10 meters distance.

4. 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 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.

5. Dredge in a manner that minimizes spillage of excess sediments from the bucket.

6. To minimize incidental take from suspending sediment during structure removal and construction, implement the best management practices and conservation measures and employ a suspended sediment (turbidity) monitoring plan.

3.4 Statutory Response Requirement

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 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.

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.

5. REFERENCES

Abatzoglou, J. T., D. E. Rupp, and P. W. Mote. 2014. Seasonal climate variability and change in the Pacific Northwest of the United States. Journal of Climate 27(5): 2125-2142.

Able, K.W., J.P. Manderson, and A.L. Studholme. 1998. The distribution of shallow water juvenile fishes in an urban estuary: The effects of manmade structures in the lower Hudson River. *Estuaries*. 21:731-744.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons (PAHs). U.S. Health and Human Services, Agency for Toxic Substances and Disease Registry. Atlanta, Georgia.

ATSDR. 2004a. Toxicological profile for copper. U.S. Health and Human Services, Agency for Toxic Substances and Disease Registry. Atlanta, Georgia.

ATSDR. 2004b. Toxicological profile for polychlorinated biphenyls (PCBs). U.S. Health and Human Services, Agency for Toxic Substances and Disease Registry. Atlanta, Georgia.

ATSDR. 2005. Toxicological profile for zinc. U.S. Health and Human Services, Agency for Toxic Substances and Disease Registry. Atlanta, Georgia.

ATSDR. 2007. Toxicological profile for lead. U.S. Health and Human Services, Agency for Toxic Substances and Disease Registry. Atlanta, Georgia.

Alpers, C.N., R.C. Antweiler, H.E. Taylor, P.D. Dileanis, and J.L. Domagalski (editors). 2000a. Volume 2: Interpretation of metal loads.In: Metals transport in the Sacramento River, California, 1996-1997, Water-Resources Investigations Report 00-4002. U.S. Geological Survey. Sacramento, California.

Alpers, C.N., R.C. Antweiler, H.E. Taylor, P.D. Dileanis, and J.L. Domagalski (editors). 2000b. Volume 1: Methods and Data.In: Metals transport in the Sacramento River, California,1996-1997, Water-Resources Investigations Report 99-4286. U.S. Geological Survey. Sacramento, California.

Anderson, T.W. 1983. Identification and development of nearshore juvenile rockfishes (genus Sebastes) in central California kelp forests. Calif. State Univ, Fresno, Calif., p. 216, Unpublished Thesis.

Anderson, C.W., F.A. Rinella, and S.A. Rounds. 1996. Occurrence of selected trace elements and organic compounds and their relation to land use in the Willamette River Basin, Oregon, 1992–94. U.S. Geological Survey. Water-Resources Investigations Report 96-4234. Portland, Oregon.

Anderson, J.J., E. Gurarie, and R.W. Zabel. 2005. Mean free-path length theory of predator-prey interactions: Application to juvenile salmon migration. Ecological Modelling. 186:196-211.

Appleby, A., and K. Keown. 1994. History of White River spring chinook broodstocking and captive rearing efforts. Wash. Dep. Fish Wildl., 53 p. (Available from Washington Dept. of Fish and Wildlife, 600 Capitol Way N., Olympia, WA 98501-1091).

Asch, R. G. 2015. Climate change and decadal shifts in the phenology of larval fishes in the California Current ecosystem. Publications National Academy of Sciences. 112: E4065-E4074.

Au W. W., J. K. Horne, and C. Jones. 2010. Basis of acoustic discrimination of Chinook salmon from other salmons by echolocating *Orcinus orca*. The Journal of the Acoustical Society of America. 128: 2225-32.

Bain, D. 1990. Examining the validity of inferences drawn from photo-identification data, with special reference to studies of the killer whale (*Orcinus orca*) in British Columbia. Report of the International Whaling Commission, Special Issue 12:93- 100.

Baird, R.W. 2000. The killer whale: foraging specializations and group hunting. Pages 127- 153 in J. Mann, R.C. Connor, P.L. Tyack, and H.Whitehead, editors. Cetacean societies: field studies of dolphins and whales. University of Chicago Press, Chicago, Illinois.

Banks, A.S. 2007. Harbor seal abundance and habitat use relative to candidate marine reserves in Skagit County, Washington. Western Washington University.

Barnett-Johnson, R., C. B. Grimes, C.F. Royer, and C. J. Donohoe. 2007. Identifying the contribution of wild and hatchery Chinook salmon (*Oncorhynchus tshawytscha*) to the ocean fishery using otolith microstructure as natural tags. Canadian Journal of Fisheries and Aquatic Sciences, 2007, 64(12): 1683-1692

Bartz KK, Ford MJ, Beechie TJ, Fresh KL, Pess GR, et al. (2015) Trends in Developed Land Cover Adjacent to Habitat for Threatened Salmon in Puget Sound, Washington, U.S.A.. PLOS ONE 10(4): e0124415. https://doi.org/10.1371/journal.pone.0124415

Barton, A., B. Hales, G.G. Waldbuster, C. Langdon, and R. Feely. 2012. The Pacific Oyster, *Crassostrea gigas*, Shows Negative Correlation to Naturally Elevated Carbon Dioxide Levels: Implications for Near-Term Ocean Acidification Effects. *Limnology and Oceanography*. 57:12.

Bax, N. J., E. O. Salo, B. P. Snyder, C. A. Simenstad, and W. J. Kinney. 1978. Salmonid outmigration studies in Hood Canal. Final Report, Phase III. January - July 1977, to U.S. Navy, Wash. Dep. Fish., and Wash. Sea Grant. Fish. Res. Inst., Univ. Wash., Seattle, WA. FRI-UW-7819. 128 pp.

Beamish, R.J., C. Mahnken, and C.M. Neville. 2004. Evidence That Reduced Early Marine Growth Is Associated with Lower Marine Survival of Coho Salmon. *Transactions of the American Fisheries Society*. 133:26-33.

Beechie, T. J., O. Stefankiv, B. Timpane-Padgham, J. E. Hall, G. R. Pess, M. Rowse, M. Liermann, K. Fresh, and M. J. Ford. 2017. Monitoring Salmon Habitat Status and Trends in Puget Sound: Development of Sample Designs, Monitoring Metrics, and Sampling Protocols for Large River, Floodplain, Delta, and Nearshore Environments. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-137.

Bigg, M. 1982. An assessment of killer whale (Orcinus orca) stocks off Vancouver Island, British Columbia. Report of the International Whaling Commission 32:655-666.

Bigg, M.A., P.F. Olesiuk, G.M. Ellis, J.K.B. Ford, and K.C. Balcomb. 1990. Social organization and genealogy of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Report of the International Whaling Commission, Special Issue 12:383-398.

Bilkovic, D.M., and M.M. Roggero. 2008. Effects of coastal development on nearshore estuarine nekton communities. Marine Ecology Progress Series. 358:27-39.

Blecha F. 2000. Immune system response to stress. In: Moberg GP, Mench IA, eds. Biology of Animal Stress: Implications for Animal Welfare. Wallingford, Oxon, UK: CAB.

Boehlert, G. W., 1984. Abrasive effects of Mt. St. Helens ash upon epidermis of yolk-sac larvae of Pacific herring, *Clupea harengus pallasi*. Mar. envir. Res. 12: 113–126.

Boehlert, G.W., Morgan, J.B. 1985. Turbidity enhances feeding abilities of larval Pacific herring, *Clupea harengus pallasi* . Hydrobiologia 123, 161–170.

Bond, N. A., M. F. Cronin, H. Freeland, and N. Mantua. 2015. Causes and impacts of the 2014 warm anomaly in the NE Pacific. Geophysical Research Letters. 42(9): 3414–3420.

Boese, B. L., Kaldy, J. E., Clinton, P. J., Eldridge, P. M., and Folger, C. L. (2009). Recolonization of intertidal *Zostera marina* L. (eelgrass) following experimental shoot removal. *Journal of Experimental Marine Biology and Ecology*, *374*(1), 69-77. doi:https://doi.org/10.1016/j.jembe.2009.04.011

Bonefeld-Jørgensen, E. C., H. R. Andersen, T. H. Rasmussen, and A. M. Vinggaard. 2001. Effect of highly bioaccumulated polychlorinated biphenyl congeners on estrogen and androgen receptor activity. Toxicology 158:141–153.

Bradford, A. L, D. W. Weller, A. E. Punt, Y. V. Ivashchenko YV, A. M. Burdin, G. R. VanBlaricom, and R. L. Brownell. 2012. Leaner leviathans: body condition variation in critically endangered whale population. J. Mammal. 93(1):251-266.

Branstetter BK, St Leger J, Acton D, Stewart J, Houser D, Finneran JJ, Jenkins K. 2017. Killer whale (Orcinus orca) behavioral audiograms. J Acoust Soc Am. 2017 Apr;141(4):2387. doi: 10.1121/1.4979116. PMID: 28464669.

Brennan, J.S., K. F. Higgins, J. R. Cordell, and V. A Stamatiou. 2004. Juvenile salmonid composition, timing, distribution and dies in Marine Nearshore waters of Central Puget Sound in 2001-2002. WRIA 8 and WRIA 9 Steering Committees and King County Water and Land Resources Division, Seattle, Washington. 167.

Brodeur, R. D., R. C. Francis, and W. G. Pearcy. 1992. Food consumption by juvenile coho (*Oncorhynchus kisutch*) and chinook salmon (*0. tshawytscha*) on the continental shelf off Washington and Oregon. Can. J. Fish. Aquat. Sci. 49:1670-1685.

Brophy LS, Greene CM, Hare VC, Holycross B, Lanier A, et al. (2019) Insights into estuary habitat loss in the western United States using a new method for mapping maximum extent of tidal wetlands. PLOS ONE 14(8): e0218558. https://doi.org/10.1371/journal.pone.0218558

Bryant, P.J., Lafferty, C.M. and Lafferty, S.K. 1984. Reoccupation of Laguna Guerrero Negro, Baja California, Mexico, by gray whales. pp. 375-387. In: M.L. Jones, S.L. Swartz, S. Leatherwood (eds.). The Gray Whale Eschrichtius robustus. Academic Press, San Diego, California. xxiv+600p

Buckler, D.R., and Granato, G.E., 1999, Assessing biological effects from highway-runoff constituents: U.S. Geological Survey Open-File Report 99-240, 45 p.

Burns, R. 1985. The shape and forms of Puget Sound. Published by Washington Sea Grant, and distributed by the University of Washington Press. 100 pages.

Busack, C., and K. P. Currens. 1995. Genetic risks and hazards in hatchery operations: Fundamental concepts and issues. AFS Symposium 15: 71-80.

Cacela, D., J. Lipton, D. Beltman, J. Hansen, and R. Wolotira. 2005. Associating ecosystem service losses with indicators of toxicity in habitat equivalency analysis. Environmental management. 35:343-351.

Campbell et al. (2017) Successful juvenile life history strategies in returning adult Chinook from five Puget Sound populations; Age and growth of Chinook salmon in selected Puget Sound and coastal Washington watersheds. SSMSP Technical Report.

Carman, R., B. Benson, T. Quinn, T. and D. Price. 2011. Trends in Shoreline Armoring in Puget Sound 2005-2010. Salish Sea Ecosystem Conference, Vancouver, B.C.

Carr, M.H. 1983. Spatial and temporal patterns of recruitment of young-of-the-year rockfishes (genus Sebastes) into a central California kelp forest. Master's thesis. San Francisco State Univ., Moss Landing Marine Laboratories, Moss Landing, CA.

Carr, M. 1991. Habitat selection and recruitment of an assemblage of temperate zone reef fishes

J. Exper Marine Biol and Ecol. Vol 146:113-137.

Carrasquero, J. 2001. Over-water Structures: Freshwater Issues. Washington State Department of Fish and Wildlife White Paper. Report of Herrera Environmental Consultants to Washington Department of Fish and Wildlife, Washington Department of Ecology, and Washington Department of Transportation.

Carretta, J. V., K. A. Forney, E. M. Oleson, D. W. Weller, A. R. Lang, J. Baker, M. M. Muto, B. Hanson, A. J. Orr, H. Huber, M. S. Lowry, J. Barlow, J. E. Moore, D. Lynch, L. Carswell, and R. L. Brownell Jr. 2019. U.S. Pacific Marine Mammal Stock Assessments: 2018. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-617.

Celedonia, M.T., R.A. Tabor, S. Sanders, S. Damm, D.W. Lantz, T.M. Lee, Z. Li, J.-M. Pratt, B.E. Price, and L. Seyda. 2008a. Movement and Habitat Use of Chinook Salmon Smolts, Northern Pikeminnow, and Smallmouth Bass Near the SR 520 Bridge, 2007 Acoustic Treacking Study. U.F.a.W. Service, editor. 139.

Celedonia, M.T., R.A. Tabor, S. Sanders, D.W. Lantz, and I. Grettenberger. 2008b. Movement and Habitat Use of Chinook Salmon Smolts and Two Predatory Fishes in Lake Washington and the Lake Washington Ship Canal, Western WS Fish and Wildlife Office Lacey, WA.

Center for Whale Research. 2019. https://www.whaleresearch.com/.

Chasco, B., I. C. Kaplan, E. J. Ward, A. Thomas, A. Acevedo-Gutierrez, D. P. Noren, M. J. Ford, M. B. Hanson, J. Scordino, S. J. Jeffries, S. F. Pearson, K. N. Marshall. 2017. Estimates of Chinook salmon consumption in Puget Sound area waters by four marine mammal predators from 1970 - 2015. Canadian Journal of Fisheries and Aquatic Sciences.

Cheung, W. W., R. D. Brodeur, T. A. Okey, D. Pauly. 2015. Projecting future changes in distributions of pelagic fish species of Northeast Pacific shelf seas. Progress in Oceanography, 130:19-31.

Clancy, M., I. Logan, J. Lowe, J. Johannessen, A. MacLennan, F.B. Van Cleve, J. Dillon, B. Lyons, R. Carman, P. Cereghino, B. Barnard, C. Tanner, D. Myers, R. Clark, J. White, C. Simenstad, M. Gilmer, and N. Chin. 2009. Management Measures for Protecting and Restoring the Puget Sound Nearshore. *In* Prepared in support of the Puget Sound Nearshore Ecosystem Restoration Project.

Clutton-Brock, T.H. 1998. Reproductive success. Studies of individual variation in contrasting breeding systems. University of Chicago Press; Chicago, Illinois.

Colman, J.A., Rice, K.C., and Willoughby, T.C., 2001, Methodology and significance of studies of atmospheric deposition in highway runoff: U.S. Geological Survey Open-File Report 01-259, 63 p.

Coulson, T., Benton, T. G., Lundberg, P., Dall, S. R., Kendall, B. E., & Gaillard, J. M. (2006). Estimating individual contributions to population growth: evolutionary fitness in ecological time. Proceedings. Biological sciences, 273(1586), 547–555. https://doi.org/10.1098/rspb.2005.3357

Crozier, L.G., Hendry, A.P., Lawson, P.W., Quinn, T.P., Mantua, N.J., Battin, J., Shaw, R.G. and Huey, R.B., 2008. Potential responses to climate change in organisms with complex life histories: evolution and plasticity in Pacific salmon. *Evolutionary Applications* 1(2): 252-270.

Crozier, L. G., M. D. Scheuerell, and E. W. Zabel. 2011. Using Time Series Analysis to Characterize Evolutionary and Plastic Responses to Environmental Change: A Case Study of a Shift Toward Earlier Migration Date in Sockeye Salmon. *The American Naturalist* 178 (6): 755-773.

Crozier L.G., M.M. McClure, T. Beechie, S.J. Bograd, D.A. Boughton, M. Carr, et al. 2019. Climate vulnerability assessment for Pacific salmon and steelhead in the California Current Large Marine Ecosystem. PLoS ONE 14(7): e0217711.

Daan, S., C. Deerenberg and C. Dijkstra. 1996. Increased daily work precipitates natural death in the kestrel. The Journal of Animal Ecology 65(5): 539 - 544.

Darnerud, P. O. 2003. Toxic effects of brominated flame retardants in man and in wildlife Environment. 29:841–853.

Darnerud, P. O. 2008. Brominated flame retardants as possible endocrine disrupters. Int. J. Androl. 31:152–160.

Daubenberger, H., J. Sullivan, E. Bishop, J. Aubin, H. Barrett. 2017. Mapping Nearshore Nodal Habitats of Juvenile Salmonids within the Hood Canal and Admiralty Inlet. Port Gamble S'Klallam Tribe Natural Resources Department. Mapping Nearshore Nodal Habitats of Juvenile Salmonids within the Hood Canal and Admiralty Inlet

Daly, E.A., R.D. Brodeur, and L.A. Weitkamp. 2009. Ontogenetic shifts in diets of juvenile and subadult coho and Chinook salmon in coastal marine waters: Important for marine survival? Transactions of the American Fisheries Society 138(6):1420-1438.

Daly, E.A., J.A. Scheurer, R.D. Brodeur, L.A. Weitkamp, B.R. Beckman, and J.A. Miller. 2014. Juvenile steelhead distribution, migration, feeding, and growth in the Columbia River estuary, plume, and coastal waters. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 6(1):62-80.

de Boer, J., K. de Boer, and J. P. Boon. 2000. Toxic effects of brominated flame retardants in man and wildlife. Environ. Int. 29:841–853.

de Guise, S., M. Levin, E. Gebhard, L. Jasperse, L. B. Hart, C. R. Smith, S. Venn-Watson, F. Townsend, R. Wells, B. Balmer, E. Zolman, T. Rowles, and L. Schwacke. 2017. Changes in immune functions in bottlenose dolphins in the northern Gulf of Mexico associated with the Deepwater Horizon oil spill. Endangered Species Research. 33: 291–303.

de Swart, R. L., P. S. Ross, J. G. Vos, and A.Osterhaus. 1996. Impaired immunity in habour seals (*Phoca vitulina*) exposed to bioaccumulated environmental contaminants: Review of long-term feeding study. Environ. Health Perspect. 104:823–828.

Deagle, B.E., D.J. Tollit, S.N. Jarman, M.A. Hindell, A.W. Trites, and N.J. Gales. 2005. Molecular scatology as a tool to study diet: analysis of prey DNA in scats from captive Steller sea lions. Mol. Ecol. 14:1831-1842.

Dernie, K.M., M.J. Kaiser, E.A. Richardson, and R.M. Warwick. 2003. Recovery of soft sediment communities and habitats following physical disturbance. Journal of experimental Marine Biology and Ecology 285-286: 415-434.

Dethier, M.N., W.W. Raymond, A.N. McBride, J.D. Toft, J.R. Cordell, A.S. Ogston, S.M. Heerhartz, and H.D. Berry. 2016. Multiscale impacts of armoring on Salish Sea shorelines: Evidence for cumulative and threshold effects. Estuarine, Coastal and Shelf Science. 175:106-117.

Dethier, M. N., and Schoch, G. C. (2005). The consequences of scale: assessing the distribution of benthic populations in a complex estuarine fjord. *Estuarine, Coastal and Shelf Science, 62*(1-2), 253-270. doi:https://doi.org/10.1016/j.ecss.2004.08.021

Di Lorenzo, E., Mantua, N. Multi-year persistence of the 2014/15 North Pacific marine heatwave. Nature Clim Change 6, 1042–1047.

Dominguez, F., E. Rivera, D. P. Lettenmaier, and C. L. Castro. 2012. Changes in Winter Precipitation Extremes for the Western United States under a Warmer Climate as Simulated by Regional Climate Models. *Geophysical Research Letters* 39(5).

Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley. 2012. Climate Change Impacts on Marine Ecosystems. *Annual Review of Marine Science*, 4: 11-37.

Drake J.S., E.A. Berntson, J.M. Cope, R.G. Gustafson, E.E. Holmes, P.S. Levin, N. Tolimieri, R.S. Waples, S.M. Sogard, and G.D. Williams. 2010. Status review of five rockfish species in Puget Sound, Washington: boccaccio (*Sebastes paucispinis*), canary rockfish (*S. pinniger*), yelloweye rockfish (*S. ruberrimus*), greenstriped rockfish (*S. elongatus*), and redstripe rockfish (*S. proriger*). U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-108, 234 pp.

Dressing, S. A., D. W. Meals, J.B. Harcum, and J. Spooner, J.B. Stribling, R.P. Richards, C.J. Millard, S.A. Lanberg, and J.G. O'Donnell. 2016. Monitoring and evaluating nonpoint source watershed projects. Prepared for the U.S. Environmental Protection Agency, Office of Water Nonpoint Source Control Branch, Washington, DC. EPA 841-R-16-010. May 2016. https://www.epa.gov/sites/production/files/2016-06/documents/nps_monitoring_guide_may_2016-combined_plain.pdf

Driscoll, E.D., P.E. Shelly, and E.W. Strecker. 1990. Pollutant loadings and impacts from highway stormwater runoff, volume III—Analytical investigation and research report: U.S. Federal Highway Administration Final Report FHWA-RD-88-008, 160 p

Duffy, E.J., and D.A. Beauchamp. 2011. Rapid growth in the early marine period improves the marine survival of Chinook salmon (*Oncorhynchus tshawytscha*) in Puget Sound, Washington. Canadian journal of fisheries and aquatic sciences/Journal canadien des sciences halieutiques et aquatiques. 68:232-240.

Duffy, E. J., D.A. Beauchamp, R. M. Buckley. 2005. Early marine life history of juvenile Pacific salmon in two regions of Puget Sound. Estuarine, Coastal and Shelf Science. 64. 94-107. 10.1016/j.ecss.2005.02.009.

Dunford RW, Ginn TC, Desvousges WH. The use of habitat equivalency analysis in natural resource damage assessments. Ecological Economics. 2004;48:49–70. doi: 10.1016/j.ecolecon.2003.07.011.

Durban, J., H. Fearnbach, D. Ellifrit, and K. Balcomb. 2009. Size and Body Condition of Southern Resident Killer Whales. Contract report to National Marine Fisheries Service, Order No. AB133F08SE4742, February 2009.

Durban, J. W., H. Fearnbach, L. Barrett-Lennard, M. Groskreutz, W. Perryman, K. Balcomb, D. Ellifrit, M. Malleson, J. Cogan, J. Ford, and J. Towers. 2017. Photogrammetry and Body Condition. Availability of Prey for Southern Resident Killer Whales. Technical Workshop Proceedings. November 15-17, 2017.

Dygert, P., A. Purcell, and L. Barre. 2018. Memorandum to Bob Turner (NMFS) from Peter Dygert (NMFS). Hatchery Production Initiative for Increasing Prey Abundance of Southern Resident Killer Whales. August 1, 2018. NMFS, Seattle, Washington. 3p.

Ecology. 2011. "Toxics in Surface Runoff to Puget Sound: Phase 3 Data and Load Estimates." Washington State Department of Ecology. Prepared by Herrera Environmental Consultants, Inc. Ecology Publication No. 11-03-010.

Ecology & King County. 2011. "Control of Toxic Chemicals in Puget Sound: Assessment of Selected Toxic Chemicals in the Puget Sound Basin, 2007-2011." Washington State Department of Ecology and King County Department of Natural Resources. Ecology Publication No. 11-03-055.

Ehinger, S. I., J. P. Fisher, R. McIntosh, D. Molenaar and J. Walters. 2015. Working Draft, April 2015: Use of The Puget Sound Nearshore Habitat Values Model with Habitat Equivalency Analysis for Characterizing Impacts and Avoidance Measures for Projects that Adversely Affect Critical Habitat of ESA-Listed Chinook and Chum Salmon.

Elasser, T.H., KC Klasing, N Flipov and F Thompson, 2000. The Metabolic consequences of stress: Targets for stress and priorities of nutrient use. In 'The Biology of Animal Stress', G P Moberg and J A Mench, pp77-110. CAB INTERNATIONAL. Wallingford.

Emmons, C. K., J. J. Hard, M. E. Dahlheim, J. Waite. 2018. Quantifying variation in killer whale (*Orcinus orca*) morphology using elliptical Fourier analysis. Marine Mammal Science.

Emmons, C.K., M.B. Hanson, and M.O. Lammers. 2019. Monitoring the occurrence of Southern resident killer whales, other marine mammals, and anthropogenic sound in the Pacific Northwest. Prepared for: U.S. Navy, U.S. Pacific Fleet, Pearl Harbor, HI. Prepared by: National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center under MIPR N00070-17-MP-4C419. 25 February 2019. 23p.

Erbe, C. and C. McPherson. 2017. Radiated noise levels from marine geotechnical drilling and standard penetration testing. The Journal of the Acoustical Society of America 141, 3847

Erickson, A. W. 1978. Population studies of killer whales (*Orcinus orca*) in the Pacific Northwest: a radio-marking and tracking study of killer whales. September 1978. U.S. Marine Mammal Commission, Washington, D.C.

Eriksson, B.K., A. Sandstrom, M. Isaeus, H. Schreiber, and P. Karas. 2004. Effects of boating activities on aquatic vegetation in the Stockholm archipelago, Baltic Sea. Estuar Coast Shelf S. 61:339-349.

Evans, M., K. Fazakas, J. Keating. 2009. Creosote Contamination in Sediments of the Grey Owl Marina in Prince Albert National Park, Saskatchewan, Canada. Water Air Soil Pollution. 201:161–184.

Fagan, W.F. and E.E. Holmes. 2006. Quantifying the extinction vortex. Ecology Letters 9:51-60.

Fearnbach, H., J. W. Durban, D. K. Ellifrit, and K. C. Balcomb. 2018. Using aerial photogrammetry to detect changes in body condition of endangered southern resident killer whales. Endangered Species Research. 35: 175–180.

Fisheries Hydroacoustic Working Group (FHWG). 2008. Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities. Technical/Policy Meeting Vancouver, WA. June, 11 2008.

Feely, R.A., T. Klinger, J.A. Newton, and M. Chadsey (editors). 2012. Scientific summary of ocean acidification in Washington state marine waters. NOAA Office of Oceanic and Atmospheric Research Special Report.

Feist, B.E., J.J. Anderson, and R. Miyamoto. 1996. Potential impacts of pile driving on juvenile pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) salmon behavior and distribution. Fisheries Research Institute Report No. FRI-UW-9603:66 pp.

Forest Ecosystem Management Assessment Team (FEMAT). 1993. Forest ecosystem management: An ecological, economic, and social assessment. Report of the Forest Ecosystem Management Assessment Team. 1993-793-071. U.S. Gov. Printing Office.

Fernandez, M., Iribarne, O., Armstrong, D. 1993. Habitat selection by young-of-the-year Dungeness crab *Cancer magister* and predation risk in intertidal habitats. Mar. Ecol. Prog. Ser. 92:171-177.

Ferrara, G. A., T. M. Mongillo, and L. M. Barre. 2017. Reducing Disturbance from Vessels to Southern Resident Killer Whales: Assessing the Effectiveness of the 2011 Federal Regulations in Advancing Recovery Goals. December 2017. NOAA Technical Memorandum NMFS-OPR-58. 82p.

Fewtrell, J. L., 2003. The response of marine finfish and invertebrates to seismic survey noise. PhD Thesis. Curtin University. 15125_Fewtrell Leah 2003.pdf (8.064Mb)

Fewtrell, J.L., and R.D. McCauley. 2012. Impact of air gun noise on the behaviour of marine fish and squid. Marine Pollution Bulletin Volume 64(5): 984-993

Fisher, J. L., W. T. Peterson, and R. R. Rykaczewski. 2015. The impact of El Niño events on the pelagic food chain in the northern California Current. Global Change Biology. 21(12): 4401–4414.

Fonnum, F., E. Mariussen, and T. Reistad. 2006. Molecular mechanisms involved in the toxic effects of polychlorinated biphenyls (PCBs) and brominated flame retardants (BFRs). J. Toxicol. Environ. Health A 69:21–35.

Ford, J. K. B. 2002. Killer whale Orcinus orca. Pages 669-676 in W. F. Perrin, B. Würsig, and J. G. M. Thewissen, editors. Encyclopedia of marine mammals. Academic Press, San Diego, California.

Ford, J. K. B. and G.M. Ellis. 2006. Selective foraging by fish-eating killer whales Orcinus orca in British Columbia. Marine Ecology Progress Series 316:185-199.

Ford, J. K. B., G. M. Ellis, and K. C. Balcomb. 2000. Killer whales: the natural history and genealogy of *Orcinus orca* in British Columbia and Washington State. 2nd ed. UBC Press, Vancouver, British Columbia.

Ford, J. K. B., G. M. Ellis, L. G. Barrett-Lennard, A. B. Morton, R. S. Palm, and K. C. B. III. 1998. Dietary specialization in two sympatric populations of killer whales (*Orcinus orca*) in coastal British Columbia and adjacent waters. Canadian Journal of Zoology. 76(8): 1456-1471.

Ford, J. K. B., J. F. Pilkington, A. Reira, M. Otsuki, B. Gisborne, R. M. Abernethy, E. H. Stredulinsky, J. R. Towers, and G. M. Ellis. 2017. Habitats of Special Importance to Resident Killer Whales (Orcinus orca) off the West Coast of Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2017/035. Viii + 57 p.

Ford, M. J. (ed.). 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-113, 281pp.

Ford, M. 2015. Results of NOAA BRT review of new genetics information, memo from the NWFSC to PRD, December 9, 2015.

Ford, M. J., T. Cooney, P. McElhany, N. J. Sands, L. A. Weitkamp, J. J. Hard, M. M. McClure, R. G. Kope, J. M. Myers, A. Albaugh, K. Barnas, D. Teel, and J. Cowen. 2011a. Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest. November 2011. U.S. Dept. Commer., NOAA Tech. Memo., NMFS-NWFSC-113. 307p.

Ford, M. J., M. B. Hanson, J. Hempelmann, K. L. Ayres, C. K. Emmons, G. S. Schorr, R. W. Baird, K. C. Balcomb, S. K. Wasser, K. M. Parsons, K. Balcomb-Bartok. 2011. Inferred Paternity and Male Reproductive Success in a Killer Whale (*Orcinus orca*) Population. Journal of Heredity. Volume 102 (Issue 5), pages 537 to 553.

Ford, M. J., J. Hempelmann, B. Hanson, K. L. Ayres, R. W. Baird, C. K. Emmons, J. I. Lundin, G. S. Schorr, S. K. Wasser, and L. K. Park. 2016. Estimation of a killer whale (*Orcinus orca*) population's diet using sequencing analysis of DNA from feces. PLoS ONE. 11(1): 1-14.

Ford, M. J., K. M. Parsons, E. J. Ward, J. Hempelmann, C. K. Emmons, M. B. Hanson, K. C. Balcomb, L. K. Park. 2018. Inbreeding in an endangered killer whale population. *Animal Conservation*. https://doi.org/10.1111/acv.12413

Fresh, K.L. 2006. Juvenile Pacific Salmon in Puget Sound. Puget Sound Nearshore Partnership Report No. 2006-06. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Fresh K., M. Dethier, C. Simenstad, M. Logsdon, H. Shipman, C. Tanner, T. Leschine, T. Mumford, G. Gelfenbaum, R. Shuman, J. Newton. 2011. Implications of Observed Anthropogenic Changes to the Nearshore Ecosystems in Puget Sound. Prepared for the Puget Sound Nearshore Ecosystem Restoration Project. Technical Report 2011-03.

Fuss, H. J., and C. Ashbrook. 1995. Hatchery Operation Plans and Performance Summaries, Annual Report. Volume I, Number 2, Puget Sound. Assessment and Development Division. Hatcheries Program. November 1995. WDFW, Olympia, Washington. 567p.

Gamel, C.M., R.W. Davis, J.H.M. David, M.A. Meyer and E. Brandon. 2005. Reproductive energetics and female attendance patterns of Cape fur seals (*Arctocephalus pusillus pusillus*) during early lactation. American Midland Naturalist 153(1): 152-170

Gard, R. 1974. Aerial census of gray whales in Baja California Lagoons, 1970 and 1973, with notes on behavior, mortality, and conservation. Calif. Fish and Game. 60(3):132-143.

Garono, R. J., R. Robinson, and C. Simenstad. 2002. Assessment of estuarine and nearshore habitats for threatened salmon stocks in the Hood Canal and eastern Strait of Juan de Fuca, Washington State: Focal Areas 1-4. Rept. submitted to Point No Point Treaty Council, Earth Design Consultants, Inc., Wetland & Watershed Assessment Group, Corvallis, OR. 27 pp + figs. http://www.pnptc.org/PNPTC_Web_data/Publications/habitat/Hood_Canal_Nearshore_Habitats_July_2002.pdf

Gaydos, J.K., and S. Raverty. 2007. Killer Whale Stranding Response, August 2007 Final Report. Report under UC Davis Agreement No. C 05-00581 V, August 2007.

Gilpin, M. E., and M. E. Soulé. 1986. Minimum viable populations: Processes of species extinction. Conservation biology: the science of scarcity and diversity. 19-34.

Glick, P., J. Clough, and B. Nunley. 2007. Sea-Level Rise and Coastal Habitats in the Pacific Northwest: An analysis for Puget Sound, southwestern Washington, and northwestern Oregon. National Wildlife Federation, Seattle, WA.

Goetz, F. A., Jeanes, E., Moore, M. E., and Quinn, T. P. (2015). Comparative migratory behavior and survival of wild and hatchery steelhead (Oncorhynchus mykiss) smolts in riverine, estuarine, and marine habitats of Puget Sound, Washington. Environmental Biology of Fishes, 98(1), 357-375. doi:http://dx.doi.org/10.1007/s10641-014-0266-3

Goode, J.R., Buffington, J.M., Tonina, D., Isaak, D.J., Thurow, R.F., Wenger, S., Nagel, D., Luce, C., Tetzlaff, D. and Soulsby, C., 2013. Potential effects of climate change on streambed scour and risks to salmonid survival in snow-dominated mountain basins. *Hydrological Processes* 27(5): 750-765

Gordon, J. and A. Moscrop. 1996. Underwater noise pollution and its significance for whales and dolphins. Pages 281-319 in M. P. Simmonds and J. D. Hutchinson, editors. The conservation of whales and dolphins: science and practice. John Wiley & Sons, Chichester, United Kingdom.

Graham, A.L. and S. J. Cooke. 2008. The effects of noise disturbance from various recreational boating activities common to inland waters on the cardiac physiology of a freshwater fish, the largemouth bass (*Micropterus salmoides*). Aquatic Conservation: Marine and Freshwater Ecosystems, 18, 1315-1324.

Greene, C. and A. Godersky. 2012. Larval rockfish in Puget Sound surface waters. Northwest Fisheries Science Center, NOAA. December 27.

Haas, M.E., C.A. Simenstad, J.R. Cordell, D.A. Beauchamp, and B.S. Miller. 2002. Effects of Large Overwater Structures on Epibenthic Juvenile Salmon Prey Assemblages in Puges Sound, WA.

Haigh, R., D. Ianson, C.A. Holt, H.E. Neate, and A.M. Edwards. 2015. Effects of ocean acidification on temperate coastal marine ecosystems and fisheries in the Northeast Pacific. PLoS ONE 10(2):e0117533.

Halderson, L. and L. J. Richards. 1987. Habitat use and young of the year copper rockfish (Sebastes caurinus) in British Columbia. Pages 129 to 141 in Proceedings of the International Rockfish Symposium, Anchorage, Alaska. Alaska Sea Grant Report, 87-2, Fairbanks, AK.

Hanson, M. B., and C. K. Emmons. 2010. Annual Residency Patterns of Southern Resident Killer Whales in the Inland Waters of Washington and British Columbia. Revised Draft - 30 October 10. 11p.

Hanson, M.B., C.K. Emmons, M.J. Ford, K. Parsons, J. Hempelmann, D.M.V. Doornik, G.S. Schorr, J. Jacobsen, M. Sears, J.G. Sneva, R.W. Baird and L. Barre. In prep. Seasonal diet of Southern Resident Killer Whales.

Hanson, M.B., R.W. Baird, J.K.B. Ford, J. Hempelmann-Halos, D.M. Van Doornik, J.R. Candy, C.K. Emmons, G.S. Schorr, B. Gisborne, K.L. Ayers, S.K. Wasser, K.C. Balcomb, K. Balcomb-Bartok, J.G. Sneva, and M.J. Ford. 2010. Species and stock identification of prey selected by endangered "southern resident" killer whales in their summer range. *Endangered Species Research* 11:69-82.

Hanson, M. B., C. K. Emmons, E. J. Ward, J. A. Nystuen, M. O. Lammers. 2013. Assessing the coastal occurrence of endangered killer whales using autonomous passive acoustic recorders. Journal of the Acoustical Society of America, 134(5):3486-3495.

Hanson, M.B., E.J. Ward, C.K. Emmons, M.M. Holt and D.M. Holzer. 2017. Assessing the movements and occurrence of Southern Resident Killer Whales relative to the U.S. Navy's Northwest Training Range Complex in the Pacific Northwest. Prepared for: U.S. Navy, U.S. Pacific Fleet, Pearl Harbor, HI. Prepared by: National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center under MIPR N00070- 15-MP-4C363. 30 June 2017. 23 pp

Hanson, M.B., E.J. Ward, C.K. Emmons, and M.M. Holt. 2018. Modeling the occurrence of endangered killer whales near a U.S. Navy Training Range in Washington State using satellite-tag locations to improve acoustic detection data. Prepared for: U.S. Navy, U.S. Pacific Fleet, Pearl Harbor, HI. Prepared by: National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center under MIPR N00070-17-MP-4C419. 8 January 2018. 33 p.

Hard, J.J., J.M. Myers, M.J. Ford, R G. Cope, G.R. Pess, R S. Waples, G.A. Winans, B.A. Berejikian, F.W. Waknitz, P.B. Adams, P.A. Bisson, D.E. Campton, and R.R. Reisenbichler. 2007. Status review of Puget Sound steelhead (*Oncorhynchus mykiss*). U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-81.

Hard, J.J., J.M. Myers, E.J. Connor, R.A. Hayman, R.G. Kope, G. Lucchetti, A.R. Marshall,

G.R. Pess, and B.E. Thompson. 2015. Viability criteria for steelhead within the Puget Sound distinct population segment. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-NWFSC-129. May 2015. 367 pp

Hastings, M.C. 2007. Calculation of SEL for Govoni et al. (2003, 2007) and Popper et al. (2007)studies. Report for Amendment to Project 15218, J&S Working Group, Applied Research Lab, Penn State University. 7 pp.

Hastings, M.C., and A. N. Popper. 2005. Effects of sound on fish. Final Report # CA05-0537 – Project P476 Noise Thresholds for Endangered Fish. For: California Department of Transportation, Sacramento, CA. January 28, 2005, August 23, 2005 (Revised Appendix B). 85 pp.

Hastings, M.C., A.N. Popper, J.J. Finneran, and P. Lanford. 1996. Effects of low-frequency underwater sound on hair cells of the inner ear and lateral line of the teleost fish Astronotus ocellatus. Journal of the Acoustical Society of America 99(3): 1759-1766

Hatchery Scientific Review Group (HSRG). 2000. Scientific framework for artificial propagation of salmon and steelhead. Puget Sound and Coastal Washington hatchery reform project.

Hatchery Scientific Review Group. 2002. Hatchery Reform Recommendations for the Puget Sound and Coastal Washington Hatchery Reform Project. Long Live the Kings, Seattle, Washington. (available from www.hatcheryreform.org).

HSRG. 2014. On the Science of Hatcheries: An updated perspective on the role of hatcheries in salmon and steelhead management in the Pacific Northwest. June 2014, (updated October 2014). 160p.

Hauser, D.D.W., M.G. Logsdon, E.E. Holmes, G.R. VanBlaricom, R.W. Osborne. 2007. Summer distribution patterns of southern resident killer whales Orcinus orca: core areas and spatial segregation of social groups. Marine Ecology Progress Series 351:301-310.

Hayden-Spear, J., 2006. Nearshore habitat Associations of Young-of-Year Copper (*Sebastes caurinus*) and quillback (*S. maliger*) rockfish in the San Juan Channel, Washington. Unpublished Master of Science Dissertation. University of Washington.

Heiser, D.W., and E.L. Finn 1970. Observations of Juvenile Chum and Pink Salmon in Marina and Bulkheaded Areas. State of Washington Department of Fisheries.

Hilborn, R., S. P. Cox, F. M. D. Gulland, D. G. Hankin, N. T. Hobbs, D. E. Schindler, A. W. Trites. 2012. The effects of salmon fisheries on Southern Resident killer whales: Final report of the Independent Science Panel. Prepared with the assistance of D. R. Marmorek and A. W. Hall, ESSA Technologies Ltd., Vancouver, BC. National Marine Fisheries Service, Seattle, WA, and Fisheries and Oceans Canada, Vancouver, BC.

Hochachka, W.M. 2006. Unequal lifetime reproductive success, and its implication for small isolated populations. Pages: 155-173. In: Biology of small populations: the song sparrows of Mandarte Island. Edited by J.N.M. Smith, A.B. Marr, L.F. Keller and P. Arcese. Oxford University Press; Oxford, United Kingdom.

Holt, M. M. 2008. Sound Exposure and Southern Resident Killer Whales (*Orcinus orca*): A Review of Current Knowledge and Data Gaps. February 2008. NOAA Technical Memorandum NMFS-NWFSC-89, U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-89. 77p.

Holt, M. M., D. P. Noren, R. C. Dunkin, and T. M. Williams. 2015. Vocal performance affects metabolic rate in dolphins: implications for animals communicating in noisy environments. Journal of Experimental Biology. 218: 1647–1654.

Hood Canal Coordinating Council (HCCC). 2005. Hood Canal and Eastern Strait of Juan de Fuca summer chum salmon recovery plan. Version November 15, 2005. 339 pp.

Hoyt, E. 2001. Whale watching 2001: worldwide tourism numbers, expenditures, and expanding socioeconomic benefits. International Fund for Animal Welfare, Yarmouth, Massachusetts.

Hunter, M.A. 1992. Hydropower flow fluctuations and salmonids: A review of the biological effects, mechanical causes, and options for mitigation. Washington Department of Fisheries. Technical Report No. 119. Olympia, Washington.

Hutchings, J. A. and J. D. Reynolds. 2004. Marine Fish Population Collapses: Consequences for Recovery and Extinction Risk. BioScience, Vol. 54(4): 297-309

Independent Scientific Advisory Board (ISAB, editor). 2007. Climate change impacts on Columbia River Basin fish and wildlife. In: Climate Change Report, ISAB 2007-2. Independent Scientific Advisory Board, Northwest Power and Conservation Council. Portland, Oregon.

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Isaak, D.J., Wollrab, S., Horan, D. and Chandler, G., 2012. Climate change effects on stream and river temperatures across the northwest US from 1980–2009 and implications for salmonid fishes. *Climatic Change* 113(2): 499-524.

Jarvela-Rosenberger, A.L., M. MacDuffee, A.G.J. Rosenberger, and P.S. Ross. 2017. Oil spills and marine mammals in British Columbia, Canada: Development and application of a risk-based conceptual framework. Arch. Environ. Contam. Toxicol. 73:131-153.

Joblon, M. J., M. A. Pokra, B. Morse, C. T. Harry, K. S. Rose, S. M. Sharp, M. E. Niemeyer, K. M. Patchett, W. B. Sharp, and M. J. Moore. 2014. Body condition scoring system for delphinids based on short-beaked common dolphins (*Delphinus delphis*). J Mar Anin Ecol 7(2):5-13.

Johannessen, J., A. MacLennan, A. Blue, J. Waggoner, S. Williams, W. Gerstel, R. Barnard, R. Carman, and H. Shipman. 2014. Marine Shoreline Design Guidelines. Washington Department of Fish and Wildlife, Olympia, Washington.

Johnson, O. W., S. W. Grant, R. G. Kope, K. Neely, and F. W. Waknitz. 1997. Status review of chum salmon from Washington, Oregon, and California. U.S. Department of Commerce NOAA Tech Memo NMFS NWFSC 32, Seattle, WA.

Jones and Stokes Associates, Inc. 1998. Subtidal Epibenthic/Infaunal Community and Habitat Evaluation. East Waterway Channel Deepening Project, Seattle, WA. Prepared for the US Army Corps of Engineers, Seattle District, Seattle, Washington.

Kagley, A., J.M. Smith, M.C. Arostegui, J.W. Chamberlin, D. Spilsbury-Pucci, K. L. Fresh, K.E. Frick, and T.P. Quinn. 2016. Movements of sub-adult Chinook salmon (Oncorhynchus tshawytscha) in Puget Sound, Washington, as indicated by hydroacoustic tracking. Presented at Salish Sea Ecosystem Conference, Vancouver, BC, Canada.

Kahler, T., M. Grassley, and D. Beauchamp. 2000. A summary of the effects of bulkheads, piers, and other artificial structures and shorezone development on ESA-listed salmonids in lakes. Final Report prepared for the City of Bellevue

Kannan, K., A.L. Blankenship, P.D. Jones, and J.P. Giesy JP. 2000. Toxicity reference values for the toxic effects of polychlorinated biphenyls to aquatic mammals. Hum Ecol Risk Assess 6:181-201.

Karrow, N., H.J. Boermans, D.G. Dixon, A. Hontella, K.R. Soloman, J.J. White, and N.C. Bols. 1999. Characterizing the immunotoxicity of creosote to rainbow trout (Oncorhynchus mykiss): a microcosm study. Aquatic Toxicology. 45 (1999) 223–239.

Kashef, N. S., S. M. Sogard, R. Fisher, and J. Largier. 2014. Ontogeny of critical swimming speeds for larval and pelagic juvenile rockfishes (Sebastes spp., family Scorpaenidae). Marine Ecology Progress Series. 500. 231-243. 10.3354/meps10669.

Kayhanian, M., A. Singh, C. Suverkropp, and S. Borroum. 2003. Impact of annual average daily traffic on highway runoff pollutant concentrations. J. Environ. Eng., 129 (2003), pp. 975-990

Kellar, N. M., T. R. Speakman, C. R. Smith, S. M. Lane and others. 2017. Low reproductive success rates of common bottlenose dolphins Tursiops truncatus in the northern Gulf of Mexico following the Deepwater Horizon disaster (2010-2015). Endang Species Res 33:143-158.

Kelty, R., and S. Bliven. 2003. Environmental and aesthetic impacts of small docks and piers workshop report: Developing a science-based decision support tool for small dock management, phase 1: Status of the science. *In* Decision Analysis Series No. 22. N.C.O. Program, editor.

Kemp, P.S., M.H. Gessel, and J.G. Williams. 2005. Seaward migrating subyearling Chinook salmon avoid overhead cover. *Journal of Fish Biology*. 67:10.

Kendall, A. W. and W. H. Lenarz. 1986. Status of early life history studies of northeast Pacific rockfishes. Proceedings of the International Rockfish Symposium, Anchorage, Alaska. Alaska Sea Grant Report, 87-2, Fairbanks 99701.

Kendall, A. W. Jr., and S. J. Picquelle. 2003. Marine protected areas and the early life history of fishes. AFSC Processed Rep. 2003-10, 30 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., Seattle, WA.

Kilduff, P., L. W. Botsford, and S. L. H. Teo. 2014. Spatial and temporal covariability in early ocean survival of Chinook salmon (*Oncorhynchus tshawytscha*) along the west coast of North America. ICES Journal of Marine Science. 71. 10.1093/icesjms/fsu031.

King County. 2014. The WRIA 9 Marine Shoreline Monitoring and Compliance Pilot Project. Prepared by Kollin Higgins, Water and Land Resources Division for the WRIA 9 Watershed Ecosystem Forum. Seattle, Washington.

King County. 2019. WRIA 9 Marine Shoreline Monitoring and Compliance Project Phase 2 Final Report. Prepared by Kollin Higgins, King County Water and Land Resources Division, Science and Technical Support Section. Seattle, Washington.

Kondolf, G.M. 1997. Hungry water: Effects of dams and gravel mining on river channels. Environmental Management 21(4):533-551.

Krahn, M.M., P.R. Wade, S.T. Kalinowski, M.E. Dahlheim, B.L. Taylor, M.B. Hanson, G.M. Ylitalo, R.B. Angliss, J.E. Stein, and R.S. Waples. 2002. Status review of Southern Resident killer whales (Orcinus orca) under the Endangered Species Act, U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC- 54, 133p.

Krahn, M.M., M.J. Ford, W.F. Perrin, P.R. Wade, R.B. Angliss, M.B. Hanson, B.L. Taylor, G.M. Ylitalo, M.E. Dahlheim, J.E. Stein, and R.S. Waples. 2004. 2004 status review of Southern Resident killer whales (*Orincus orca*) under the Endangered Species Act, U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-62, 73p.

Krahn, M.M., M.B. Hanson, R.W. Baird, R.H. Boyer, D.G. Burrows, C.K. Emmons, J.K.B. Ford, L.L. Jones, D.P. Noren, P.S. Ross, G.S. Schorr, and T.K. Collier. 2007. Persistent organic pollutants and stable isotopes in biopsy samples (2004/2006) from Southern Resident killer whales. Marine Pollution Bulletin 54:1903-1911.

Krahn, M.M., M.B. Hanson, G.S. Schorr, C.K. Emmons, D.G. Burrows, J.L. Bolton, R.W. Baird, and Gina Ylitalo. 2009. Effects of age, sex and reproductive status on persistent organic pollutant concentrations in “Southern Resident” killer whales. Marine Pollution Bulletin 58:1522-1529.

Kunkel, K. E., L. E. Stevens, S. E. Stevens, L. Sun, E. Janssen, D. Wuebbles, K. T. Redmond, and J. G. Dobson. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 6. *Climate of the Northwest U.S. NOAA Technical Report NESDIS 142-6*. 83 pp. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, Washington, D.C.

Krenz, D. 2020. October 29, 2020 Email Communication between Stephanie Ehinger of National Marine Fisheries Services and Daniel Krentz, Seattle District. US Army Corps of Engineers. Subnect: Maintenance Dredging Information Needs.

Lachmuth, C. L., L. G. Barrett-Lennard, D. Q. Steyn, and W. K. Milsom. 2011. Estimation of Southern Resident Killer Whale exposure to exhaust emissions from whale-watching vessels and potential adverse health effects and toxicity thresholds. Marine Pollution Bulletin. 62: 792–805.

Lacy, R. C., R. Williams, E. Ashe, K. C. Balcomb III, L. J. N. Brent, C. W. Clark, D. P. Croft, D. A. Giles, M. MacDuffee, and P. C. Paquet. 2017. Evaluating anthropogenic threats to endangered killer whales to inform effective recovery plans. Scientific Reports. 7:14119. doi:10.1038/s41598-017-0.

Landrum, P.F., B.J. Eadie, W.R. Faust, N.R. Morehead, and M.J. McCormick. 1984. Role of sediment in t e bioaccumulation of benzo(a)pyrene by the amphipod, *Pontoporeia hoyi*. Pages 799-812 in M. Cooke and A.J. Dennis (eds.). Polynuclear aromatic hydrocarbons: mechanisms, methods and metabolism. Battelle Press, Columbus, Ohio.

Landrum, P.F., and D. Scavia. 1983. Influence of sediment on anthracene uptake, depuration, and biotransformation by the amphipod *Hyalella azteca*. Canada. J. Fish. Aquatic Sci. 40:298-305.

LaSalle, M.W. 1988. Physical and chemical alterations associated with dredging: an overview. Pages 1-12 in C.A. Simenstad, ed. Effects of dredging on anadromous Pacific coast fishes. University of Washington, Seattle, Washington.

Lawson, P. W., Logerwell, E. A., Mantua, N. J., Francis, R. C., and V. N. Agostini. 2004. Environmental factors influencing freshwater survival and smolt production in Pacific Northwest coho salmon (Oncorhynchus kisutch). Canadian Journal of Fisheries and Aquatic Sciences 61(3): 360-373

Lawson, Teresa M., G. M. Ylitalo, S. M. O'Neill, M. E. Dahlheim, P. R. Wade, C. O. Matkin, V. Burkanov, and D. T. Boyd. 2020. Concentrations and profiles of organochlorine contaminants in North Pacific resident and transient killer whale (Orcinus orca) populations. Science of Total Environment. 722: 137776

Learmonth, J. A., C. D. MacLeod, M. B. Santos, G.J. Pierce, H. Crick and R.A. Robinson. 2007. Potential Effects Of Climate Change On Marine Mammals *In* Oceanography and Marine Biology: An Annual Review, 2006, 44: 431-464. 10.1201/9781420006391.ch8.

Lee, R. and G. Dobbs. 1972. Uptake, Metabolism and Discharge of Polycyclic Aromatic Hydrocarbons by Marine Fish. Marine Biology. 17, 201-208.

Leet, W.S., A Dewees, C.M., A Haugen, C.W. 1992. California's Living Marine Resources and Their Utilization. University of California, Davis. Wildlife and Fisheries Biology. Sea Grant Extension Program, Department of Wildlife and Fisheries Biology, University of California

Legler, J. 2008. New insights into the endocrine disrupting effects of brominated flame retardants. Chemosphere 73:216–222.

Legler, J., and A. Brouwer. 2003. Are brominated flame retardants endocrine disruptors? Environ. Int. 29:879–885.

Lemmen, D.S., F.J. Warren, T.S. James, and C.S.L. Mercer Clarke (Eds.). 2016. Canada's marine coasts in a changing climate. Government of Canada, Ottowa, Ontario.

Levin, P. S. and Williams, J.G. 2002. Interspecific effects of artificially propagated fish: An additional conservation risk for salmon. Conservation Biology 16: 1581-1587.

Limburg, K., R. Brown, R. Johnson, B. Pine, R. Rulifson, D. Secor, et al. 2016. Round-the-coast: Snapshots of estuarine climate change effects. Fisheries 41(7):392-394. https://doi.org/10.1080/03632415.2016.1182506.

LLTK. 2015. Why focus on Salish Sea? Salish Sea Marine Survival Project. Long Live The Kings and Pacific Salmon Fund: https://marinesurvivalproject.com/the-project/why/.

Love, M. S., M. H. Carr, and L. J. Haldorson. 1991. The ecology of substrate-associated juveniles of the genus Sebastes. Environ. Biol. Fishes 30:225–243.

Love, M. 1996. Probably more than you want to know about the fishes of the Pacific Coast. 2nd Ed. Santa Barbara, CA: Really Big Press, 335 p.

Love, M. S., M. Yoklavich, and L. Thorsteinson. 2002. The Rockfishes of the Northeast Pacific. University of California Press. 404 p.

Lucey S. M. and J. A. Nye. 2010. Shifting species assemblages in the Northeast US Continental Shelf Large Marine Ecosystem. Mar Ecol Prog Ser 415:23-33.

Lundin, J.I., R.L. Dills, G.M. Ylitalo, M.B. Hanson, C.K. Emmons, G.S. Schorr, J. Ahmad, J.A. Hempelmann, K.M. Parsons and S.K. Wasser. 2016a. Persistent Organic Pollutant Determination in Killer Whale Scat Samples: Optimization of a Gas 3 Chromatography/Mass Spectrometry Method and Application to Field Samples. Archives of Environmental Contamination and Toxicology 70: 9-19.

Lundin, J. I., G. M. Ylitalo, R. K. Booth, B. F. Anulacion, J. Hempelmann, K. M. Parsons, D. A. Giles, E. A. Seely, M. B. Hanson, C. K. Emmons, S. K. Wasser. 2016b. Modulation in Persistent Organic Pollutant level and profile by prey availability and reproductive status in Southern Resident killer whale scat samples. Environmental Science & Technology, 50:6506-6516.

Lundin, J. I., G. M. Ylitalo, D. A. Giles, E. A. Seely, B. F. Anulacion, D. T. Boyd, J. A. Hempelmann, K. M. Parsons, R. K. Booth, and S. K. Wasser. 2018. Pre-oil spill baseline profiling for contaminants in Southern Resident killer whale fecal samples indicates possible exposure to vessel exhaust. Marine pollution bulletin 136 (2018): 448-453.

Lusseau, D., D. E. Bain, R. Williams, and J. C. Smith. 2009. Vessel traffic disrupts the foraging behavior of southern resident killer whales *Orcinus orca*. Endangered Species Research. 6: 211-221.

McCabe, G. T., Hinton, S. A., and Emmet, R. L. (1998). *Benthic invertebrates and sediment characteristics in a shallow navigation channel of the lower Columbia River, before and after dredging*. Retrieved from Seattle, WA: https://research.libraries.wsu.edu/xmlui/bitstream/handle/2376/1220/v72%20p116%20McCabe%20et%20al.PDF?sequence=1&isAllowed=y

MacCall, A. D., S. Ralston, D. Pearson and E. Williams. 1999. Status of bocaccio off California in 1999 and outlook for the next millenium. In: Appendices to the Status of the Pacific Coast Groundfish Fishery Through 1999 and Recommended Acceptable Biological Catches for 2000. Pacific Fishery Management Council, 2000 SW First Ave., Portland, OR, 97201.

Mackenzie, C, J. McIntyre, E. Howe, and J. Israel. 2018. Stormwater quality in Puget Sound: impacts and solutions in reviewed literature. Seattle, WA: The Nature Conservancy, Washington State Chapter, 42 pp.

MacLeod, C D. 2009. Global climate change, range changes and potential implications for the conservation of marine cetaceans: a review and synthesis. Endang Species Res. Vol. 7: 125–136.

Maggini, S., A. Pierre, and P. C. Calder. 2018. Immune function and micronutrient requirements change over the life course. Nutrients. 10, 1531; doi:10.3390/nu10101531.

Mantua, N. J., S. R. Hare, Y. Zhang, J. M. Wallace, and R. C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society 78:1069-1079.

Mantua, N., I. Tohver, and A. Hamlet. 2009. Impacts of Climate Change on Key Aspects of Freshwater Salmon Habitat in Washington State. *In* The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, edited by M. M. Elsner, J. Littell, L. Whitely Binder, 217-253. The Climate Impacts Group, University of Washington, Seattle, Washington

Mantua, N., I. Tohver, and A. Hamlet. 2010. Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. *Climatic Change* 102(1): 187-223.

Martins, E. G., S. G. Hinch, S. J. Cooke, and D. A. Patterson. 2012. Climate effects on growth, phenology, and survival of sockeye salmon (*Oncorhynchus nerka*): a synthesis of the current state of knowledge and future research directions. Reviews in Fish Biology and Fisheries. 22(4): 887-914.

Mathis, J.T., S.R. Cooley, N. Lucey, S. Colt, J. Ekstrom, T. Hurst, et al. 2015. Ocean acidification risk assessment for Alaska's fishery sector. Progress in Oceanography 136:71-91.

Matkin, C.O., E.L. Saulitis, G. M. Ellis, P. Olesiuk, S.D. Rice. 2008. Ongoing population- level impacts on killer whales *Orcinus orca* following the 'Exxon Valdez' oil spill in Prince William Sound, Alaska. Marine Ecology Progress Series. 356: 269-281.

Matthews, K.R. 1989. A comparative study of habitat use by young-of-the year, sub-adult, and adult rockfishes on four habitat types in Central Puget Sound. Fishery Bulletin, U.S. olume 88, pages 223-239

Mauger, G. S., J. H. Casola, H. A. Morgan, R. L. Strauch, B. Jones, B. Curry, T. M. B. Isaksen, L. W. Binder, M. B. Krosby, and A. K. Snover. 2015. State of Knowledge: Climate Change in Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. November 2015. 309p.

McCain, B., D.C. Malins, M.M. Krahn, D.W. Brown, W.D. Gronlund, L.K. Moore, and S-L. Chan. 1990. Uptake of Aromatic and Chlorinated Hydrocarbons by Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) in an Urban Estuary. Arch. Environ. Contam. Toxicol. 19, 10-16 (1990).

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-42. June 2000. 156 pp.

McIntyre, J. K., Davis, J. W., Hinman, C., Macneale, K. H., Anulacion, B. F., Scholz, N. L., & Stark, J. D. (2015). Soil bioretention protects juvenile salmon and their prey from the toxic impacts of urban stormwater runoff. Chemosphere, 132, 213-219.

McIntyre, J. K., Lundin, J. I., Cameron, J. R., Chow, M. I., Davis, J. W., Incardona, J. P., & Scholz, N. L. (2018). Interspecies variation in the susceptibility of adult Pacific salmon to toxic urban stormwater runoff. Environmental Pollution, 238, 196-203.

McMahon, T.E., and G.F. Hartman. 1989. Influence of cover complexity and current velocity on winter habitat use by juvenile coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences 46: 1551–1557.

Meador, J.P., F.C. Sommers, G.M. Ylitalo and C.A. Sloan. 2006. Altered growth and related physiological responses in juvenile Chinook salmon (*Oncorhynchus tshawytscha*) from dietary exposure too polycyclic aromatic hydrocarbons (PAHs). Canadian Journal of Fisheries and Aquatic Sciences 63: 2364-2376.

Melbourne, B. A., and A. Hastings. 2008. Extinction risk depends strongly on factors contributing to stochasticity. Nature. 454(7200): 100-103.

Meyer, J. L., M. J. Sale, P. J. Mulholland, and N. L. Poff. 1999. Impacts of climate change on aquatic ecosystem functioning and health. JAWRA Journal of the American Water Resources Association 35(6): 1373-1386

Miller, B. and S. Borton. 1980. Geographical distribution of Puget Sound fishes: Maps and data source sheets. Wash. Sea Grant and Fish. Res. Inst. Publ., Univ. Washington, Seattle. 681 p.

Miksis, J.L., M.D. Grund, D.P. Nowacek, A.R. Solow, R.C. Connor, and P.L. Tyack. 2001. Cardiac responses to acoustic playback experiments in the captive bottlenose dolphin (Tursiops truncatus). Journal of Comparative Psychology A 115:227-232.

Milon, J.W., Dodge R.E. 2001. Applying habitat equivalency analysis for coral reef damage assessment and restoration. Island Press, Washington, DC. 155p. MEA 2005b

Moberg, GP. 1987. Influence of the adrenal axis upon the gonads. Oxford Reviews of Reproductive Biology 9 456–496.

Mongillo, T. M., G. M. Ylitalo, L. D. Rhodes, S. M. O'Neill, D. P. Noren, M. B. Hanson. 2016. Exposure to a mixture of toxic chemicals: Implications to the health of endangered Southern Resident killer whales. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-X8.

Moore, M. E., and B. A. Berejikian. 2017. Population, habitat, and marine location effects on early marine survival and behavior of Puget Sound steelhead smolts. Ecosphere 8(5):e01834. 10.1002/ecs2.1834

Moore, M. E., B. A. Berejikian, and E. P. Tezak. 2013. A Floating Bridge Disrupts Seaward Migration and Increases Mortality of Steelhead Smolts in Hood Canal, Washington State. PloS one. September 2013. Vol 8. Issue 9. E73427. 10 pp.

Moore, M. E., F. A. Goetz, D. M. Van Doornik, E. P. Tezak, T. P. Quinn, J. J. Reyes-Tomassini, and B. A. Berejikian. 2010. Early marine migration patterns of wild coastal cutthroat trout (*Oncorhynchus clarki clarki*), steelhead trout (*Oncorhynchus mykiss*), and their hybrids. PLoS ONE 5(9):e12881. Doi:10.1371/journal.pone.0012881. 10 pp.

Morgan, J. D. and C. D. Levings. 1989. Effects of suspended sediment on eggs and larvae of lingcod *Ophiodon elongatus*, Pacific herring *Clupea harengus pallasi*, and surf smelt *Hypomesus pretiosus*. Canadian Technical Report of Fisheries & Aquatic Sciences, 1729:I-VII; 1-31.

Morley, S.A., J.D. Toft, and K.M. Hanson. 2012. Ecological Effects of Shoreline Armoring on Intertidal Habitats of a Puget Sound Urban Estuary. *Estuaries and Coasts*. 35:774-784.

Morris, J. F. T., M. Trudel, J. Fisher, S. A. Hinton, E. A. Fergusson, J. A. Orsi, and J. Edward V. Farley. 2007. Stock-specific migrations of juvenile coho salmon derived from coded-wire tag recoveries on the continental shelf of Western North America. American Fisheries Society Symposium. 57: 81.

Morrison, W., M. Nelson, J. Howard, E. Teeters, J.A. Hare, R. Griffis. 2015. Methodology for assessing the vulnerability of fish stocks to changing climate. National Marine Fisheries Service, Office of Sustainable Fisheries, Report No.: NOAA Technical Memorandum NMFS-OSF-3.

Moser, H. G. 1967. Reproduction and development of Sebastodes paucispinis and comparison with other rockfishes off southern California. Copeia. Volume 4, pages 773-797

Mote, P.W., J.T. Abatzoglou, and K.E. Kunkel. 2013. Climate: Variability and Change in the Past and the Future. In Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, edited by M.M. Dalton, P.W. Mote, and A.K. Snover, 41-58. Island Press, Washington, DC.

Mote, P.W, A. K. Snover, S. Capalbo, S.D. Eigenbrode, P. Glick, J. Littell, R.R. Raymondi, and W.S. Reeder. 2014. Ch. 21: Northwest. *In* Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, T.C. Richmond, and G.W. Yohe, Eds., U.S. Global Change Research Program, 487-513.

Mote, P.W., D.E. Rupp, S. Li, D.J. Sharp, F. Otto, P.F. Uhe, M. Xiao, D.P. Lettenmaier, H. Cullen, and M. R. Allen. 2016. Perspectives on the cause of exceptionally low 2015 snowpack in the western United States, Geophysical Research Letters, 43, doi:10.1002/2016GLO69665.

Mueller, G. 1980. Effects of Recreational River Traffic on Nest Defense by Longear Sunfish. Transactions of the American Fisheries Society, 109, 248-251.

Mumford, T.F. 2007. Kelp and Eelgrass in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-05. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Munday, P.L., D.L. Dixson, J.M. Donelson, G.P. Jones, M.S. Pratchett, G.V. Devitsina, et al. 2009. Ocean acidification impairs olfactory discrimination and homing ability of a marine fish. Proceedings of the National Aademy of Sciences of the United States of America. 106(6):1848–52. https://doi.org/10.1073/pnas.0809996106 ISI:000263252500033. PMID: 19188596

Munsch, S.H., J.R. Cordell, J.D. Toft, and E.E. Morgan. 2014. Effects of Seawalls and Piers on Fish Assemblages and Juvenile Salmon Feeding Behavior. North American Journal of Fisheries Management. 34:814-827.

Murphy, M. L., S. W. Johnson, and D. J. Csepp. 2000. A comparison of fish assemblages in eelgrass and adjacent subtidal habitat near Craig Alaska. Alaska Fishery Bulletin. Volume 7.

Murray, C.C., L. Hannah, T. Doniol-Valcroze, B. Wright, E. Stredulinsky, A. Locke, and R. Lacy. 2019. Cumulative effects assessment for Northern and Southern Resident Killer Whale Populations in the Northeast Pacific. Canadian Science Advisory Secretariat, Research Document 2019/056. Fisheries and Oceans Canada; Ecosystems and Oceans Science.

Musick, J.A. 1999. Criteria to define extinction risk in marine fishes: The American Fisheries Society Initiative. Fisheries. Volume 24, pages 6-14.

Myers, J. M., J. J. Hard, E. J. Connor, R. A. Hayman, R. G. Kope, G. Lucchetti, A. R. Marshall, G. R. Pess, and B. E. Thompson. 2015. Identifying historical populations of steelhead within the Puget Sound distinct population segment. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC 128.

Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. February 1998. U.S. Dept. Commer., NOAA Tech Memo., NMFS-NWFSC-35. 476p.

Naish, K.A., J.E. Taylor, III, P.S. Levin, T.P. Quinn, J.R. Winton, D. Huppert, and R. Hilborn. 2007. An evaluation of the effects of conservation and fishery enhancement hatcheries on wild populations of salmon. Advances in Marine Biology 53: 61-194.

Neale, J. C. C., F. M. D. Gulland, K. R. Schmelzer, J. T. Harvey, E. A. Berg, S. G. Allen, D. J. Greig, E. K. Grigg, and R. S. Tjeerdema. 2005. Contaminant loads and hematological correlates in the harbor seal (*Phoca vitulina*) of San Francisco Bay, California. J. Toxicol. Environ. Health, Part A: Current Issues 68:617–633.

Neff, J.M. 1982. Accumulation and release of polycyclic aromatic hydrocarbons from water, food, and sediment by marine animals. Pages 282-320 in N.L. Richards and B.L. Jackson (eds.). Symposium: carcinogenic polynuclear aromatic hydrocarbons n the marine environment. U.S. Environ. Protection Agency Rep. 600/9-82-013.

Neff, J. M., B. A. Cox, D. Dixit, and J. W. Anderson. 1976. Accumulation and release of petroleum-derived aromatic hydrocarbons by four species of marine animals. Marine Biology 38(3):279-289. https://setac.onlinelibrary.wiley.com/doi/abs/10.1002/etc.5620151218

Newcombe, C.P., and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. 16:34.

Nickelson, T.E., Solazzi, M.F., and S.L. Johnson. 1986. Use of hatchery coho salmon (*Oncorhynchus kisutch*) presmolts to rebuild wild populations in Oregon coastal streams. Canadian Journal of Fisheries and Aquatic Sciences 43: 2443-2449.

Nightingale, B, and C.A. Simenstad. 2001a. White paper: Dredging Activities: Marine Issues. Washington Department of Fish and Wildlife, Washington Department of Ecology, and Washington Department of Transportation, Olympia, WA. 184pp.

Nightingale, B., and C.A. Simenstad. 2001b. Overwater Structures: Marine Issues. University of Washington, Washington State Transportation Center. 133.

National Marine Fisheries Service (NMFS). 2003. Preliminary conclusions regarding the updated status of listed ESUs of West Coast salmon and steelhead: Draft report. West Coast Salmon Biological Review Team: Northwest Fisheries Science Center, Seattle, WA and Southwest Fisheries Science Center, Santa Cruz, CA.

NMFS. 2005. Policy on the consideration of hatchery-origin fish in Endangered Species Act listing determinations for Pacific salmon and steelhead. Federal Register, Volume 70 No. 123(June 28, 2005):37204-37216.

NMFS. 2007a. Final Supplement to the recovery plan for the Hood Canal and eastern Strait of Juan de Fuca summer chum salmon (*Oncorhynchus keta*). National Marine Fisheries Service, Northwest Region. Portland, Oregon

NMFS. 2007b. Rationale for the Use of 187 dB Sound Exposure Level for Pile Driving Impacts Threshold. Unpublished memorandum. Seattle, Washington: National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

NMFS. 2008. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Blue Heron Conservation Bank. June 10, 2008. NMFS Consulation No. NWR -2007-08287

NMFS. 2008a. Recovery plan for Southern Resident killer whales (*Orcinus orca*). National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS. 2010. Final Environmental Assessment for New Regulations to Protect Killer Whales from Vessel Effects in Inland Waters of Washington. National Marine Fisheries Service, Northwest Region. November 2010. 224p.

NMFS. 2012. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. EPA's Proposed Approval of Certain Oregon Administrative Rules Related to Revised Water Quality Criteria for Toxic Pollutants. August 14, 2012 NMFS Consultation No.: NWR-2008-00148. 784p.

NMFS. 2014. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. USACE Mud Mountain Dam. October 3, 2014 NMFS Consultation No.: NWR-2013-10095. 176p.

NMFS. 2014a. Final Environmental Impact Statement to inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs. West Coast Region. National Marine Fisheries Service. Portland, Oregon.

NMFS. 2015a. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation and Fish and Wildlife Coordination Act Recommendations for the Continued Use of Multi-User Dredged Material Disposal Sites in Puget Sound and Grays Harbor, Washington. WCR-2015-2975. December 17, 2015. 75 pp.

NMFS. 2015b. Endangered Species Act Section 7(a)(2) Informal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Coweeman Habitat Bank. 6th Field HUC 1708000508, Lower Columbia. Cowlitz County, Washington. WCR-2015-3100. 32pp

NMFS. 2015c. Workshop to Assess Causes of Decreased Survival and Reproduction in Southern Resident Killer Whales: Priorities Report. December 2015. 18p.

NMFS. 2016a. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation and Fish and Wildlife Coordination Act Recommendations. NOAA's National Marine Fisheries Service's Response for the Regional General Permit 6 (RGP6): Stuctures in Inland Marine Waters of Washington State. September 13, 2016. NMFS Consultation No.: WCR-2016-4361. 115p.

NMFS. 2016b. Southern Resident Killer Whales (*Orcinus orca*) 5-Year Review: Summary and Evaluation. December 2016. NMFS, West Coast Region, Seattle, Washington. 74p. https://www.fisheries.noaa.gov/resource/document/southern-resident-killer-whales-orcinus-orca-5-year-review-summary-and-evaluation

NMFS. 2016c. Endangered Species Act Section 7(a)(2) Biological Opinion, Conference Opinion,and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. National Marine Fisheries Service (NMFS) Evaluation of Three Hatchery and Genetic Management Plans for Dungeness River Basin Salmon Under Limit 6 of the Endangered Species Act Section 4(d) Rule. Portland, Oregon. May 31, 2016. NMFS Consultation No.: NWR-2013-9701. 158p.

NMFS. 2017a. Rockfish Recovery Plan: Puget Sound / Georgia Basin yelloweye rockfish (*Sebastes ruberrimus*) and bocaccio (*Sebastes paucispinis*). National Marine Fisheries Service. Seattle, WA.

NMFS. 2017b. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. NOAA's National Marine Fisheries Service's implementation of the Mitchell Act Final Environmental Impact Statement preferred alternative and administration of Mitchell Act hatchery funding. January 15, 2017. NMFS Consultation No.: WCR-2014-697. 535p.

NMFS. 2018. 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p.

NMFS. 2018a. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response. Consultation on effects of the 2018-2027 *U.S. v. Oregon* Management Agreement. February 23, 2018. NMFS Consultation No.: WCR-2017-7164. 597p.

NMFS. 2019a. ESA Recovery Plan for the Puget Sound Steelhead Distinct Population Segment (*Oncorhynchus mykiss*). National Marine Fisheries Service. Seattle, WA. Retrieved from https://www.fisheries.noaa.gov/resource/document/esa-recovery-plan-puget-sound-steelhead-distinct-population-segment-oncorhynchus

NMFS. 2019b. Proposed Revision of the Critical Habitat Designation for Southern Resident Killer Whales: Draft Biological Report (to accompany the Proposed Rule). 92 + Appendix pp.

NMFS. 2019c. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. USACE Howard Hanson Dam Operations and Maintenance, Green River, King County, Washington. February 15, 2019. WCR-2014-997. 167p.

NMFS. 2019d. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson Stevens Fishery Conservation and Management Act Essential Fish Habitat Response Consultation on the Delegation of Management Authority for Specified Salmon Fisheries to the State of Alaska. NMFS Consultation No.: WCR-2018-10660. April 5, 2019. 443p.

NMFS. 2019e. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. National Marine Fisheries Service (NMFS) Evaluation of Four Hatchery and Genetic Management Plans for Salmon in the Stillaguamish River basin under Limit 6 of the Endangered Species Act Section 4(d) Rule. June 20, 2019. NMFS Consultation No.: WCR-2018-8876. 151p.

NMFS. 2019f. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response: Impacts of the Role of the BIA Under its Authority to Assist with the Development of the 2019-2020 Puget Sound Chinook Harvest Plan, Salmon Fishing Activities Authorized by the U.S. Fish and Wildlife Service, and Fisheries Authorized by the U.S. Fraser Panel in 2019. May 3, 2019. National Marine Fisheries Service, West Coast Region. NMFS Consultation No.: WCR-2019-00381. 284p.

NMFS. 2020. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Conference Opinion Consultation on Implementation of the Pacific Fishery Management Council Salmon Fishery Management Plan in 2020 for Southern Resident Killer Whales and their Current and Proposed Critical Habitat. NMFS Consultation Number: WCRO-2019-04040. 149p.

National Oceanic and Atmospheric Administration (NOAA) Fisheries. 2005. Final assessment of NOAA Fisheries' Critical Habitat Analytical Review Teams for 12 evolutionarily significant units of west coast salmon and steelhead. Protected Resources Division, Portland, OR. August 2005.

National Research Council (NRC). 2009. Urban Stormwater Management in the United States. National Research Council. The National Academies Press. Washington, D.C.

NOAA and Washington Department of Fish and Wildlife (WDFW). 2018. Southern Resident Killer Whale Priority Chinook Stocks Report. June 22, 2018. 8p.

Noren, D. P., A. H. Johnson, D. Rehder, and A. Larson. 2009. Close approaches by vessels elicit surface active displays by Southern Resident killer whales. Endangered Species Research. 8:179-192.

Noren, D. P., R. C. Dunkin, T. M. Williams, and M. M. Holt. 2012. Energetic cost of behaviors performed in response to vessel disturbance: One link the in population consequences of acoustic disturbance model. In: Anthony Hawkins and Arthur N. Popper, Eds. The Effects of Noise on Aquatic Life, pp. 427–430.

Noren, D. P., M. M. Holt, R. C. Dunkin, and T. M. Williams. 2013. The metabolic cost of communicative sound production in bottlenose dolphins (Tursiops truncatus). The Journal of Experimental Biology. 216: 1624-1629.

Norman, S.A., C.E. Bowlby, M.S. Brancato, J. Calambokidis, D. Duffield, P.J. Gearin, T.A. Gornall, M.E. Gosho, B. Hanson, J. Hodder, S.J. Jeffries, B. Lagerquist, D.M. Lanbourn, B. Mate, B. Norberg, R.W. Osborne, J.A. Rash, S. Riemer, and J. Scordino. 2004. Cetacean strandings in Oregon and Washington between 1930 and 2002. Journal of Cetacean Research and Management 6: 87-99.

Northwest Fisheries Science Center (NWFSC). 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. December 21. 356 pp.

O'Connor, S., R. Campbell, H. Cortez, and T. Knowles. 2009. Whale Watching Worldwide: Tourism numbers, expenditures and expanding economic benefits, a special report from the International Fund for Animal Welfare. Economists at Large, Yarmouth, MA.

Olesiuk, P. F., M. A. Bigg, and G. M. Ellis. 1990. Life history and population dynamics of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Pages 209-244 in International Whaling Commission, Individual Recognition of Cetaceans: Use of Photo-Identification and Other Techniques to Estimate Population Parameters (Special Issue 12), incorporating the proceedings of the symposium and workshop on individual recognition and the estimation of cetacean population parameters.

Olesiuk, P. F., G. M. Ellis, and J. K. B. Ford. 2005. Life history and population dynamics of northern resident killer whales (Orcinus orca) in British Columbia (pages 1-75). Canadian Science Advisory Secretariat.

Olson, J.K., J. Wood, R.W. Osborne, L. Barrett-lennard, and S. Larson. 2018. Sightings of southern resident killer whales in the Salish Sea 1976−2014: the importance of a long-term opportunistic dataset. Endang. Species Res. Col 37: 105-118.

O’Neill, S.M. and J.E. West. 2009. Marine Distribution, Life History Traits, and the Accumulation of Polychlorinated Biphenyls in Chinook Salmon from Puget Sound, Washington. Transactions of the American Fisheries Society 138: 616-632.

O’Neill, S.M., G. M. Ylitalo, and J. E. West. 2014. Energy content of Pacific salmon as prey of northern and southern resident killer whales. Endanger. Species Res. 25:265–281.

Orr, J. W., M. A. Brown, and D. C. Baker. 2000. Guide to rockfishes (Scorpaenidae) of the genera Sebastes, Sebastolobus, and Abelosebastes of the northeast Pacific Ocean, Second Edition. NOAA Technical Memorandum NMFS-AFSC-117. 56 pages.

Osborne, R.W. 1999. A historical ecology of Salish Sea “resident” killer whales (*Orcinus orca*): with implications for management. Doctoral dissertation. University of Victoria, Victoria, British Columbia.

Ou, M., T.J. Hamilton, J. Eom, E.M. Lyall, J. Gallup, A. Jiang, et al. 2015. Responses of pink salmon to CO2-induced aquatic acidification. Nature Climate Change. 5(10). https://doi.org/10.1038/nclimate2694 WOS:000361840600017.

Pacunski, R. E., W. A. Palsson, and H. G. Greene. 2013. Estimating Fish Abundance and Community Composition on Rocky Habitats in the San Juan Islands Using a Small Remotely Operated Vehicle. FPT 13-02. Retrieved from https://wdfw.wa.gov/publications/01453/

Palsson, W.A., T. Tsou, G.G. Bargmann, R. M. Buckley, J. E. West, M. L. Mills, Y. W Cheng, and R. E. Pacunski. 2009. The biology and Assessment of Rockfishes in Puget Sound. Washington Department of Fish and Wildlife. 208 p.

Patterson, D., H. Trim and T. Trohimiovich. 2014. Practical Guide: Cost-effective compliance with Shoreline Regulations. Futurewise.org

Parametrix. 2011. Creosote Release from Cut/Broken Piles. Washington Department of Natural Resources. Olympia, WA.

Parks, D., A. Shaffer, and D. Barry. 2013. Nearshore drift-cell sediment processes and ecological function for forage fish: implications for ecological restoration of impaired Pacific Northwest marine ecosystems. J. Coast. Res. 29:984–997.

Patrick, C.J, D.E. Weller, X. Li. and M. Ryder. 2014. Effects of shoreline alteration and other stressors on submerged aquatic vegetation in subestuaries of Chesapeake Bay and the mid-Atlantic coastal bays. Estuaries and coasts, 37(6), 1516-1531.

Pearcy, W.G. 2002. Marine nekton off Oregon and the 1997–98 El Niño. Progress in Oceanography 54 (1-4), 399-403

Pearcy, W. G., and S. M. McKinnell. 2007. The ocean ecology of salmon in the Northeast Pacific Ocean - An abridged history. American Fisheries Society Symposium. 57: 7-30.

Penttila, D. 2007. Marine Forage Fishes in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-03. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Pettis H. M., R. M. Rolland, P. K. Hamilton, S. Brault, A. R. Knowlton, S. D. Kraus. 2004. Visual health assessment of North Atlantic right whales (*Eubalaena glacialis*) using photographs. Can J Zool 82:8-19.

PFMC (Pacific Fishery Management Council). 1998. Description and identification of essential fish habitat for the Coastal Pelagic Species Fishery Management Plan. Appendix D to Amendment 8 to the Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council, Portland, Oregon. December.

PFMC. 2005. Amendment 18 (bycatch mitigation program), Amendment 19 (essential fish habitat) to the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington groundfish fishery. Pacific Fishery Management Council, Portland, Oregon. November.

PFMC. 2008. Management of krill as an essential component of the California Current ecosystem. Amendment 12 to the Coastal Pelagic Species Fishery Management Plan. Environmental assessment, regulatory impact review & regulatory flexibility analysis. Pacific Fishery Management Council, Portland, Oregon. February.]

PFMC. 2014. Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18 to the Pacific Coast Salmon Plan: Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon. Pacific Fishery Management Council, Portland, OR. September 2014. 196 p. + appendices.

PFMC. 2020. Pacific Fishery Management Council Salmon Fishery Management Plan Impacts to Southern Resident Killer Whales. Risk Assessment. March 2020. SRKW Workgroup Report 1. 164p

Picciulin, M., Sebastianutto, L., Codarin, A., Farina, A. & Ferrero, E.A. 2010. In situ behavioural responses to boat noise exposure of *Gobius cruentatus* (Gmelin, 1789; fam. Gobiidae) and *Chromis chromis* (Linnaeus, 1758; fam. Pomacentridae) living in a Marine Protected Area. Journal of Experimental Marine Biology and Ecology, 386, 125-132.

Point No Point Treaty Tribes and Washington Department of Fish and Wildlife (PNPTT and WDFW). 2014. Five-year review of the Summer Chum Salmon Conservation Initiative for the period 2005 through 2013. Supplemental report No. 8, Summer Chum Salmon Conservation Initiative – an implementation plan to recover summer chum salmon in the Hood Canal and Strait of Juan de Fuca region. Washington Department of Fish and Wildlife. Olympia, WA. 244 p., including Appendices.

Popper, A. N. 2003. Effects of Anthropogenic Sounds on Fishes. Available in Fisheries 28(10):24-31·October 2003.

Popper, A.N., M.E. Smith, P.A. Cott, B.W. Hanna, A.O. MacGillivray, M.E. Austin, and D.A. Mann. 2005. Effects of exposure to seismic airgun use on hearing of three fish species. Journal of the Acoustical Society of America 117:3958-3971.

Puget Sound Indian Tribes (PSIT), and WDFW. 2004. Puget Sound Chinook Salmon Hatcheries Comprehensive Chinook Salmon Management Plan. March 31, 2004. Washington Department of Fish and Wildlife and Puget Sound Treaty Tribes. 154p.

Puget Sound Marine and Nearshore Grant Program (PSMNGP). 2014 Shore Friendly Final Report. Prepared by Colehour + Cohen, Applied Research Northwest, Social Marketing Services, Futurewise, and Coastal Geologic Services for Washington Department of Fish and Wildlife and Wash. Department of Natural Resources. http://wdfw.wa.gov/grants/ps_marine_nearshore/files/final_report.pdf

Puget Sound Partnership. 2018. 2018-2022 Action Agenda and Comprehensive Plan. Puget Sound Partnership, Olympia, WA. December 2018. https://psp.wa.gov/action_agenda_center.php

Puget Sound Regional Council. 2020. Regional Macroeconomic Forecast. Accessed June 19, 2020, at https://www.psrc.org/regional-macroeconomic-forecast

Quinn, T.P. 2005. The Behavior and Ecology of Pacific Salmon and Trout. UW Press.

Raymondi, R.R., J.E. Cuhaciyan, P. Glick, S.M. Capalbo, L.L. Houston, S.L. Shafer, and O. Grah. 2013. Water Resources: Implications of Changes in Temperature and Precipitation. *In* Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, edited by M.M. Dalton, P.W. Mote, and A.K. Snover, 41-58. Island Press, Washington, DC.

Reeves, R.R. 1977. The problem of gray whale (*Eschrichtius robustus*) harassment: At the breeding lagoons and during migration. Unpublished report to U.S. Marine Mammal Commission, Washington, D.C., under contract MM6AC021. Available from U.S. National Technical Information Service, Springfield, Virginia, PB 272 506.

Redhorse, D. 2014. Acting Northwest Regional Director, Bureau of Indian Affairs. March 25, 2014. Letter to Will Stelle (Regional Administrator, NMFS West Coast Region) amending request for consultation dated March 7, 2014. On file with NMFS West Coast Region.

Reddy, M. L., J. S. Reif, A. Bachand, and S. H. Ridgway. 2001. Opportunities for using Navy marine mammals to explore associations between organochlorine contaminants and unfavorable effects on reproduction. Sci. Total Environ. 274:171–182.

Reeder, W.S., P.R. Ruggiero, S.L. Shafer, A.K. Snover, L.L Houston, P. Glick, J.A. Newton, and S.M Capalbo. 2013. Coasts: Complex Changes Affecting the Northwest's Diverse Shorelines. In Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, edited by M.M. Dalton, P.W. Mote, and A.K. Snover, 41-58. Island Press, Washington, DC.

Reijnders, P. J. 1986. Reproductive failure in common seals feeding on fish from polluted coastal waters. Nature 324:456–457.

Rice, CA. 2006. Effects of shoreline modification on a northern Puget Sound beach: microclimate and embryo mortality in surf smelt (*Hypomesus pretiosus*). *Estuaries and Coasts*. 29(1): 63-71

Rice, C.A., C.M. Greene, P. Moran, D.J. Teel, D.R. Kuligowski, R.R. Reisenbichler, E.M. Beamer, J.R. Karr, and K.L. Fresh. 2011. Abundance, Stock Origin, and Length of Marked and Unmarked Juvenile Chinook Salmon in the Surface Waters of Greater Puget Sound. Transactions of the American Fisheries Society. 140:170-189.

Richards, L. J. 1986. Depth and habitat distributions of three species of rockfish (Sebastes) in British Columbia: observations from the submersible PISCES IV. Environmental Biology of Fishes. Volume 17(1), pages 13-21.

Richardson, W. J., C. R. Greene, C. I. Malme Jr., and D. H. Thomson. 1995. Marine Mammals and Noise. Academic Press, 525 B Street, Ste. 1900, San Diego, California 92101-4495.

Riera A, J. F. Pilkington, J. K. B. Ford, E. H. Stredulinsky, N.R. Chapman. 2019. Passive acoustic monitoring off Vancouver Island reveals extensive use by at-risk Resident killer whale (*Orcinus orca*) populations. Endang Species Res 39:221-234. https://doi.org/10.3354/esr00966

Rivest S., and C Rivier C. 1995. The role of corticotropin-releasing factor and interleukin-1 in the regulation of neurons controlling reproductive functions. Endocr. Rev. 16, 177-99.

Romano, T.A., M. J. Keogh, C. Kelly, P. Feng, L. Berk, C. E. Schlundt, D. A. Carder, and J. J. Finneran. 2003. Anthropogenic sound and marine mammal health: measures of the nervous and immune systems before and after intense sound exposure. Canadian Journal of Fisheries and Aquatic Sciences 61:1124-1134.

Romberg, P. 2005. Recontamination Sources at Three Sediment Caps in Seattle. Proceedings of the 2005 Puget Sound Georgia Basin Research Conference. 7 pp.

Roni, P. T.J. Beechie, R.E. Bilby, F.E. Leonetti, M.M. Pollock, and G. R. Pess. 2002. A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds. North American Journal of Fisheries Management 22, 1-20.

Ross, P.S., R.L. De Swart, R.F. Addison, H. Van Loveren, J.G. Vos, Osterhaus. ADME. 1996. Contaminant-induced immunotoxicity in harbour seals: wildlife at risk? Toxicology 112:157-169.

Ross, P.S., G.M. Ellis, M.G. Ikonomou, L.G. Barrett-Lennard, and R.F. Addison. 2000. High PCB concentrations in free-ranging Pacific killer whales, Orcinus orca: effects of age, sex, and dietary preference. Marine Pollution Bulletin 40(6):504-515.

Roubal, W. T., Collier, T. K., and Malins, D. C. (1977). Accumulation and metabolism of carbon-14 labeled benzene, naphthalene, and anthracene by young Coho salmon (*Oncorhynchus kisutch*). Archives of Environmental Contamination and Toxicology, 5, 513-529. doi:https://doi.org/10.1007/BF02220929

Ruckelshaus, M., K. Currens, W. Graeber, R. Fuerstenberg, K. Rawson, N. Sands, and J. Scott. 2002. Planning ranges and preliminary guidelines for the delisting and recovery of the Puget Sound Chinook salmon evolutionarily significant unit. Puget Sound Technical Recovery Team. National Marine Fisheries Service, Northwest Fisheries Science Center. Seattle.

Ruggerone, G. T. and F. Goetz. 2004. Survival of Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*) in response to climate-induced competition with pink salmon (*Oncorhynchus gorbuscha*). Canadian Journal of Fisheries and Aquatic Sciences. 61. 1756-1770. 10.1139/f04-112

Ruggerone, G. T., S. Goodman, and R. Miner. 2008. Behavioral Response and Survival of juvenile Coho Salmon Exposed to Pile Driving Sounds. Prepared for the Port of Seattle, Seattle, Washington.

Salo, E. O. 1991. Life history of chum salmon (*Oncorhynchus keta*). Page 233 in L. Groot and C. Margolis, editors. Pacific salmon life histories. UBC Press, Vancouver, British Columbia, Canada.

Sands, N. J., K. Rawson, K. Currens, W. Graeber, M. H. Ruckelshaus, R. Fuerstenberg, J. Scott. 2009. Determination of independent populations and viability criteria for the Hood Canal summer chum salmon evolutionarily significant unit. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-101, 58 p.

Santore, R.C., D.M. Di Toro, P.R. Paquin, H.E. Allen, and J.S. Meyer. 2001. Biotic ligand model of the acute toxicity of metals. 2. Application to acute copper toxicity in freshwater fish and Daphnia. Environmental Toxicology and Chemistry 20(10):2397-2402.

Schaefer, K.M. 1996. Spawn time, frequency, and batch fecundity of yellowfin tuna (*Thunnus albacares*) near Clipperton Attoll in the eastern Pacific Ocean. Fisheries Bulletin 94: 98-112.

Scheuerell, M.D., and J.G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*). Fisheries Oceanography 14:448-457.

Schlenger, P., A. MacLennan, E. Iverson, K. Fresh, C. Tanner, B. Lyons, S. Todd, R. Carman, D. Myers, S. Campbell, and A. Wick. 2011. Strategic Needs Assessment: Analysis of Nearshore Ecosystem Process Degradation in Puget Sound. Prepared for the Puget Sound Nearshore Ecosystem Restoration Project.

Scholik, A.R., and H.Y. Yan. 2002. Effects of boat engine noise on the auditory sensitivity of the fathead minnow, *Pimephales promelas*. Environmental Biology of Fishes. 63:203-209.

Schwacke, L. H., E. O. Voit, L. J. Hansen, R. S. Wells, G. B. Mitchum, A. A. Hohn, and P.A. Fair. 2002. Probabilistic risk assessment of reproductive effects of polychlorinated biphenyls on bottlenose dolphins (*Tursiops truncatus*) from the southeast United States coast. Environ. Toxicol. Chem. 21:2752–2764.

Schwacke, L. H., C. R. Smith, F. I. Townsend, R. S. Wells, L. B. Hart, B. C. Balmer, T. K. Collier, S. De Guise, M. M. Fry, L. J. Guillette, Jr., S. V. Lamb, S. M. Lane, W. E. McFee, N. J. Place, M. C. Tumlin, G. M. Ylitalo, E. S. Zolman, and T. K. Rowles. 2013. Health of common bottlenose dolphins (*Tursiops truncatus*) in Barataria Bay, Louisiana, following the *Deepwater Horizon* Oil spill. Environ. Sci. Technol. 48:93- 103.

Sebastianutto, L., M. Picciulin, M. Costantini, and E.A. Ferrero. 2011. How boat noise affects an ecologically crucial behavior: the caser of territoriality in *Gobius cruentatus* (Gobiidae). Environmental Biology of Fishes. 92:207-215.

Seely, E. 2020. Final 2019 Soundwatch Program Annual Contract Report.

Sericano, J. L., T. L. Wade, S. T. Sweet, J. Ramirez, and G. G. Lauenstein. 2014. Temporal trends and spatial distribution of DDT in bivalves from the coastal marine environments of the continental United States, 1986–2009. Mar. Pollut. Bull. 81:303–316. https://www.sciencedirect.com/science/article/abs/pii/S0025326X13007972

Servizi, J.A., and D.W. Martens. 1991. Effect of temperature, season, and fish size on acute lethality of suspended sediments to coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences. 48:493-497.

Shafer, D.J. 1999. The effects of dock shading on the seagrass Halodule wrightii in Perdido Bay, Alabama. Estuaries. 22:936-943.

Shafer, D.J. 2002. REcommendations to minimize potential impasts to seagrasses from single family residantil doct structures in the PNW. S.D. Prepared for the U.S. Army Corps of Engineers, editor.

Shaffer, J. A. Doty, D. C., Buckley, R. M., and J. E. West. 1995. Crustacean community composition and trophic use of the drift vegetation habitat by juvenile sp1itnose rockfish *Sebastes diploproa*. Marine Ecology Progress Series. Volume 123, pages 13 to 21.

Shared Strategy for Puget Sound (SSPS). 2007. Puget Sound Salmon Recovery Plan – Volume 1. Shared Strategy for Puget Sound, 1411 4th Ave., Ste. 1015, Seattle, WA 98101. Adopted by NMFS January 19, 2007. 503 pp.

Sharma, R., and T. P. Quinn. 2012. Linkages between life history type and migration pathways in freshwater and marine environments for Chinook salmon, *Oncorhynchus tshawytscha*. Acta Oecol. 41:1–13

Shedd. 2019. 2018 Soundwatch Program Annual Contract Report. Soundwatch Public Outreach/Boater Education Program. The Whale Museum. Contract No. RA-133F-12-CQ-0057.

Shedd. 2020. 2019 Soundwatch Program Annual Contract Report. Soundwatch Public Outreach/Boater Education Program. The Whale Museum.

Shipman, H., Dethier, M. N., Gelfenbaum, G., Fresh, K. L. and Dinicola, R. S. (*Eds.*). 2010. Puget Sound Shorelines and the Impacts of Armoring-- Proceedings of a State of the Science Workshop, May 2009. U.S. Geological Survey, Scientific Investigations Report 2010-5254.

Siegle M.R., E.B. Taylor, K.M. Miller, R.E. Withler, and K.L. Yamanaka. 2013. Subtle population genetic structure in yelloweye rockfish (Sebastes ruberrimus) is consistent with a major oceanographic division in British Columbia, Canada. PLoS ONE, 8.

Simenstad, C.A. 1988. Summary and Conclusions from Workshop and Working Group Discussions. Pages 144-152 in Proceedings, Workshop on the Effects of Dredging on Anadromous Pacific Coast Fishes, Seattle, Washington, September 8-9, 1988. C.A. Simenstad, ed., Washington Sea Grant Program, University of Washington, Seattle, Washington.

Simenstad, C. A., B. J. Nightingale, R. M. Thom and D. K. Shreffer. 1999. Impacts of ferry terminals on juvenile salmon migrating along Puget Sound shorelines, Phase I: synthesis of state of knowledge. Final Res. Rept., Res. Proj. T9903, Task A2, Wash. State Dept.Transportation, Washington Sate Trans. Center (TRAC), Seattle, WA. 116 pp + appendices

Simenstad, C.A., M. Ramirez, J. Burke, M. Logsdon, H. Shipman, C. Tanner, J. Toft, B. Craig, C. Davis, J. Fung, P. Bloch, K. Fresh, S. Campbell, D. Myers, E. Iverson, A. Bailey, P. Schlenger, C. Kiblinger, P. Myre, W. Gerstel, and A. MacLennan. 2011. Historical Change of Puget Sound Shorelines: Puget Sound Nearshore Ecosystem Project Change Analysis. Puget Sound Nearshore Report No. 2011-01. Published by Washington Department of Fish and Wildlife, Olympia, Washington, and U.S. Army Corps of Engineers, Seattle, Washington.

Simpson, S.D., A.N Radford, S.L. Nedelac, M.C.O. Ferrari, D.P Chivers, M.I. McCormick and M.G. Meekan. 2016. Anthropogenic noise increases fish mortality by predation. Nat. Commun 7, 10544. https://doi.org/10.1038/ncomms10544

Smith, C. J., and B. Sele. 1995. Dungeness River Chinook Salmon Rebuilding Project *in* Techniques of Hydraulic Redd Sampling, Seining and Electroshocking. Pages 40-57, C.J. Smith and P. Wampler, editors. Progress report 1992-1993. Northwest Fishery Resource Bulletin, Project Report Series Number 3. Northwest Indian Fisheries Commission, Olympia, Washington.

Smith, S.C. and H. Whitehead. 1993. Variations in the feeding success and behaviour of Galapagos sperm whales (*Physeter macrocephalus*) as they relate to oceanographic conditions. Canadian Journal of Zoology, 71, 1991-1996. https://www.nrcresearchpress.com/doi/abs/10.1139/z93-283#.XsmzVmhKhPY

Smith, P. 2008. Risks to human health and estuarine ecology posed by pulling out creosote treated timber on oyster farms. Aquatic Toxicology 86 (2008) 287–298.

Sobocinski K.L. 2003. The impact of shoreline armoring on supratidal beach fauna of central Puget Sound. Unpublished Masters Thesis, University of Washington: 83 pp.

Sobocinski, K.L., J.R. Cordell and C.A. Simenstad. 2010. Effects of Shoreline Modifications on Supratidal Macroinvertebrate Fauna on Puget Sound, Washington Beaches. Estuaries and Coasts. 33:699-711.

Southard, S.L., R.M. Thom, G.D. Williams, T.J. D., C.W. May, G.A. McMichael, J.A. Vucelick, J.T. Newell, and J.A. Southard. 2006. Impacts of Ferry Terminals on Juvenile Salmon Movement along Puget Sound Shorelines. Battelle Memorial Institute, Pacific Northwest Division.

Speaks, S. 2017. Northwest Regional Director, Bureau of Indian Affairs. April 21, 2017. Letter to Barry Thom (Regional Administrator, NMFS West Coast Region) requesting consultation on for Puget Sound salmon fisheries based on co-manager agreed revisions to the 2010 Puget Sound Chinook Harvest Management Plan for 2017-2018 Chinook fisheries in Puget Sound. On file with NMFS West Coast Region, Sand Point office.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. ManTech Environmental Research Services, Inc. Corvallis, Oregon. National Marine Fisheries Service, Portland, Oregon.

Stadler, J.H., and D.P. Woodbury. 2009. Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria. *In* inter-noise 2009, Ottawa, CA. 8.

Stephens, C. 2015. Summary of West Coast Oil Spill Data: Calendar Year 2015. Pacific States/British Columbia Oil Spill Task Force. June 2015. 26p. Available at: http://oilspilltaskforce.org/wp-content/uploads/2016/07/Oil-Spill-Data-Summary_2015_FINALpdf.pdf

Stephens, C. 2017. Summary of West Coast Oil Spill Data: Calendar Year 2016. Pacific States/British Columbia Oil Spill Task Force. May 2017. 27p. Available at: http://oilspilltaskforce.org/wp-content/uploads/2013/08/summary_2016_DRAFT_16May2017_2.pdf

Strange, Elisabeth, H. Galbraith, S. Bickel, D. Mills, D. Beltman, J. Lipton. 2002. Environmental Assessment. Determining Ecological Equivalence in Service-to-Service Scaling of Salt Marsh Restoration. Environmental Management Vol. 29, No.2, pp. 290- 300

SSPS. 2005. Puget Sound Salmon Recovery Plan. Volumes I, II and III. Plan Adopted by the National Marine Fisheries Service (NMFS) January 19, 2007. Submitted by the Shared Strategy Development Committee. Shared Strategy for Puget Sound. Seattle, Washington. 503p.

Studebaker, R. S., K. N. Cox, and T. J. Mulligan. 2009. Recent and historical spatial distributions of juvenile rockfish species in rocky intertidal tide pools, with emphasis on black rockfish. Transactions of the American Fisheries Society. Volume 138, pages 645-651.

Subramanian, A., S. Tanabe, R. Tatsukawa, S. Saito, and N. Miyazaki. 1987. Reduction in the testosterone levels by PCBs and DDE in Dall's porpoises of Northwestern North Pacific. Mar. Pollut. Bull. 18:643–646.

Sunda, W. G., and W. J. Cai. 2012. Eutrophication induced CO2-acidification of subsurface coastal waters: interactive effects of temperature, salinity, and atmospheric p CO2. *Environmental Science & Technology,* 46(19): 10651-10659

Tagal, M, K.C. Massee, N. Ashton, R. Campbell, P. Pleasha, and M.B. Rust. 2002 . Larval development of yelloweye rockfish, Sebastes ruberrimus. N, Northwest Fisheries Science Center.

Tague, C. L., Choate, J. S., & Grant, G. 2013. Parameterizing sub-surface drainage with geology to improve modeling streamflow responses to climate in data limited environments. *Hydrology and Earth System Sciences* 17(1): 341-354.

Thur, S. M. 2006. Resolving oil pollution liability with restoration-based claims: the United States' experience. Institut oceanographique, Paris (France).

Tillmann, P. and D. Siemann. 2011. Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region. National Wildlife Federation. Retrieved from https://www.nwf.org/~/media/PDFs/Global-Warming/2014/Marine-Report/NPLCC_Marine_Climate-Effects_Final.pdf

Toft, J.D., J.R. Cordell, C.A. Simenstad, and L.A. Stamatiou. 2007. Fish distribution, abundance, and behavior along city shoreline types in Puget Sound. North American Journal of Fisheries Management. 27, 465-480.

Toft, J.D., A.S. Ogston, S.M. Heerhartz, J.R. Cordell, and E.E. Flemer. 2013. Ecological response and physical stability of habitat enhancements along an urban armored shoreline. Ecological Engineering. 57:97-108.

Tolimieri, N., and P. S. Levin. 2005. The roles of fishing and climate in the population dynamics of bocaccio rockfish. Ecological Applications, 15(2):459-468.

Tonnes, D.M., M. Bhuthimethee, J. Sawchuk, N. Tolimieri, K. Andrews, and K. Nichols. 2016. Yelloweye rockfish (*Sebastes ruberrimus*), canary rockfish (*Sebastes pinniger*), and bocaccio (*Sebastes paucispinis*) of the Puget Sound/Georgia Basin. 5-Year Review. National Marine Fisheries Service. Seattle, WA.

Trites, A.W. and C.P. Donnelly. 2003. The decline of Steller sea lions *Eumetopias jubatus* in Alaska: a review of the nutritional stress hypothesis. Mammal Rev. 33(1): 3-28.

Trites, A. W. and D. A. S. Rosen (eds). 2018. Availability of Prey for Southern Resident Killer Whales. Technical Workshop Proceedings. November 15–17, 2017. Marine Mammal Research Unit, Institute for the Oceans and Fisheries, University of British Columbia, Vancouver, B.C., 64 p.

Turner, B., and R. Reid. 2018. Pacific Salmon Commission transmittal letter. PST, Vancouver, B.C. August 23, 2018. 97p.

Turnpenny, A., and J. Newell. 1994. The effects on marine fish, diving mammals, and birds of underwater sound generated by seismic surveys. Fawley Aquatic Research Laboratories Limited, Marine and Freshwater Biology Unit, Southampton, Hampshire, UK. 48 p.

Turnpenny, A.W.H., K.P Thatcher, and J.R. Nedwell. 1994. The effects on fish and other marine animals of high-level underwater sound. Fawley Aquatic Research Laboratory, Ltd., Report FRR 127/94, United Kingdom. 79 p.

Tynan, T. 2010. Personal communication from Tim Tynan, Fishery Biologist, NMFS, Lacey, WA. April 13, 2010, with Susan Bishop, Fishery Biologist, NMFS NWR, regarding status of new Chinook supplementation programs in the South Forks of the Nooksack and Stillaguamish Rivers.

U.S. Department of Commerce (USDC). 2013. Endangered and Threatened Species; proposed rule for designation of critical habitat for Lower Columbia River coho salmon and Puget Sound steelhead. Federal Register, Vol. 78, No. 9. January 14, 2013.

USDC. 2014. Endangered and Threatened Wildlife; final rule to revise the Code of Federal Regulations for species under the jurisdiction of the National Marine Fisheries Service. Federal Register, Vol. 79, No. 71. April 14, 2014.

Van Metre, P.C, B.J. Mahler, M. Scoggins, P.A. Hamilton. 2005. Parking lot sealcoat- A major source of PAHs in urban and suburban environments: U.S. Geological Survey Fact Sheet 2005-3147, 6 pp.

Varanasi, U., E. Casillas, M. R. Arkoosh, T. Hom, D. A. Misitano, D. W.Brown, S. L. Chan, T. K. Collier, B. B. McCain, and J. E. Stein. 1993. Contaminant exposure and associated biological effects in juvenile Chinook salmon (*Oncorhynchus tshawytscha*) from urban and nonurban estuaries of Puget Sound. (NMFS-NWFSC-8). Seattle, WA: NMFS NWFSC Retrieved from https://www.nwfsc.noaa.gov/publications/scipubs/techmemos/tm8/tm8.html

Veirs, S., V. Veirs, and J. D. Wood. 2016. Ship noise extends to frequencies used for echolocation by endangered killer whales. PeerJ. 4: 1-35.

Veldhoen, N., M.G. Ikonomou, C. Dubetz, N. MacPherson, T. Sampson, B.C. Kelly, and C.C. Helbing. 2010. Gene expression profiling and environmental contaminant assessment of migrating Pacific salmon in the Fraser River watershed of British Columbia. Aquatic Toxicology 97(3):212-225.

Vélez-Espino, L.A., J.K.B. Ford, H.A. Araujo, G. Ellis, C.K. Parken, and K.C. Balcomb. 2014. Comparative demography and viability of northeastern Pacific resident killer whale populations at risk. Can. Tech. Rep. Fish. Aquat. Sci. 3084: v + 58 p.

Venn-Watson S, Colegrove KM, Litz J, Kinsel M, Terio K, Saliki J, et al. 2015. Adrenal Gland and Lung Lesions in Gulf of Mexico Common Bottlenose Dolphins (Tursiops truncatus) Found Dead following the Deepwater Horizon Oil Spill. PLoS ONE 10(5): e0126538. doi:10.1371/journal. pone.0126538

Vestal, B., and A. Rieser. 1995. Methodologies and mechanisms for management of cumulative coastal environmental impacts. Part 1 – Synthesis, with Annotated Bibliography. NOAA Coastal Ocean Office. Silver Spring, Maryland.

Viberg, H., A. Fredriksson, and P. Eriksson. 2003. Neonatal exposure to polybrominated diphenyl ether (PBDE-153) disrupts spontaneous behaviour, impairs learning and memory, and decreases hippocampal cholinergic receptors in adult mice. Toxicol. Appl. Pharmacol. 192:95–106.

Viberg, H., N. Johansson, A. Fredriksson, J. Eriksson, G. Marsh, and P. Eriksson. 2006. Neonatal exposure to higher brominated diphenyl ethers, hepta-, octa-, or nonabromodiphenyl ether, impairs spontaneous behavior and learning and memory functions of adult mice. Toxicol. Sci. 92:211–218.

Voellmy, I.K., J. Purser, D Flynn, P. Kennedy, S.D. Simpson, A.N. Radford. Acoustic Noise reduces foraging success in two sympatric fish species. Animal Behavior 89, 191-198.

Wainwright, T. C., and L. A. Weitkamp. 2013. Effects of climate change on Oregon Coast coho salmon: habitat and life-cycle interactions. Northwest Science 87(3): 219-242.

Wait, M., J. Fletcher, and A. Tuohy. 2018. Nearshore habitat use by Hood Canal Summer run chum salmon in Hood Canal and the Strait of Juan de Fuca. Presented at Salish Sea Ecosystem Conference, Seattle. WA. https://cedar.wwu.edu/ssec/2018ssec/allsessions/464

Ward, E.J., M.J. Ford, R.G. Kope, J.K.B. Ford, L.A. Velez-Espino, C.K. Parken, L.W. LaVoy, M.B. Hanson, and K.C. Balcomb. 2013. Estimating the impacts of Chinook salmon abundance and prey removal by ocean fishing on Southern Resident killer whale population dynamics. U.S. Dept. Commer., NOAA Tech. Memo. NMFS- NWFSC-123.

Washington, P. 1977. Recreationally important marine fishes of Puget Sound, Washington. National Oceanic and Atmospheric Administration, Northwest and Alaska Fisheries Center. 122 pages.

Washington State Department of Ecology (WDOE). 2017. Spill Prevention, Preparedness, and Response Program. 2017-2019 Program Plan. Publication 17-08-018. 29p.

Washington Department of Natural Resources (DNR). 2014. Washington State Department of Natural Resources Fact Sheet: Removing Creosote-treated materials from Puget Sound and its beaches. 2014.

Wasser, S. K., J. I. Lundin, K. Ayers, E. Seely, D. Giles, K. Balcomb, J. Hempelmann, K. Parsons, R. Booth. 2017. Population growth is limited by nutritional impacts on pregnancy success in endangered Southern Resident killer whales (*Orcinus orca*). PLoS ONE 12(6): e0179824. https://doi.org/10.1371/journal. pone.0179824.

Weis, L.J. 2004. The effects of San Juan County, Washington, marine protected areas on larval rockfish production. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science, University of Washington.

Weispfenning, A. J. 2006. Study of nearshore demersal fishes within candidate marine reserves in Skagit County Washington. Master of Science thesis. Western Washington University, Bellingham, WA.

Weitkamp, L., and K. Neely (2002) Coho salmon (*Oncorhynchus kisutch*) ocean migration patterns: insight from marine coded-wire tag recoveries *Can. J. Fish. Aquat. Sci.* **59** 1100–1115

Wells, B.K., J.A. Santora, J.C Field, R.B. MacFarlane, B.B. Marinovic, W.J. Sydeman. 2012. Population dynamics of Chinook salmon Oncorhynchus tshawytscha relative to prey availability in the central California coastal region. Mar Ecol Prog Ser. 457:125–37. https://doi.org/10.3354/meps09727

Whitehead, H. 1997. Sea surface temperature and the abundance of sperm whale calves off the Galapagos Islands: implications for the effects of global warming. Reports of the international Whaling Commission 47: 941-944.

Whitfield, A.K., and A. Becker. 2014. Impacts of recreational motorboats on fishes: A review. Marine Pollution Bulletin 83, 24-31.

Whitman, T., D. Penttila, K. Krueger, P. Dionne, K. Pierce, Jr., and T. Quinn. 2014. Tidal elevation of surf smelt spawn habitat study for San Juan County Washington. Friends of the San Juans, Salish Sea Biological and Washington Department of Fish and Wildlife.

Wiles, G. J. 2004. Washington State Status Report for the Killer Whale. March 2004. WDFW, Olympia, Washington. 120p.Willette, T.M. 2001. Foraging behaviour of juvenile pink salmon (Oncorhynchus gorbuscha) and size-dependent predation risk. Fisheries Oceanography. 10:110-131.

Williams, G. D., and R. M. Thom. 2001. Marine and Estuarine Shoreline Modification Issues. White paper submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology, and Washington Department of Transportation. 99p. http://chapter.ser.org/northwest/files/2012/08/WDFW_marine_shoreline_white_paper.pdf

Williams, R., D. Lusseau and P. S. Hammond. 2006. Estimating relative energetic costs of human disturbance to killer whales (*Orcinus orca*). Biol. Cons. 133:301–311.

Williams, R., E. Ashe, and D. Lusseau. 2010. Killer whale activity budgets under no-boat, kayak-only and power-boat conditions. Contract via Herrera Consulting, Seattle, Washington. 29 pp.

Wilson, D., and P. Romberg. 1996. The Denny Way sediment cap. 1994 data. King County Department of Natural Resources Water Pollution Control Division, Seattle, Washington.

Winder, M. and D. E. Schindler. 2004. Climate change uncouples trophic interactions in an aquatic ecosystem. Ecology 85: 2100–2106.

Xie, Y.B., Michielsens, C.G.J., Gray, A.P., Martens, F.J. & Boffey, J.L. 2008. Observations of avoidance reactions of migrating salmon to a mobile survey vessel in a riverine environment. *Canadian* Journal of Fisheries and Aquatic Sciences, 65, 2178-2190.

Yamanaka, K. L., L. C. Lacko, R. Witheler, C. Grandin, J. K. Lochead, J.-C. Martin, N. Olsen, and S. S. Wallace. 2006. A review of yelloweye rockfish *Sebastes ruberrimus* along the Pacific coast of Canada: biology, distribution and abundance trends. Research Document 2006/076. Fisheries and Oceans Canada. 54 p.

Ylitalo, G. M., J. E. Stein, T. Horn, L. L. Johnson, K. L. Tilbury, A. J. Hall, T. Rowles, D. Greig, L. J. Lowenstine, and F. M. Gulland. 2005. The role of organochlorines in cancer-associated mortality in California sea lions (*Zalophus californianus*). Mar. Pollut. Bull. 50:30–39.

Zabel, R.W., M.D. Scheuerell, M.M. McClure, and J.G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20(1):190-200

Zamon, J.E., T.J. Guy, K. Balcomb, and D. Ellifrit. 2007. Winter Observations of Southern Resident Killer Whales (*Orcinus orca*) near the Columbia River Plume during the 2005 Spring Chinook Salmon (*Oncorhynchus tshawytscha*) Spawning Migration. Northwestern Naturalist 88(3):193-198.

Ziccardi, M.H., S.M.Wilkin, T.K. Rowles, and S. Johnson. 2015. Pinniped and Cetacean Oil Spill Response Guidelines. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-52, 138p.

6. ATTACHMENTS 1-39 AND APPENDICES 1-5

Summary of current status of **NWS-2017-796** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-252.1 (- debits/+ credits)**

NOTE – This output include 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: **86/5**
- Number of days that pile driving will occur/ number of work windows: **86/5**
- Impact pile driving activities - maximum number of pile strikes per day**: 3000**
- Vibratory pile driving activities – minutes of vibratory driving per day: **NA**
- Creosote removal – minimum tons removed (can remove more): **147.9**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **49800**
- 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**

Summary of current status of **NWS-2017-587** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-131.6 (- debits/+ credits)**

NOTE – This output include 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: **NA/1**
- 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 overwater structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **110**
- Bulkhead/bank armoring – structure placement should not extend 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**

Summary of current status of **NWS-2018-963** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **No**
- Current Nearshore Habitat Values Model Output: **23.2 (- debits/+ credits)**

NOTE – This output include 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: **2/1**
- Impact pile driving activities - maximum number of pile strikes per day**: NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **280**
- Creosote removal – minimum tons removed (can remove more): **11**
- Dredging projects - maximum cubic yards dredge: **713**
- In and overwater structure – maximum square foot of overwater structure: **1173**
- 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 **- Required**
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 - **Required**
T&C 3 - **Required**
T&C 4 - **NA**
T&C 5 **- Required**

Summary of current status of **NWS-2018-229** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **No**
- Current Nearshore Habitat Values Model Output: **1.8 (- debits/+ credits)**

NOTE – This output include 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: **NA/1**
- 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): **0.5**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **33**
- Bulkhead/bank armoring – structure placement should not extend below: **10 ft MLLW**
- 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**

Project Attachment for USACE Administrative Ease for: **NWS-2018-465**
Puget Sound Nearshore Batch Opinion WCRO-2020-01361

Summary of current status of **NWS-2018-465** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-82.3** **(- debits/+ credits)**

NOTE – This output include 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: **14/1**
- Number of days that pile driving will occur/ number of work windows: **NA/1**
- 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 overwater structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **75**
- Bulkhead/bank armoring – structure placement should not extend below: **2 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**

Summary of current status of **NWS-2018-53** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-352.3 (- debits/+ credits)**

NOTE – This output include 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: **NA/1**
- 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 overwater structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **26/124**
- Bulkhead/bank armoring – structure placement should not extend below: **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 **- NA**
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 - **NA**
T&C 4 - **NA**
T&C 5 **- Required**

Summary of current status of **NWS-2018-636** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-20.8 (- debits/+ credits)**

NOTE – This output include 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: **4/1**
- Impact pile driving activities - maximum number of pile strikes per day**: NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **140**
- Creosote removal – minimum tons removed (can remove more): **15**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **2514**
- 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**

Summary of current status of **NWS-2017-955** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-101.8 (- debits/+ credits)**

NOTE – This output include 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: **14/1**
- Number of days that pile driving will occur/ number of work windows: **NA/1**
- 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): **1**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **140**
- 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**

Summary of current status of **NWS-2018-760** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-54.4 (- debits/+ credits)**

NOTE – This output include 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: **3/1**
- Number of days that pile driving will occur/ number of work windows: **2/1**
- Impact pile driving activities - maximum number of pile strikes per day**: NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **80**
- Creosote removal – minimum tons removed (can remove more): **0.96**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **1460**
- 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**

Summary of current status of **NWS-2017-840** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-87.1 (- debits/+ credits)**

NOTE – This output include 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: **NA/1**
- 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 overwater structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **136**
- Bulkhead/bank armoring – structure placement should not extend below: **1 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**

Summary of current status of **NWS-2018-981** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-1.9 (- debits/+ credits)**

NOTE – This output include 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: **4/1**
- Impact pile driving activities - maximum number of pile strikes per day**: 4000**
- Vibratory pile driving activities – minutes of vibratory driving per day: **160**
- Creosote removal – minimum tons removed (can remove more): **22**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **2722**
- 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**

Summary of current status of **NWS-2018-1143** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **3** **(- debits/+ credits)**

NOTE – This output include 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: **14/1**
- Number of days that pile driving will occur/ number of work windows: **NA/1**
- 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 overwater structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **60**
- Bulkhead/bank armoring – structure placement should not extend below: **1 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**

Summary of current status of **NWS-2018-570** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-329.2 (- debits/+ credits)**

NOTE – This output include 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 2 – March 2**
- 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: **8/1**
- Impact pile driving activities - maximum number of pile strikes per day**: NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **160**
- Creosote removal – minimum tons removed (can remove more): **179.5**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **5469**
- Bulkhead/bank armoring – maximum linear foot of structure: **386**
- Bulkhead/bank armoring – structure placement should not extend below: **2 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 - **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**

Summary of current status of **NSW-2018-1165** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **No**
- Current Nearshore Habitat Values Model Output: **16.4 (- debits/+ credits)**

NOTE – This output include 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: **NA/1**
- 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): **10**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **782**
- 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**

Summary of current status of **NWS-2017-573** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-1045.2 (- debits/+ credits)**

NOTE – This output include 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 - October 14**
- 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: **20/1**
- Impact pile driving activities - maximum number of pile strikes per day**: 400**
- Vibratory pile driving activities – minutes of vibratory driving per day: **160**
- Creosote removal – minimum tons removed (can remove more): **NA**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **11670**
- 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**

Summary of current status of **NWS-2018-382** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-39.6 (- debits/+ credits)**

NOTE – This output include 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 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: **NA/1**
- 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): **17.86**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **125**
- Bulkhead/bank armoring – structure placement should not extend 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**

Summary of current status of **NWS-2019-207** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-80.7 (- debits/+ credits)**

NOTE – This output include 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: **NA/1**
- 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): **20**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **4168**
- 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 **- NA**
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 - **NA**
T&C 4 - **NA**
T&C 5 - **Required**

Summary of current status of **NWS-2019-552** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-374.8 (- debits/+ credits)**

NOTE – This output include 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- January 31**
- Number of days of in-water work/number of work windows: **15/1**
- Number of days that pile driving will occur/ number of work windows: **6/1**
- Impact pile driving activities - maximum number of pile strikes per day**: NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **100**
- Creosote removal – minimum tons removed (can remove more): **NA**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **307**
- Bulkhead/bank armoring – structure placement should not extend below: **2 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 - **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**

Project Attachment for USACE Administrative Ease for: **NWS-2019-676**
Puget Sound Nearshore Batch Opinion WCRO-2020-01361

Summary of current status of **NWS-2019-676** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **No**
- Current Nearshore Habitat Values Model Output: **0** **(- debits/+ credits)**

NOTE – This output include 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: **7/1**
- Number of days that pile driving will occur/ number of work windows: **NA/1**
- 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): **1.36**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **64**
- 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**

Summary of current status of **NWS-2019-526** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **No**
- Current Nearshore Habitat Values Model Output: **15.5 (- debits/+ credits)**

NOTE – This output include 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: **2/1**
- Impact pile driving activities - maximum number of pile strikes per day**: NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **160**
- Creosote removal – minimum tons removed (can remove more): **22**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **3615**
- 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**

Summary of current status of **NWS-2018-750** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-146.2 (- debits/+ credits)**

NOTE – This output include 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: **60/4**
- Number of days that pile driving will occur/ number of work windows: **60/4**
- Impact pile driving activities - maximum number of pile strikes per day**: NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **160**
- Creosote removal – minimum tons removed (can remove more): **120**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **31744**
- 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**

Summary of current status of **NWS-2018-39** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-28.3 (- debits/+ credits)**

NOTE – This output include 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: **2/1**
- Number of days that pile driving will occur/ number of work windows: **NA/1**
- 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 overwater 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 **- NA**
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 - **NA**
T&C 4 - **NA**
T&C 5 **- Required**

Summary of current status of **NWS-2019-491** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-260.7 (- debits/+ credits)**

NOTE – This output include 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: **8/1**
- Number of days that pile driving will occur/ number of work windows: **NA/1**
- 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 overwater structure: **2292**
- 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**

Summary of current status of **NWS-2019-664** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-550.1 (- debits/+ credits)**

NOTE – This output include 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: **NA/1**
- 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 overwater structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **360**
- Bulkhead/bank armoring – structure placement should not extend below: **8 inches 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 **- NA**
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 - **NA**
T&C 4 - **NA**
T&C 5 - **Required**

Summary of current status of **NWS-2019-336** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-530.5 (- debits/+ credits)**

NOTE – This output include 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: **31/10**
- Number of days that pile driving will occur/ number of work windows: **31/10**
- Impact pile driving activities - maximum number of pile strikes per day**: NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **160**
- Creosote removal – minimum tons removed (can remove more): **196**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **240**
- 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**

Summary of current status of **NWS-2018-525** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-202.3** **(- debits/+ credits)**

NOTE – This output include 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: **2/1**
- Impact pile driving activities - maximum number of pile strikes per day**: NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **160**
- Creosote removal – minimum tons removed (can remove more): **13**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **12778**
- 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**

Summary of current status of **NWS-2018-492** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-2043.14 (- debits/+ credits)**

NOTE – This output include 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: **60/3**
- Number of days that pile driving will occur/ number of work windows: **60/3**
- Impact pile driving activities - maximum number of pile strikes per day**: 22500**
- Vibratory pile driving activities – minutes of vibratory driving per day: **100**
- Creosote removal – minimum tons removed (can remove more): **198**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **834**
- Bulkhead/bank armoring – structure placement should not extend below: **14 ft below MHHW**
- Stormwater discharge – square foot of impervious surface generating stormwater: **73000**

The RPM(s) that are applicable to this project are:
RPM 1 - **Required**
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 - **Required**
T&C 2 - **NA**
T&C 3 - **Required**
T&C 4 - **Required**
T&C 5 - **Required**

Summary of current status of **NWS-2019-478** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-9.3 (- debits/+ credits)**

NOTE – This output include 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: **20/1**
- Number of days that pile driving will occur/ number of work windows: **NA/1**
- 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: **7500**
- In and overwater structure – maximum square foot of overwater 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**

Summary of current status of **NWS-2019-956** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-212.05** **(- debits/+ credits)**

NOTE – This output include 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: **NA/1**
- 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): **14.61**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **117/13**
- Bulkhead/bank armoring – structure placement should not extend 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**

Summary of current status of **NWS-2019-0883** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **No**
- Current Nearshore Habitat Values Model Output: **14.3 (- debits/+ credits)**

NOTE – This output include 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: **25/1**
- Impact pile driving activities - maximum number of pile strikes per day**: NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **40**
- Creosote removal – minimum tons removed (can remove more): **11**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **1000**
- 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**

Summary of current status of **NWS-2019-728** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **No**
- Current Nearshore Habitat Values Model Output: **7.8 (- debits/+ credits)**

NOTE – This output include 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: **2/1**
- Number of days that pile driving will occur/ number of work windows: **NA/1**
- 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 overwater structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **4**
- Bulkhead/bank armoring – structure placement should not extend 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**

Summary of current status of **NWS-2019-690** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-37.7 (- debits/+ credits)**

NOTE – This output include 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 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: **NA/1**
- 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): **4**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **220**
- Bulkhead/bank armoring – maximum linear foot of structure: **35**
- Bulkhead/bank armoring – structure placement should not extend below: **1 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**

Summary of current status of **NWS-2019-0703** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **No**
- Current Nearshore Habitat Values Model Output: **957.4 (- debits/+ credits)**

NOTE – This output include 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**: September 1- February 15**
- Number of days of in-water work/number of work windows: **119/5**
- Number of days that pile driving will occur/ number of work windows: **119/5**
- Impact pile driving activities - maximum number of pile strikes per day**: 10800**
- Vibratory pile driving activities – minutes of vibratory driving per day: **405**
- Creosote removal – minimum tons removed (can remove more): **2232**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **74636**
- 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**

Summary of current status of **NWS-2020-0204** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-1185.6 (- debits/+ credits)**

NOTE – This output include 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: **100/2**
- Number of days that pile driving will occur/ number of work windows: **NA/2**
- 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 overwater structure: **4124**
- Bulkhead/bank armoring – maximum linear foot of structure: **330**
- Bulkhead/bank armoring – structure placement should not extend below: **3 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**

Summary of current status of **NWS-2017-550** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **No**
- Current Nearshore Habitat Values Model Output: **440.2 (- debits/+ credits)**

NOTE – This output include 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 - October 14**
- Number of days of in-water work/number of work windows: **90/10**
- Number of days that pile driving will occur/ number of work windows: **90/10**
- Impact pile driving activities - maximum number of pile strikes per day**: 245**
- Vibratory pile driving activities – minutes of vibratory driving per day: **140**
- Creosote removal – minimum tons removed (can remove more): **272.21**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **1883**
- 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**

Summary of current status of **NWS-2019-101** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **No**
- Current Nearshore Habitat Values Model Output: **208.8 (- debits/+ credits)**

NOTE – This output include 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- January 31**
- Number of days of in-water work/number of work windows: **30/5**
- Number of days that pile driving will occur/ number of work windows: **20/5**
- Impact pile driving activities - maximum number of pile strikes per day**: 4000**
- Vibratory pile driving activities – minutes of vibratory driving per day: **80**
- Creosote removal – minimum tons removed (can remove more): **167**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **1139**
- 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**

Summary of current status of **NWS-2019-832** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **No**
- Current Nearshore Habitat Values Model Output: **30 (- debits/+ credits)**

NOTE – This output include 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: **7/1**
- Impact pile driving activities - maximum number of pile strikes per day**: NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **160**
- Creosote removal – minimum tons removed (can remove more): **11.5**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **948**
- 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**

Summary of current status of **NWS-2017-427** (at date of final signing of WCRO 2020-01361)

- Subject to the Reasonable and Prudent Alternative (RPA): **Yes**
- Current Nearshore Habitat Values Model Output: **-2.1 (- debits/+ credits)**

NOTE – This output include 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 - October 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: **1/1**
- Impact pile driving activities - maximum number of pile strikes per day**: 600**
- Vibratory pile driving activities – minutes of vibratory driving per day: **20**
- Creosote removal – minimum tons removed (can remove more): **NA**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **37**
- 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 **- NA**
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 - **NA**
T&C 4 - **NA**
T&C 5 - **Required**

Summary of current status of **NWS-2019-983** (at date of final signing of WCRO 2020-01361)

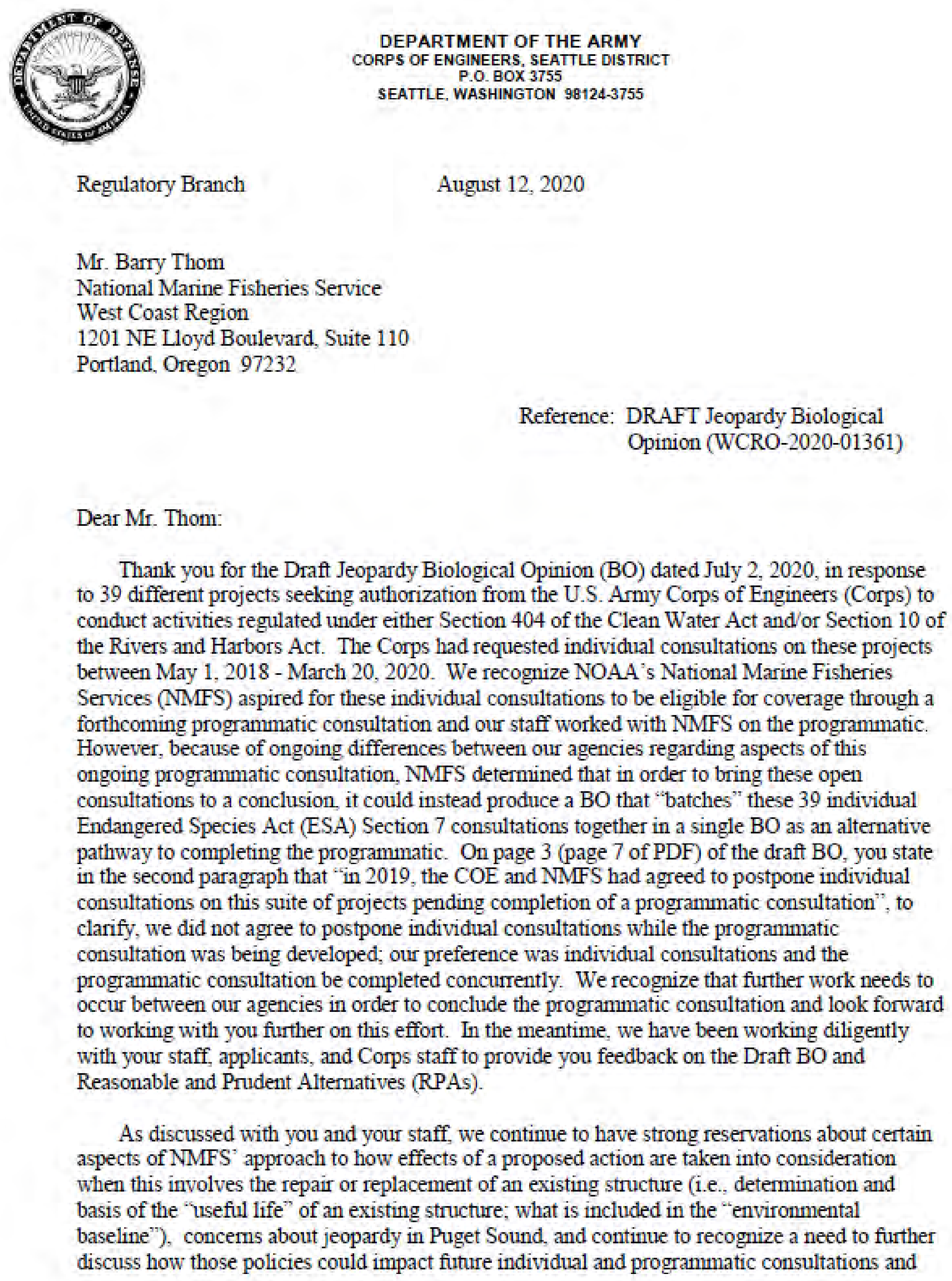
- Subject to the Reasonable and Prudent Alternative (RPA): **No**
- Current Nearshore Habitat Values Model Output: **19.8 (- debits/+ credits)**

NOTE – This output include 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: **NA/1**
- 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): **27**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of overwater structure: **704**
- 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: **8269**

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**



DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Regulatory Branch August 12, 2020

Mr. Barry Thom
National Marine Fisheries Service
West Coast Region
1201 NE Lloyd Boulevard, Suite 110
Portland, Oregon 97232

Reference: DRAFT Jeopardy Biological
Opinion (WCRO-2020-01361)

Dear Mr. Thom:

Thank you for the Draft Jeopardy Biological Opinion (BO) dated July 2, 2020, in response to 39 different projects seeking authorization from the U.S. Army Corps of Engineers (Corps) to conduct activities regulated under either Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act. The Corps had requested individual consultations on these projects between May 1, 2018 - March 20, 2020. We recognize NOAA's National Marine Fisheries Services (NMFS) aspired for these individual consultations to be eligible for coverage through a forthcoming programmatic consultation and our staff worked with NMFS on the programmatic. However, because of ongoing differences between our agencies regarding aspects of this ongoing programmatic consultation, NMFS determined that in order to bring these open consultations to a conclusion, it could instead produce a BO that "batches" these 39 individual Endangered Species Act (ESA) Section 7 consultations together in a single BO as an alternative pathway to completing the programmatic. On page 3 (page 7 of PDF) of the draft BO, you state in the second paragraph that "in 2019, the COE and NMFS had agreed to postpone individual consultations on this suite of projects pending completion of a programmatic consultation", to clarify, we did not agree to postpone individual consultations while the programmatic consultation was being developed; our preference was individual consultations and the programmatic consultation be completed concurrently. We recognize that further work needs to occur between our agencies in order to conclude the programmatic consultation and look forward to working with you further on this effort. In the meantime, we have been working diligently with your staff, applicants, and Corps staff to provide you feedback on the Draft BO and Reasonable and Prudent Alternatives (RPAs).

As discussed with you and your staff, we continue to have strong reservations about certain aspects of NMFS' approach to how effects of a proposed action are taken into consideration when this involves the repair or replacement of an existing structure (i.e., determination and basis of the "useful life" of an existing structure; what is included in the "environmental baseline"), concerns about jeopardy in Puget Sound, and continue to recognize a need to further discuss how those policies could impact future individual and programmatic consultations and

Civil Works projects. We will continue to have Corps legal staff coordinate with your general counsel in an attempt to resolve these concerns separate from the batched BO to eliminate further delays to finalizing this BO.

While we and the applicants appreciate the flexibility NMFS proposed to offer regarding a range of options available to each applicant to implement RPAs to avoid jeopardizing an ESA listed species and adversely modifying designated critical habitat, the Corps needs to have more certainty as to the full scope of the applicant's proposed activity before a Department of the Army (DA) permit decision can be made. As currently framed in the Draft BO, an applicant may elect to fulfill the RPAs by pursuing compensatory conservation actions through a number of potential pathways, all of which depend upon the actions of a third party (not the Corps), and some of which would involve additional work (beyond what the applicant originally proposed) in waters of the U.S. requiring DA authorization. In particular, the Corps needs to know the extent of all impacts to waters of the U.S. and its effects before a permit decision can be made. This is particularly the case when faced with a determination from NMFS that the proposed activity by an applicant will result in jeopardizing the continued existence of ESA-listed species or adversely modify designated critical habitat.

Therefore, we cannot wait for up to 2 years and 6 months after finalization of the BO for the applicant to submit a plan to meet the RPAs. For the Corps, this would mean we could not make a permit decision until the RPA plan is submitted and approved by NOAA and the Corps. Waiting 2 years and 6 months to make a permit decision is not an acceptable option for the Corps.

Under 50 CFR 402.15, the Corps needs to determine whether and in what manner it will proceed with the action in light of its ESA Section 7 obligations and the NMFS' BO. To provide the Corps with sufficient certainty, and to meet the 60-day requirement at 50 CFR 402.15 for the Corps to respond to NMFS after finalization of a Jeopardy BO, we intend to require applicants subject to this batched BO to provide a written plan to the Corps and NMFS within 30 days from the finalization date of the BO (if not already provided) describing how they will meet the RPAs of the BO, and express an affirmation that the applicant commits to meeting all applicable requirements of the BO for their project. We respectfully request that upon your receipt of those written affirmations, you reply to the Corps no later than 55 days from the date of finalization of the BO with your concurrence that the applicant meets the RPA requirements. On this basis, we will then provide NMFS affirmation of which applicants the Corps would or would not be able to accept implementation of the RPAs.

For those applicants who do not affirmatively indicate that they will meet the RPA requirements as framed in the final BO, we will request that they are withdrawn from the batched BO and request NMFS continue with completing individual (not batched) consultation for those projects. If NMFS believes the outcome of individual Section 7 consultation will be the same as the batched BO, we feel it is appropriate that NMFS provide that messaging directly to the applicants so they fully understand the consequences of them not accepting the batched BO and how it will negatively affect their ability to obtain a DA permit since they will not have a completed ESA consultation. We also believe it is NMFS' responsibility to explain to these applicants the time frame for completing these individual consultations. The Corps will explain to these applicants that they will also have the option of requesting the Corps make a permit decision based on the findings of the final BO. Because it is a jeopardy opinion and the applicant is unwilling to meet the RPA requirements, the likely outcome would be a permit denial.

Please find detailed below our feedback regarding the draft BO. Please note that portions of these comments are purposely kept in Track Changes to clearly show our proposed changes to the text in the draft BO and certain comments highlighted in gray provide our reason for the proposed revision.

Revised and or Clarifications to Project Descriptions

Your staff and Corps staff have coordinated with the 39 applicants to provide accurate and up-to-date project descriptions such that NMFS can accurately account for impacts and the required amount of conservation credits. We have endeavored to provide your staff with this feedback on all projects by the date of this letter but given the volume of applicants and the limited amount of time, we are still collecting this information for some projects and will provide it to your staff as quickly as we receive it.

Marine Mammal Monitoring Plan (MMMP)

In the draft BO there are references to a requirement for a MMMP for all projects including impact or vibratory pile driving. There have been questions regarding this requirement because for several projects, certain measures will be implemented to reduce noise and vibrations below harmful levels. It appears you are requiring a MMMP for all projects with impact or vibratory pile driving, regardless of noise levels or noise mitigation measures. For example, there have been questions from applicants whether or not a MMMP is required if a bubble curtain is used. We have also had a question from the applicant for NWS-2019-552 whether a MMMP is required because as described in the Biological Evaluation for the project, it was determined that harmful levels will not be reached. We request that the MMMP requirement be reassessed based on the specific construction and noise mitigation measures proposed, not just the fact that there will be impact or vibratory pile driving. Please clarify this in the final BO.

Also, the logistics of obtaining an acceptable MMMP from all relevant applicants before finalization of the BO would be very time consuming and would delay finalization of the BO. To prevent further delays, in lieu of the Corps having MMMPs in place with each application before finalization of the BO, the Corps suggests the revised text (see below) be included in the final BO to reference the need for applicants to submit and receive approval on a MMMP from

NOAA before any work in waters of the U.S. can commence. To emphasize this requirement, in the permit/verification letter to the applicant, the Corps will include the following language:

> "Please be reminded that Special Condition "**[XX]**" of your permit requires that you implement and abide by the Endangered Species Act (ESA) requirements and/or agreements set forth in the Biological Evaluation/Assessment (BE/BA) and the Biological Opinion (BO) for this project. In particular, note that the BO requires that you submit a *Marine Mammal Monitoring Plan* which will need to be reviewed and approved by a NMFS biologist before work in waters of the U.S. can commence. Failure to comply with the commitments made in the BE/BA constitutes non-compliance with the ESA and with this authorization."

DRAFT BO, page 18 (page 22 of PDF), proposed text changes regarding MMMP:

For the proposed projects, the Corps has proposed the following best management practices:
4. All project that include impact or vibratory pile driving which will exceed harmful noise levels will have a NOAA-approved ~~will include a~~ Marine Mammal Monitoring Plan in place before any work can commence in waters of the U.S. The MMMP must meet the requirements of NOAA's guidance for MMMPs found on NOAA's website: http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/monitoring_plan_guidance.html.

~~that is sufficient to ensure pile driving ceases before marine mammals enter the area where sound will exceed 120 dBRMS. [CORPS PLEASE ENSURE THIS IS ACCURATE]~~

Take Tables 24 and 25

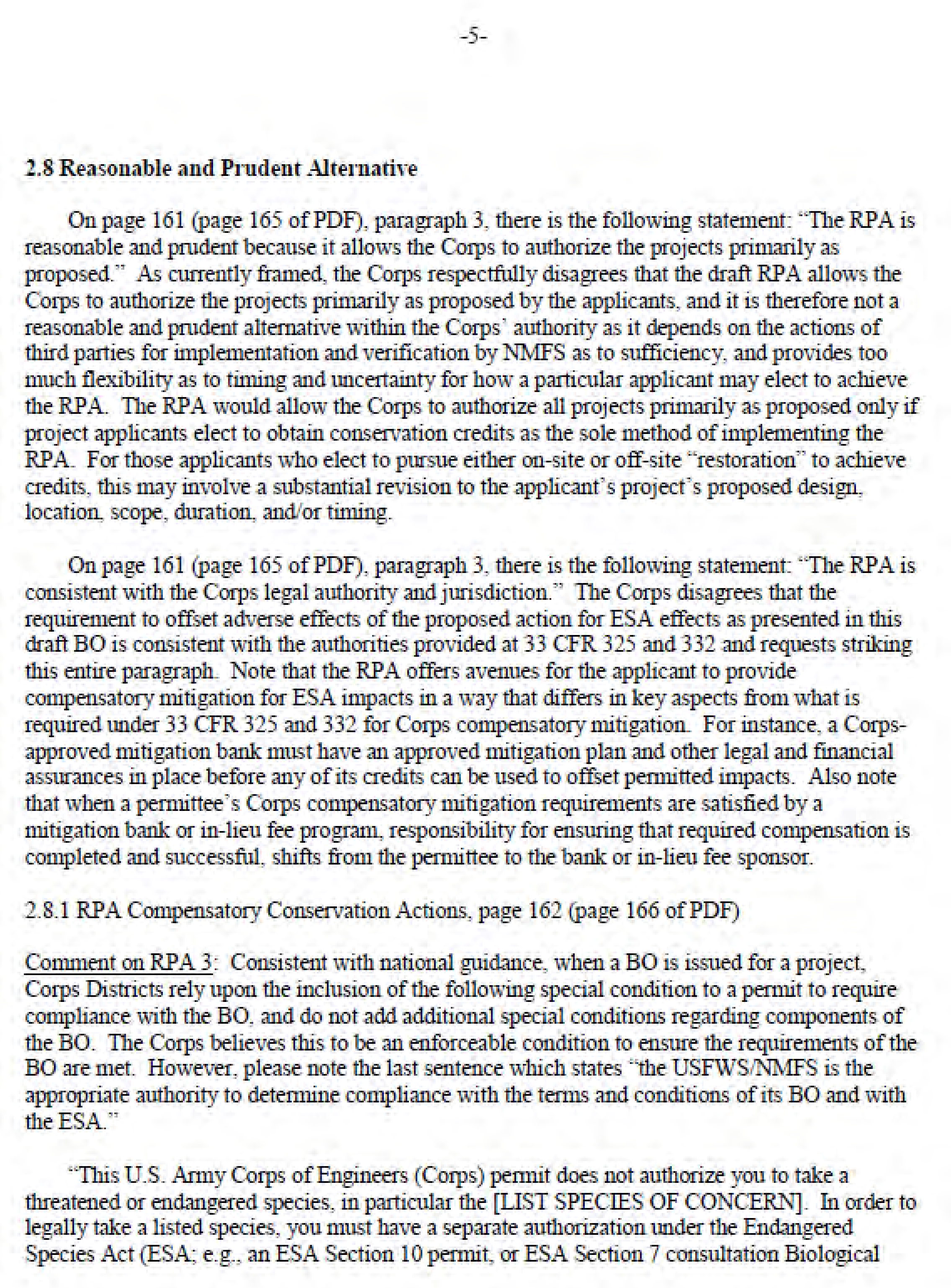
Specific project information for Tables 24 and 25 were requested by NMFS for a number of projects. We are still in the process of collecting that data and will submit completed tables as soon as possible.

Impacts due to Vessel Noise – Construction vessels and vessels using completed structure

In the draft BO, effects of and take due to vessel noise are discussed. While we understand under ESA these effects are considered, please be reminded that the Corps does not regulate vessel use or movement.

Use - Reasonable and Prudent Alternatives (RPAs)

Please see our comments and suggested edits below to provide more enforceable language and clarity for applicants while allowing flexibility.



2.8 Reasonable and Prudent Alternative

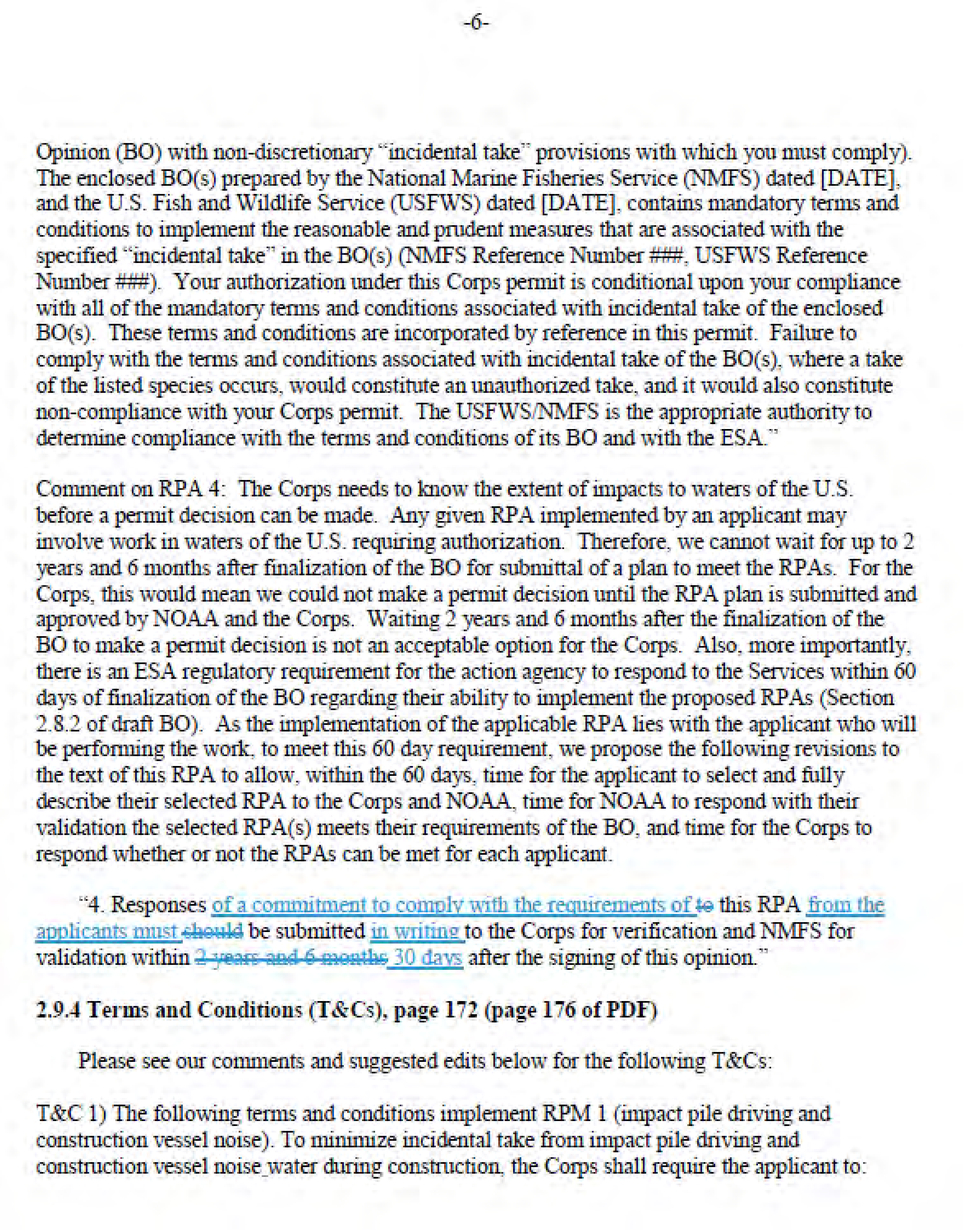
On page 161 (page 165 of PDF), paragraph 3, there is the following statement: "The RPA is reasonable and prudent because it allows the Corps to authorize the projects primarily as proposed." As currently framed, the Corps respectfully disagrees that the draft RPA allows the Corps to authorize the projects primarily as proposed by the applicants, and it is therefore not a reasonable and prudent alternative within the Corps' authority as it depends on the actions of third parties for implementation and verification by NMFS as to sufficiency, and provides too much flexibility as to timing and uncertainty for how a particular applicant may elect to achieve the RPA. The RPA would allow the Corps to authorize all projects primarily as proposed only if project applicants elect to obtain conservation credits as the sole method of implementing the RPA. For those applicants who elect to pursue either on-site or off-site "restoration" to achieve credits, this may involve a substantial revision to the applicant's project's proposed design, location, scope, duration, and/or timing.

On page 161 (page 165 of PDF), paragraph 3, there is the following statement: "The RPA is consistent with the Corps legal authority and jurisdiction." The Corps disagrees that the requirement to offset adverse effects of the proposed action for ESA effects as presented in this draft BO is consistent with the authorities provided at 33 CFR 325 and 332 and requests striking this entire paragraph. Note that the RPA offers avenues for the applicant to provide compensatory mitigation for ESA impacts in a way that differs in key aspects from what is required under 33 CFR 325 and 332 for Corps compensatory mitigation. For instance, a Corps-approved mitigation bank must have an approved mitigation plan and other legal and financial assurances in place before any of its credits can be used to offset permitted impacts. Also note that when a permittee's Corps compensatory mitigation requirements are satisfied by a mitigation bank or in-lieu fee program, responsibility for ensuring that required compensation is completed and successful, shifts from the permittee to the bank or in-lieu fee sponsor.

2.8.1 RPA Compensatory Conservation Actions, page 162 (page 166 of PDF)

Comment on RPA 3: Consistent with national guidance, when a BO is issued for a project, Corps Districts rely upon the inclusion of the following special condition to a permit to require compliance with the BO, and do not add additional special conditions regarding components of the BO. The Corps believes this to be an enforceable condition to ensure the requirements of the BO are met. However, please note the last sentence which states "the USFWS/NMFS is the appropriate authority to determine compliance with the terms and conditions of its BO and with the ESA."

"This U.S. Army Corps of Engineers (Corps) permit does not authorize you to take a threatened or endangered species, in particular the [LIST SPECIES OF CONCERN]. In order to legally take a listed species, you must have a separate authorization under the Endangered Species Act (ESA; e.g., an ESA Section 10 permit, or ESA Section 7 consultation Biological



Opinion (BO) with non-discretionary “incidental take” provisions with which you must comply). The enclosed BO(s) prepared by the National Marine Fisheries Service (NMFS) dated [DATE], and the U.S. Fish and Wildlife Service (USFWS) dated [DATE], contains mandatory terms and conditions to implement the reasonable and prudent measures that are associated with the specified “incidental take” in the BO(s) (NMFS Reference Number ###, USFWS Reference Number ###). Your authorization under this Corps permit is conditional upon your compliance with all of the mandatory terms and conditions associated with incidental take of the enclosed BO(s). These terms and conditions are incorporated by reference in this permit. Failure to comply with the terms and conditions associated with incidental take of the BO(s), where a take of the listed species occurs, would constitute an unauthorized take, and it would also constitute non-compliance with your Corps permit. The USFWS/NMFS is the appropriate authority to determine compliance with the terms and conditions of its BO and with the ESA.”

Comment on RPA 4: The Corps needs to know the extent of impacts to waters of the U.S. before a permit decision can be made. Any given RPA implemented by an applicant may involve work in waters of the U.S. requiring authorization. Therefore, we cannot wait for up to 2 years and 6 months after finalization of the BO for submittal of a plan to meet the RPAs. For the Corps, this would mean we could not make a permit decision until the RPA plan is submitted and approved by NOAA and the Corps. Waiting 2 years and 6 months after the finalization of the BO to make a permit decision is not an acceptable option for the Corps. Also, more importantly, there is an ESA regulatory requirement for the action agency to respond to the Services within 60 days of finalization of the BO regarding their ability to implement the proposed RPAs (Section 2.8.2 of draft BO). As the implementation of the applicable RPA lies with the applicant who will be performing the work, to meet this 60 day requirement, we propose the following revisions to the text of this RPA to allow, within the 60 days, time for the applicant to select and fully describe their selected RPA to the Corps and NOAA, time for NOAA to respond with their validation the selected RPA(s) meets their requirements of the BO, and time for the Corps to respond whether or not the RPAs can be met for each applicant.

“4. Responses of a commitment to comply with the requirements of ~~to~~ this RPA from the applicants must ~~should~~ be submitted in writing to the Corps for verification and NMFS for validation within ~~2 years and 6 months~~ 30 days after the signing of this opinion.”

2.9.4 Terms and Conditions (T&Cs), page 172 (page 176 of PDF)

Please see our comments and suggested edits below for the following T&Cs:

T&C 1) The following terms and conditions implement RPM 1 (impact pile driving and construction vessel noise). To minimize incidental take from impact pile driving and construction vessel noise water during construction, the Corps shall require the applicant to:

a) Adhere to the work window of July 15 to February 15 or the applicable work window for the specific geographic region. [This addition will allow for any variance between the 39 projects.]
b) Utilize vibratory pile driving whenever sediment conditions allow.
~~c) NMFS will work with Corps to determine maximum number of hours a day pile driving may occur.~~ [This should be deleted as this limit should be determined by NOAA as part of the BO.]
~~d) NMFS will work with Corps to determine maximum number of steel impact strikes, including proofing, allowed per day.~~ [This should be deleted as this limit should be determined by NOAA as part of the BO.]
e) Utilize sound attenuation measure(s) (double walled piled, wooden block, bubble curtain, etc.) for all steel impact pile driving activities to keep source sound levels below the following thresholds at 10 meters distance.
f) The applicant must ~~D~~develop ~~and implement~~ an Acoustic Monitoring Plan and submit to and receive approval from NOAA before pile driving can commence~~each year for a subset of the anticipated piles that will be placed. The Plan must be approved by NMFS each year.~~ The Acoustic Monitoring Plan shall document the results of acoustic monitoring and be sent annually by the applicant to the NMFS Oregon Washington Coastal Office. ...

T&C 4) The following terms and conditions implement R~~M~~PM 4 (RPA 1):

This T&C overlaps with provisions in RPA 2 and 4. We suggest deleting the details in RPM 4 that overlap/duplicate with the provisions of these RPAs. Comments here are intended to provide recommendations for clarify the specificity in or consolidation of revised RPAs.

a) To minimize incidental take resulting from the proposed action including all bank armoring, overwater structures, and dredging, the applicant shall ~~,~~ receive validation from NMFS within 60 days after finalization of the BO for ~~submit~~ a proposal to ~~the Corps for verification and to NMFS for validation, within 2 years and 6 months after the signing of this opinion, a plan to~~ implement one or more of the following:
   i) Restoration Plans:
      (1) ~~Prior to beginning construction, submit to Corp for verification and NMFS for validation. O~~on or off-site plans that demonstrate improvement of the same type of nearshore estuarine habitat within the marine basin or natal estuary that is affected by the proposed action.
      (2) Plans should include the NHVM calculations or results from similar tool verifying credit equivalency. [It appears that NMFS would be the entity to identify and determine if there was a "similar" tool OTHER than the compensation calculator. This adds complexity for the applicant; and increased uncertainty. Because this is intended to address an alternative for these applicants only, we suggest instead identifying the other "similar

tool(s)" that NMFS knows about in the final RPA. (e.g., Hood Canal ILF, etc). As well as whether, in the face of multiple tools being available, which one the applicant should rely upon as it is unclear on what basis "equivalency" would be determined by NMFS, or what information should be provided to NMFS to inform that determination].

(3) ~~Once NMFS has verified, provide date to be completed with proof of commitment of implementation~~. Plans shall be submitted in writing to the Corps for coordination and to NMFS for validation within 30 days after the signing of this opinion. If the applicant chooses this option, implementation must occur within three years after the signing of this opinion.

ii) Documented agreement with state or local watershed group to contribute funds to a project that will improve nearshore and/or estuarine habitat within the marine basin or natal estuary that the proposed project will take place and that demonstrates improvement of the same type of nearshore estuarine habitat that is affected by the proposed action. If the applicant chooses this option, funds must be contributed, and implementation must occur, within three years after the signing of this opinion.

(1) NHVM calculations or results from similar tool [see previous comment about "similar tool"] verifying credit equivalency.

(2) Date and proof of completion or date to be completed with proof of commitment implementation must be submitted by the applicant to NMFS. ~~If the applicant chooses to satisfy this with a proof of commitment, implementation must occur within three years after the signing of this opinion.~~ [suggest deleting because redundant since stated above in item "ii"]

iii) Documented agreement with other landowners to remove an in-water and over-water structure within the marine basin or natal estuary

(1) NHVM calculations or results from a similar tool [see previous comment about "similar tool"] verifying credit equivalency.

(2) Date and proof of completion or date to be completed with proof of commitment implementation and documented conservation easement or like instrument insuring conservation protections must be submitted in writing by the applicant to NMFS and Corps within 30 days after finalization of the BO. If the applicant chooses this option, implementation must occur within three years after the signing of this opinion.

iv) Receipt from a NMFS-approved conservation bank for proof of payment for conservation or mitigation credits.

(1) NHVM calculations or results from a similar tool [see previous comment about "similar tool"] verifying credit equivalency.

(2) Date and proof of completion or date to be completed with proof of commitment implementation must be submitted in writing by the applicant to NMFS and Corps within 30 days after finalization of the BO. If the

applicant chooses this option, credits must be purchased within three years after the signing of this opinion.

T&C 5) The following terms and conditions implement reasonable and prudent measure 5 (Monitoring and Reporting):

a) Before beginning work require all contractors working on site to be provided with a complete list of the DA~~Corps~~ permit special conditions, this biological opinion's RPMs, and terms and conditions intended to minimize the amount and extent of take resulting from in water work.

b) Within 60 days of project completion the ~~Corps~~ applicant shall prepare and send to the Corps and NMFS a project completion report that contains the following:

   i) Project identification
   ii) Project name
   iii) Type of activity
   iv) 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.
   v) Corps contact person(s)
   vi) Starting and ending dates for work completed
   vii) Starting and ending dates of in-water work completed
   viii) A description of how the ~~Corps'~~ applicant successfully met the terms and conditions contained in this Opinion.

To reiterate, as stated at the beginning of this letter, the RPAs and T&Cs provide flexibility but do not provide the needed clarity for the Corps. For example, regarding availability and timing of implementation of RPAs, on page 217 (page 221 of PDF), in the paragraph after the T &Cs it states whether an offset action in a particular basin is not "readily available to implement or purchase (and are not expected to become available within the next 3 years)" an option exists to pursue an action in another basin since the applicant would have 2 years and 6 months to identify a particular approach. The Corps needs to know from the applicant what specifically they will be proposing for us to make a legally sound permit decision based on assessing all impacts and effects to waters of the U.S.

If you make significant changes to the BO and RPAs, and would like further applicant and Corps feedback on the revised RPA, we would welcome the opportunity to provide feedback if it would help provide clarity to applicants and result in more applicants being able to accept the RPAs for their individual project. Thank you again for the opportunity to comment on the draft

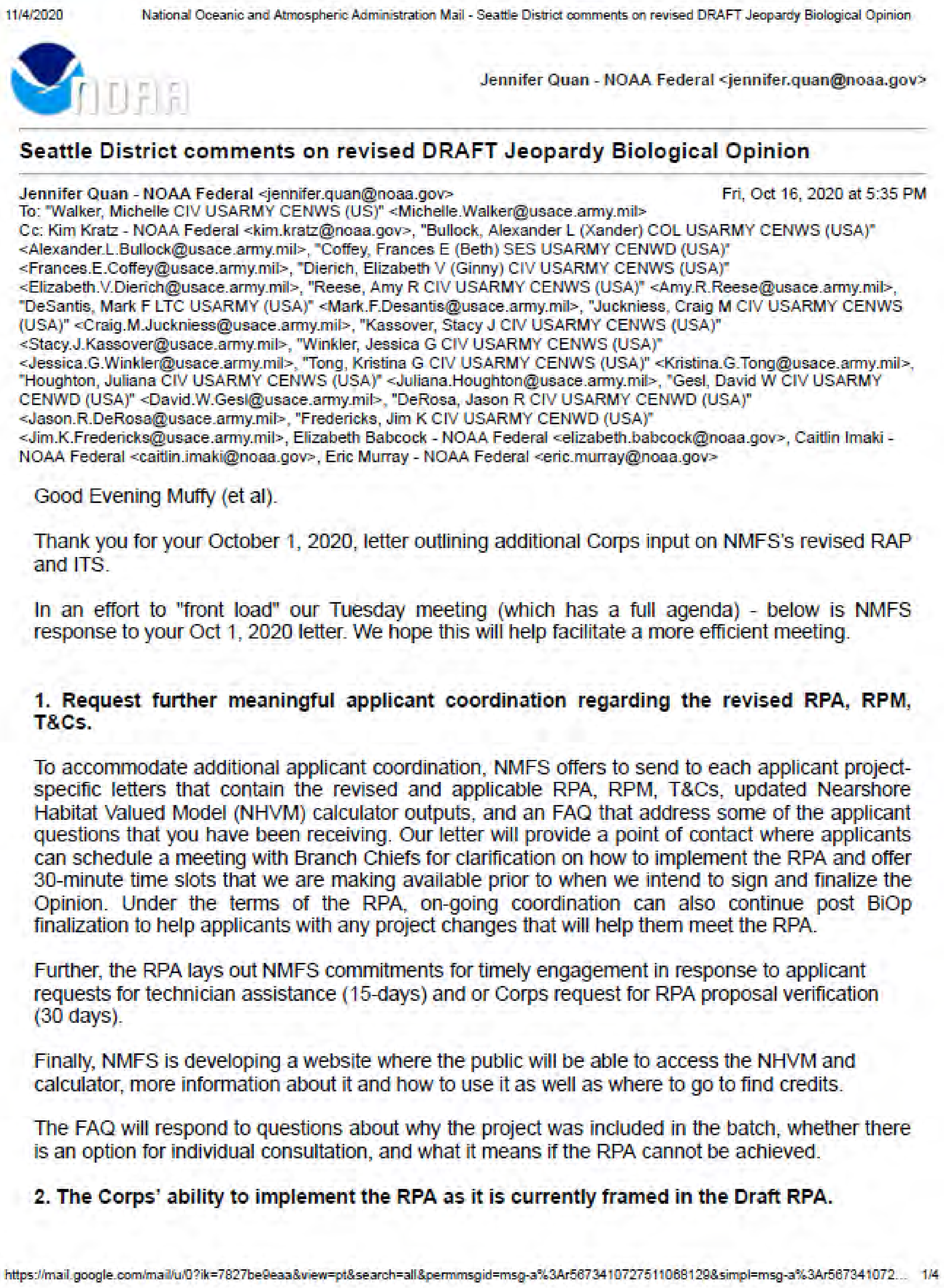
BO. If you have any questions, please contact me at michelle.walker@usace.army.mil or (206) 764-6915 or contact Ms. Kristina Tong at kristina.g.tong@usace.army.mil or (206) 764-6913 or Ms. Juliana Houghton at juliana.houghton@usace.army.mil or (206) 764-3768.

Sincerely,

Michelle Walker

Michelle Walker, Chief
Regulatory Branch

Appendix 2
WCRO-2020-03161



Jennifer Quan - NOAA Federal <jennifer.quan@noaa.gov>

Seattle District comments on revised DRAFT Jeopardy Biological Opinion

Jennifer Quan - NOAA Federal <jennifer.quan@noaa.gov> Fri, Oct 16, 2020 at 5:35 PM
To: "Walker, Michelle CIV USARMY CENWS (US)" <Michelle.Walker@usace.army.mil>
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Good Evening Muffy (et al).

Thank you for your October 1, 2020, letter outlining additional Corps input on NMFS's revised RAP and ITS.

In an effort to "front load" our Tuesday meeting (which has a full agenda) - below is NMFS response to your Oct 1, 2020 letter. We hope this will help facilitate a more efficient meeting.

1. Request further meaningful applicant coordination regarding the revised RPA, RPM, T&Cs.

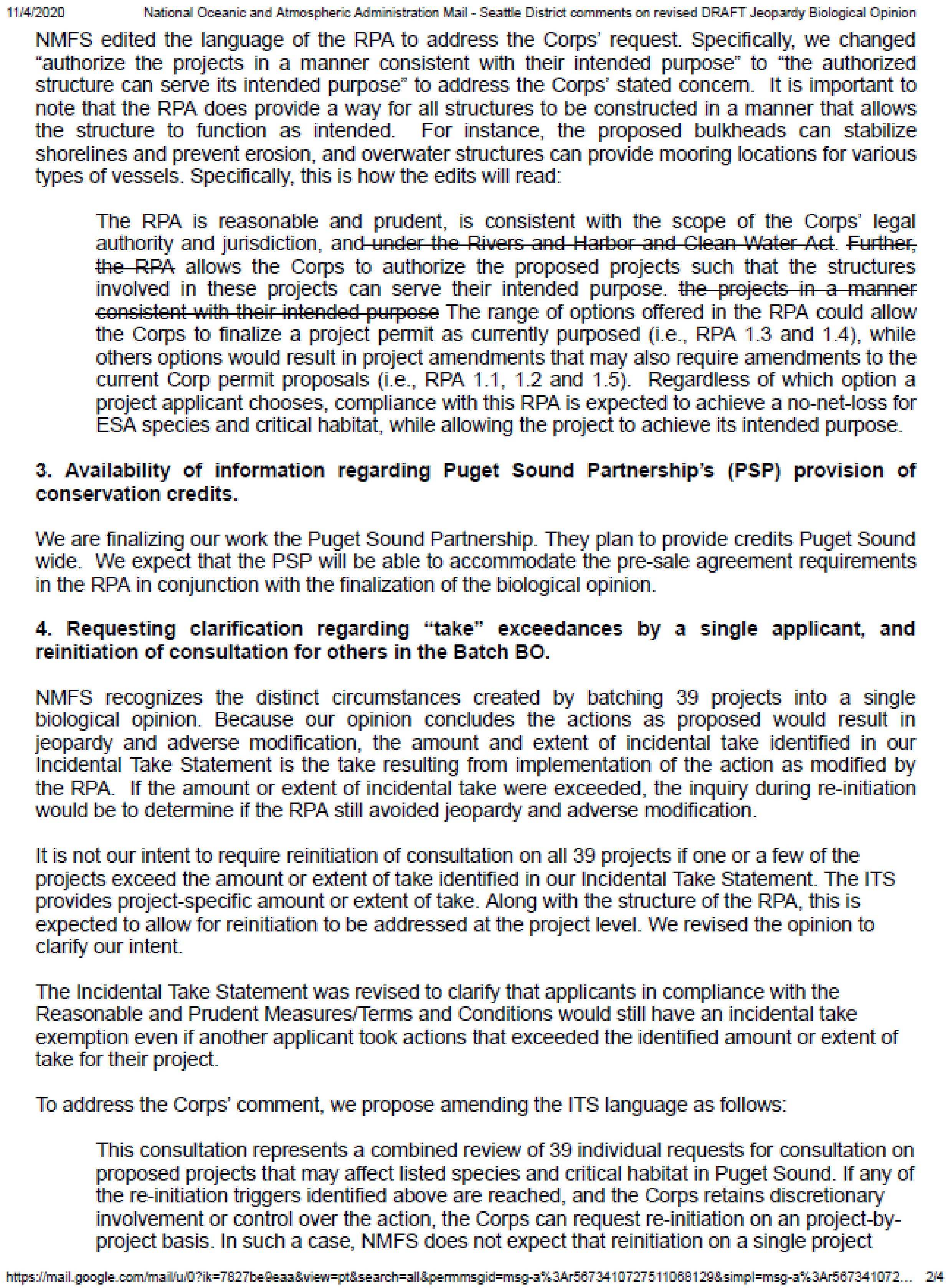
To accommodate additional applicant coordination, NMFS offers to send to each applicant project-specific letters that contain the revised and applicable RPA, RPM, T&Cs, updated Nearshore Habitat Valued Model (NHVM) calculator outputs, and an FAQ that address some of the applicant questions that you have been receiving. Our letter will provide a point of contact where applicants can schedule a meeting with Branch Chiefs for clarification on how to implement the RPA and offer 30-minute time slots that we are making available prior to when we intend to sign and finalize the Opinion. Under the terms of the RPA, on-going coordination can also continue post BiOp finalization to help applicants with any project changes that will help them meet the RPA.

Further, the RPA lays out NMFS commitments for timely engagement in response to applicant requests for technician assistance (15-days) and or Corps request for RPA proposal verification (30 days).

Finally, NMFS is developing a website where the public will be able to access the NHVM and calculator, more information about it and how to use it as well as where to go to find credits.

The FAQ will respond to questions about why the project was included in the batch, whether there is an option for individual consultation, and what it means if the RPA cannot be achieved.

2. The Corps' ability to implement the RPA as it is currently framed in the Draft RPA.



NMFS edited the language of the RPA to address the Corps' request. Specifically, we changed "authorize the projects in a manner consistent with their intended purpose" to "the authorized structure can serve its intended purpose" to address the Corps' stated concern. It is important to note that the RPA does provide a way for all structures to be constructed in a manner that allows the structure to function as intended. For instance, the proposed bulkheads can stabilize shorelines and prevent erosion, and overwater structures can provide mooring locations for various types of vessels. Specifically, this is how the edits will read:

> The RPA is reasonable and prudent, is consistent with the scope of the Corps' legal authority and jurisdiction, and ~~under the Rivers and Harbor and Clean Water Act~~. ~~Further, the RPA~~ allows the Corps to authorize the proposed projects such that the structures involved in these projects can serve their intended purpose. ~~the projects in a manner consistent with their intended purpose~~ The range of options offered in the RPA could allow the Corps to finalize a project permit as currently purposed (i.e., RPA 1.3 and 1.4), while others options would result in project amendments that may also require amendments to the current Corp 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 a no-net-loss for ESA species and critical habitat, while allowing the project to achieve its intended purpose.

3. Availability of information regarding Puget Sound Partnership's (PSP) provision of conservation credits.

We are finalizing our work the Puget Sound Partnership. They plan to provide credits Puget Sound wide. We expect that the PSP will be able to accommodate the pre-sale agreement requirements in the RPA in conjunction with the finalization of the biological opinion.

4. Requesting clarification regarding "take" exceedances by a single applicant, and reinitiation of consultation for others in the Batch BO.

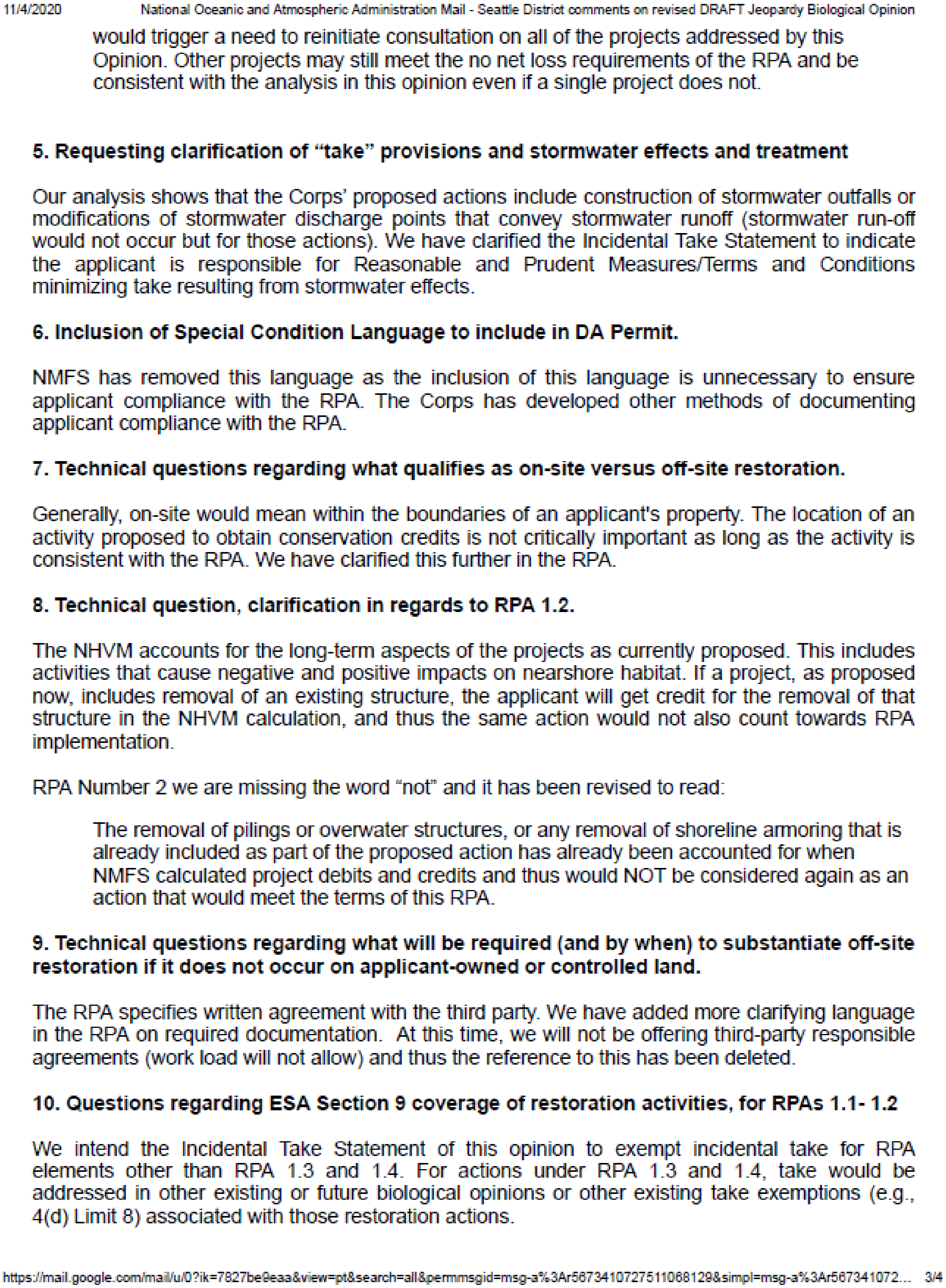
NMFS recognizes the distinct circumstances created by batching 39 projects into a single biological opinion. Because our opinion concludes the actions as proposed would result in jeopardy and adverse modification, the amount and extent of incidental take identified in our Incidental Take Statement is the take resulting from implementation of the action as modified by the RPA. If the amount or extent of incidental take were exceeded, the inquiry during re-initiation would be to determine if the RPA still avoided jeopardy and adverse modification.

It is not our intent to require reinitiation of consultation on all 39 projects if one or a few of the projects exceed the amount or extent of take identified in our Incidental Take Statement. The ITS provides project-specific amount or extent of take. Along with the structure of the RPA, this is expected to allow for reinitiation to be addressed at the project level. We revised the opinion to clarify our intent.

The Incidental Take Statement was revised to clarify that applicants in compliance with the Reasonable and Prudent Measures/Terms and Conditions would still have an incidental take exemption even if another applicant took actions that exceeded the identified amount or extent of take for their project.

To address the Corps' comment, we propose amending the ITS language as follows:

> This consultation represents a combined review of 39 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 Corps retains discretionary involvement or control over the action, the Corps can request re-initiation on an 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.

5. Requesting clarification of "take" provisions and stormwater effects and treatment

Our analysis shows that the Corps' proposed actions include construction of stormwater outfalls or modifications of stormwater discharge points that convey stormwater runoff (stormwater run-off would not occur but for those actions). We have clarified the Incidental Take Statement to indicate the applicant is responsible for Reasonable and Prudent Measures/Terms and Conditions minimizing take resulting from stormwater effects.

6. Inclusion of Special Condition Language to include in DA Permit.

NMFS has removed this language as the inclusion of this language is unnecessary to ensure applicant compliance with the RPA. The Corps has developed other methods of documenting applicant compliance with the RPA.

7. Technical questions regarding what qualifies as on-site versus off-site restoration.

Generally, on-site would mean within the boundaries of an applicant's property. The location of an activity proposed to obtain conservation credits is not critically important as long as the activity is consistent with the RPA. We have clarified this further in the RPA.

8. Technical question, clarification in regards to RPA 1.2.

The NHVM accounts for the long-term aspects of the projects as currently proposed. This includes activities that cause negative and positive impacts on nearshore habitat. If a project, as proposed now, includes removal of an existing structure, the applicant will get credit for the removal of that structure in the NHVM calculation, and thus the same action would not also count towards RPA implementation.

RPA Number 2 we are missing the word "not" and it has been revised to read:

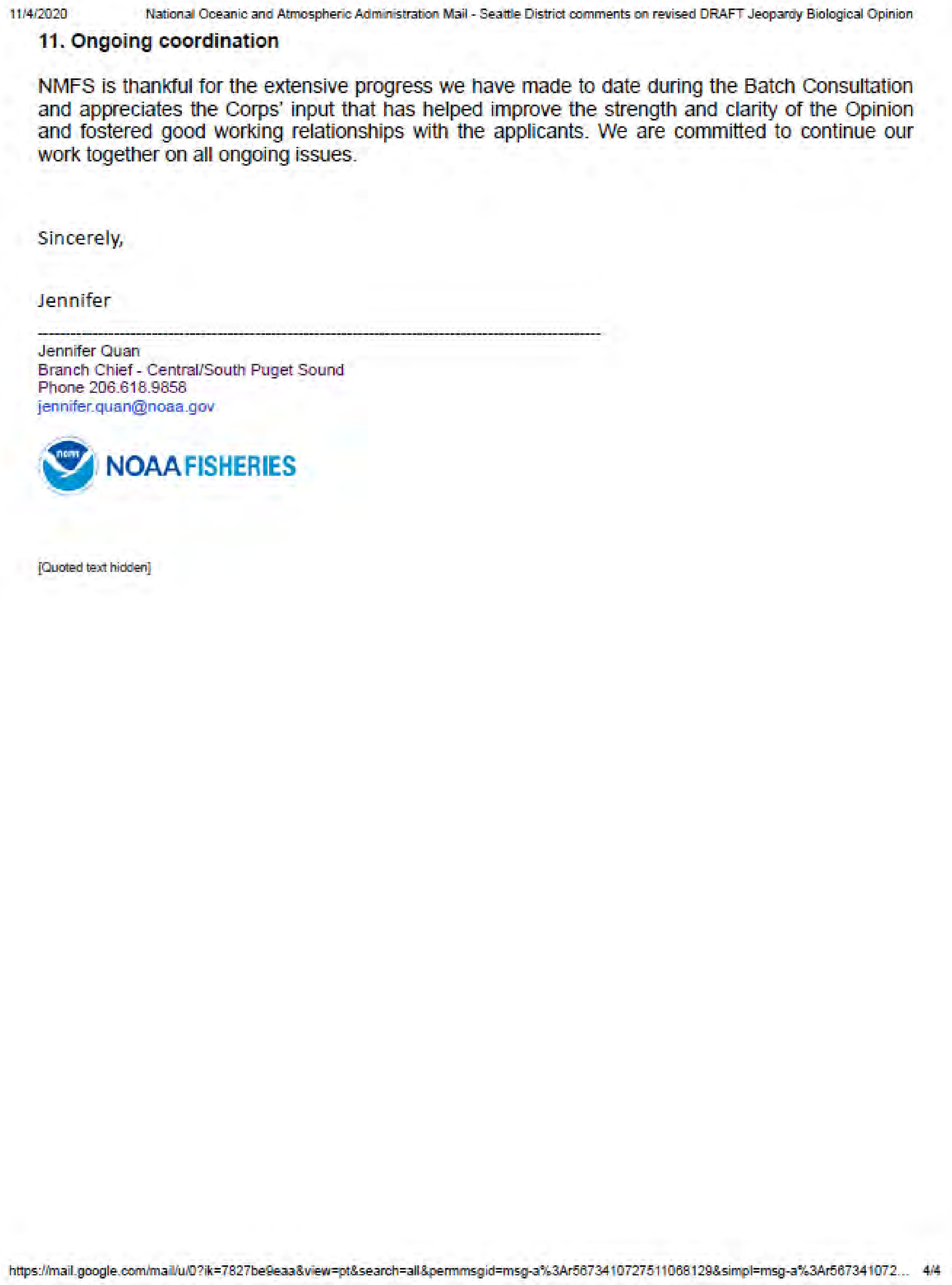
> The removal of pilings or overwater structures, or any removal of shoreline armoring that is already included as part of the proposed action has already been accounted for when NMFS calculated project debits and credits and thus would NOT be considered again as an action that would meet the terms of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

9. Technical questions regarding what will be required (and by when) to substantiate off-site restoration if it does not occur on applicant-owned or controlled land.

The RPA specifies written agreement with the third party. We have added more clarifying language in the RPA on required documentation. At this time, we will not be offering third-party responsible agreements (work load will not allow) and thus the reference to this has been deleted.

10. Questions regarding ESA Section 9 coverage of restoration activities, for RPAs 1.1- 1.2

We intend the Incidental Take Statement of this opinion to exempt incidental take for RPA elements other than RPA 1.3 and 1.4. For actions under RPA 1.3 and 1.4, take would be addressed in other existing or future biological opinions or other existing take exemptions (e.g., 4(d) Limit 8) associated with those restoration actions.



11. Ongoing coordination

NMFS is thankful for the extensive progress we have made to date during the Batch Consultation and appreciates the Corps' input that has helped improve the strength and clarity of the Opinion and fostered good working relationships with the applicants. We are committed to continue our work together on all ongoing issues.

Sincerely,

Jennifer

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NOAA FISHERIES

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DEPARTMENT OF THE ARMY
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Regulatory Branch

October 1, 2020

Mr. Barry Thom
National Marine Fisheries Service
West Coast Region
1201 NE Lloyd Boulevard, Suite 110
Portland, Oregon 97232

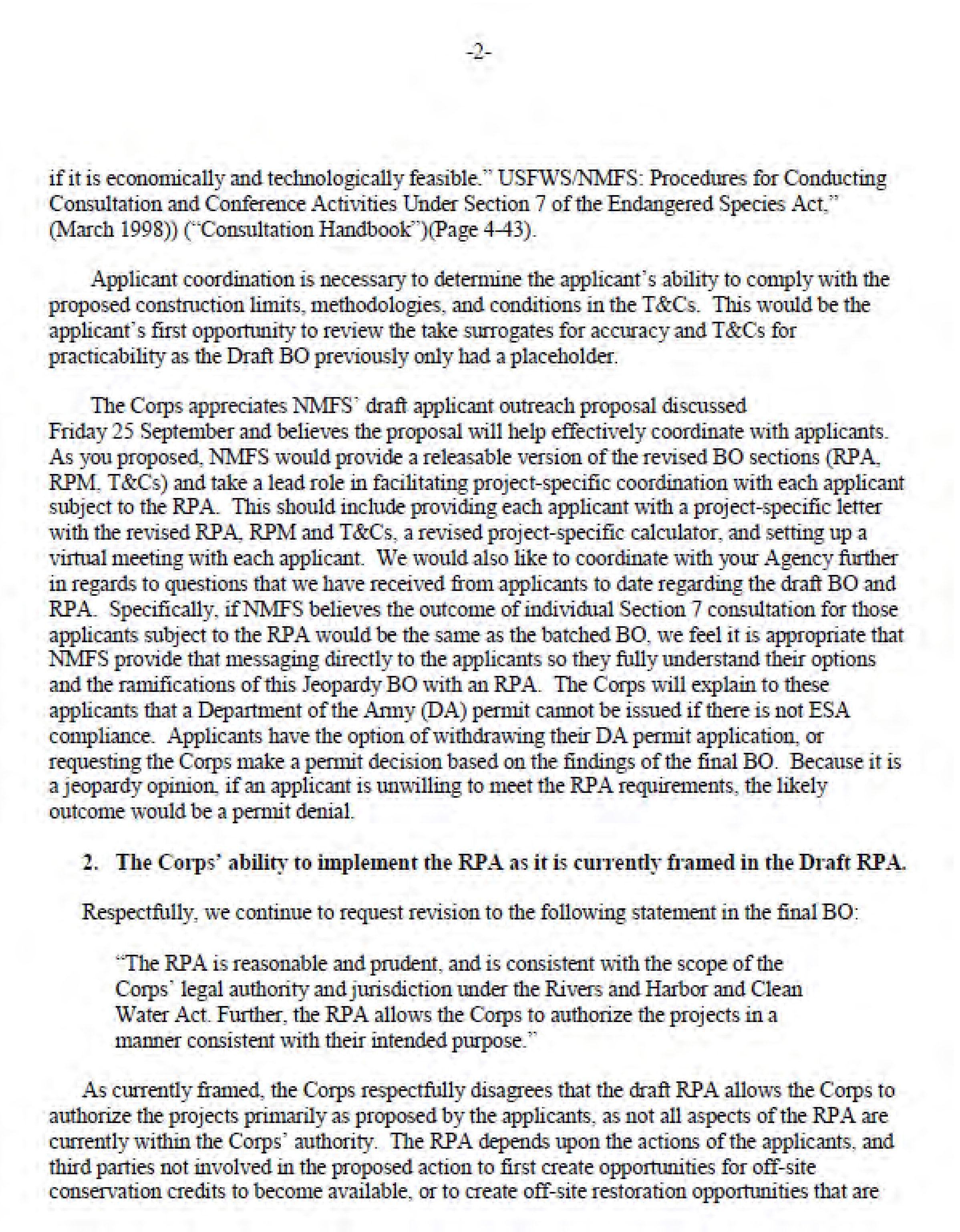
Reference: DRAFT Jeopardy Biological
Opinion (WCRO-2020-01361)

Dear Mr. Thom:

Thank you for providing updated and revised portions of the Draft Jeopardy Biological Opinion (BO)'s Reasonable and Prudent Alternative (RPA), Reasonable and Prudent Measures (RPM) and terms and conditions (T&C's) on September 16, 2020, in response to 39 different projects seeking authorization from the U.S. Army Corps of Engineers (Corps) to conduct activities regulated under either Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act. The Corps appreciates this additional opportunity to provide agency input regarding the corrective actions addressed in the revised RPA, RPM, and T&Cs, and requests further coordination with the 39 applicants proposing activities subject to this consultation regarding these updated and revised provisions prior to NMFS' finalization of this BO. We offer the following comments for your consideration and look forward to further collaboration on this consultation.

1. **Request further meaningful applicant coordination regarding the revised RPA, RPM, T&Cs.**

While applicants were provided with an opportunity to review a prior version of the RPA earlier this summer, National Marine Fisheries Service (NMFS) has continued to develop substantive updates to the RPA and new information regarding RPMs and T&Cs that will affect applicants. The Corps considers this an important opportunity for NMFS to address ongoing development of the RPA, RPM, and T&Cs, and to share additional information that exists regarding implementation between and amongst the Corps, applicant, and NMFS prior to finalization of the BO. NMFS has previously recognized the importance of providing "every opportunity" to both the action agency *and* applicants when developing an RPA prior to finalization of a BO. ("The action agency and the applicant (if any) should be given every opportunity to assist in developing the reasonable and prudent alternatives. Often they are the only ones who can determine if an alternative is within their legal authority and jurisdiction, and



if it is economically and technologically feasible." USFWS/NMFS: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act," (March 1998)) ("Consultation Handbook")(Page 4-43).

Applicant coordination is necessary to determine the applicant's ability to comply with the proposed construction limits, methodologies, and conditions in the T&Cs. This would be the applicant's first opportunity to review the take surrogates for accuracy and T&Cs for practicability as the Draft BO previously only had a placeholder.

The Corps appreciates NMFS' draft applicant outreach proposal discussed Friday 25 September and believes the proposal will help effectively coordinate with applicants. As you proposed, NMFS would provide a releasable version of the revised BO sections (RPA, RPM, T&Cs) and take a lead role in facilitating project-specific coordination with each applicant subject to the RPA. This should include providing each applicant with a project-specific letter with the revised RPA, RPM and T&Cs, a revised project-specific calculator, and setting up a virtual meeting with each applicant. We would also like to coordinate with your Agency further in regards to questions that we have received from applicants to date regarding the draft BO and RPA. Specifically, if NMFS believes the outcome of individual Section 7 consultation for those applicants subject to the RPA would be the same as the batched BO, we feel it is appropriate that NMFS provide that messaging directly to the applicants so they fully understand their options and the ramifications of this Jeopardy BO with an RPA. The Corps will explain to these applicants that a Department of the Army (DA) permit cannot be issued if there is not ESA compliance. Applicants have the option of withdrawing their DA permit application, or requesting the Corps make a permit decision based on the findings of the final BO. Because it is a jeopardy opinion, if an applicant is unwilling to meet the RPA requirements, the likely outcome would be a permit denial.

2. **The Corps' ability to implement the RPA as it is currently framed in the Draft RPA.**

Respectfully, we continue to request revision to the following statement in the final BO:

> "The RPA is reasonable and prudent, and is consistent with the scope of the Corps' legal authority and jurisdiction under the Rivers and Harbor and Clean Water Act. Further, the RPA allows the Corps to authorize the projects in a manner consistent with their intended purpose."

As currently framed, the Corps respectfully disagrees that the draft RPA allows the Corps to authorize the projects primarily as proposed by the applicants, as not all aspects of the RPA are currently within the Corps' authority. The RPA depends upon the actions of the applicants, and third parties not involved in the proposed action to first create opportunities for off-site conservation credits to become available, or to create off-site restoration opportunities that are then subject to further verification by NMFS as to sufficiency. The revised and updated RPA allows the Corps to authorize projects primarily as proposed only if project applicants have a proposed project within an existing service area of an ESA-approved conservation credit stakeholder, and elect to obtain conservation credits as the sole method of implementing the RPA. For those applicants who elect to pursue either on-site or off-site "restoration" to achieve credits, this alternative would likely involve a substantial revision to the applicant's project's proposed design, location, scope, duration, and/or timing, and may involve actions over lands where the action agency has no jurisdiction or residual authority to enforce compliance. This appears to be recognized by NMFS elsewhere in the revised RPA, with the provision: "The range of options offered in the RPA could allow the Corps to finalize a project permit as currently purposed (i.e., RPA 1.3 and 1.4), while others options would result in project amendments that may also require amendments to the current DA permit proposals (i.e., RPA 1.1, 1.2 and 1.5)".

3. **Availability of information regarding Puget Sound Partnership's (PSP) provision of conservation credits.**

NMFS states "significant opportunities exist for project proponents to obtain conservation credits". (Page 1). To date, however, there is limited information available regarding the forthcoming provision of ESA-approved conservation credits with PSP. This is particularly important when considering the impact of this RPA to each of the individual applicants subject to this BO and RPA. Will PSP have a service area that extends throughout Puget Sound? Will the Corps and applicants be able to see a copy of the Memorandum of Understanding (MOU) between NMFS and PSP to better understand the opportunities for conservation credits? In addition, Partners/Sponsors will not always have restoration projects in the queue, so project details and a calculator may not be ready when an applicant wishes to buy credits. On a more technical note, the Corps would like to add that the Hood Canal Coordinating Council In-lieu Fee (HCCC ILF) use requires IRT approval; not solely NMFS approval for use as conservation credits. The Corps is also concerned that HCCC ILF and Blue Heron Slough Conservation Bank have limited service areas and at any given time, the amount of available credits for sale is limited.

4. **Requesting clarification regarding "take" exceedances by a single applicant, and re-initiation of consultation for others in the Batch BO.**

The last paragraph on page 23 provides: "This consultation represents a combined review of 39 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 Corps retains discretionary involvement or control over the action, the Corps can request re-initiation on an action-by-action basis. NMFS will evaluate appropriate next steps, but in most cases, re-initiation of consultation on single project evaluated in this Opinion will not trigger a need to reinitiate consultation on all of the projects addressed by this Opinion".

This seems to indicate that an exceedance of take by one project could trigger re-initiation of consultation for other applicants in the batch consultation. One of the Corps' specific parameters for proceeding with this consultation process that "batches" these 39 individual requests for consultation into a single BO was the separation of take for each applicant. Please clarify that individual applicants in the batch consultation would not be subject to lapsed ESA coverage if another applicant exceeds "take" as provided in the final BO, Incidental Take Statement (ITS), RPM, & T&Cs.

5. **Requesting clarification of "take" provisions and stormwater effects and treatment.**

The revised and updated BO includes provisions regarding stormwater effects and treatment (see pages 17-18). Specifically, surrogacy for the extent of take expected due to stormwater runoff is the physical extent (square feet) of pollution generating impervious surface "associated with the permitted structure (i.e., access roads and parking lots)". While the updated information does not specifically identify which applicants these provisions would apply to, these provisions raise concerns regarding the applicability of the surrogate identified. These provisions raise questions that may require fact-specific information with individual applicants regarding the specifics of their proposed action, and whether their proposed action that is seeking DA authorization is the "but for" causation of stormwater impacts. This is particularly the case where there is an already existing impervious surface present in the uplands. To the extent that these provisions are intended to specifically apply to an applicant, the terms and conditions on page 19 includes general language indicating that: "The Corps or any applicant" must comply with RPMs, and indicates that both have an ongoing duty to monitor impacts of ITS and report." We request this T&C be removed, or specifically addressed to the applicant and not the Corps.

6. **Inclusion of Special Condition Language to include in DA Permit.**

The Revised RPA on page 5 also includes specific language that NMFS indicates the Corps shall provide as a special condition of a DA permit. It is unclear why this provision is necessary given a DA permit will not be issued to an individual applicant until after NMFS has already provided verification as to the adequacy of a particular applicant's proposed approach to implement the RPA, and it varies from the standard language that is present in DA permit decisions regarding ESA compliance throughout the country.

7. **Technical questions regarding what qualifies as on-site versus off-site restoration.**

The revised RPA on page 7 indicates that the Corps must verify responses from applicants meet the requirements for the RPA provisions, but there remain some key technical distinctions to figure out. For instance, the Corps requests clarification of the revised RPA 1.1, on page 2, as to what may be considered an "on-site" (versus off-site) habitat improvement project, as falling within "the immediate vicinity" of the project site?

8. Technical question, clarification in regards to RPA 1.2.

The Corps requests clarification of what is meant in regards to the following provision (is this intended to allow "double-counting?"):

"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 be considered again as an action that would meet the terms of this RPA*." (emphasis added).

9. Technical questions regarding what will be required (and by when) to substantiate off-site restoration if it does not occur on applicant-owned or controlled land.

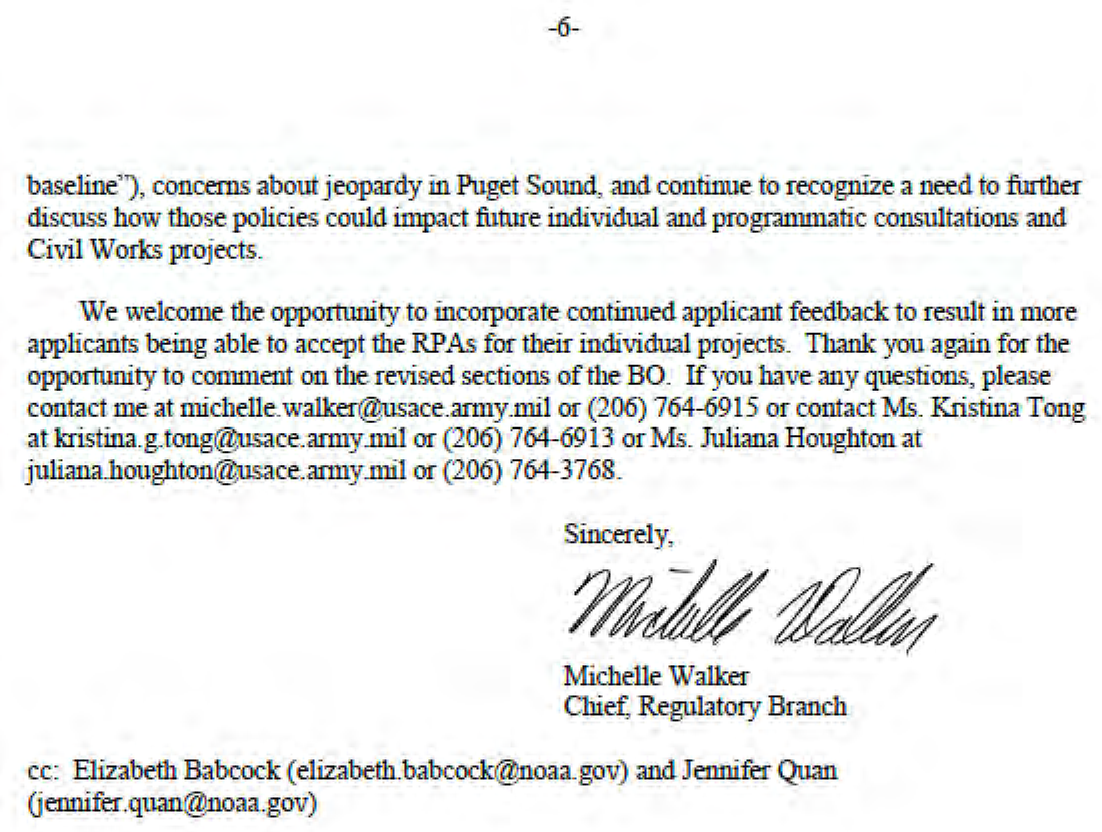
Along the same lines as above, in regards to RPA 1.2 or 1.4, what will need to be required to be provided if the off-site restoration does not occur on applicant-owned or controlled land? Will the Habitat Improvement Plan suffice as evidence of intent? Is there a sample third-party responsible conservation agreement that could be made available to applicants?

10. Questions regarding ESA Section 9 coverage of restoration activities, for RPAs 1.1-1.2.

In regards to the general provisions (page 5),where implementation of RPAs 1.1-1.2 must meet the design, Best Management Practices, and restoration actions of the Fish Passage Restoration Programmatic (FPRP), the Corps is not sure all potential proposals will meet these parameters. What happens if the proposal does not meet FPRP? The Corps assumes that this would require individual ESA section 7 consultation. Because applicants in the batch are paying a fee to conservation bank sponsors, is it accurate that the Corps/applicant does not need to initiate this ESA consultation, but rather the Sponsor/Partner does when they have an actual restoration project? On page 8, does "anticipating" consistency mean all applicants will meet FPRP and individual ESA consultation is not required?

11. Ongoing coordination.

As discussed with you and your staff, we continue to have strong reservations about certain aspects of NMFS' approach to how effects of a proposed action are taken into consideration when this involves the repair or replacement of an existing structure (i.e., determination and basis of the "useful life" of an existing structure; what is included in the "environmental



baseline"), concerns about jeopardy in Puget Sound, and continue to recognize a need to further discuss how those policies could impact future individual and programmatic consultations and Civil Works projects.

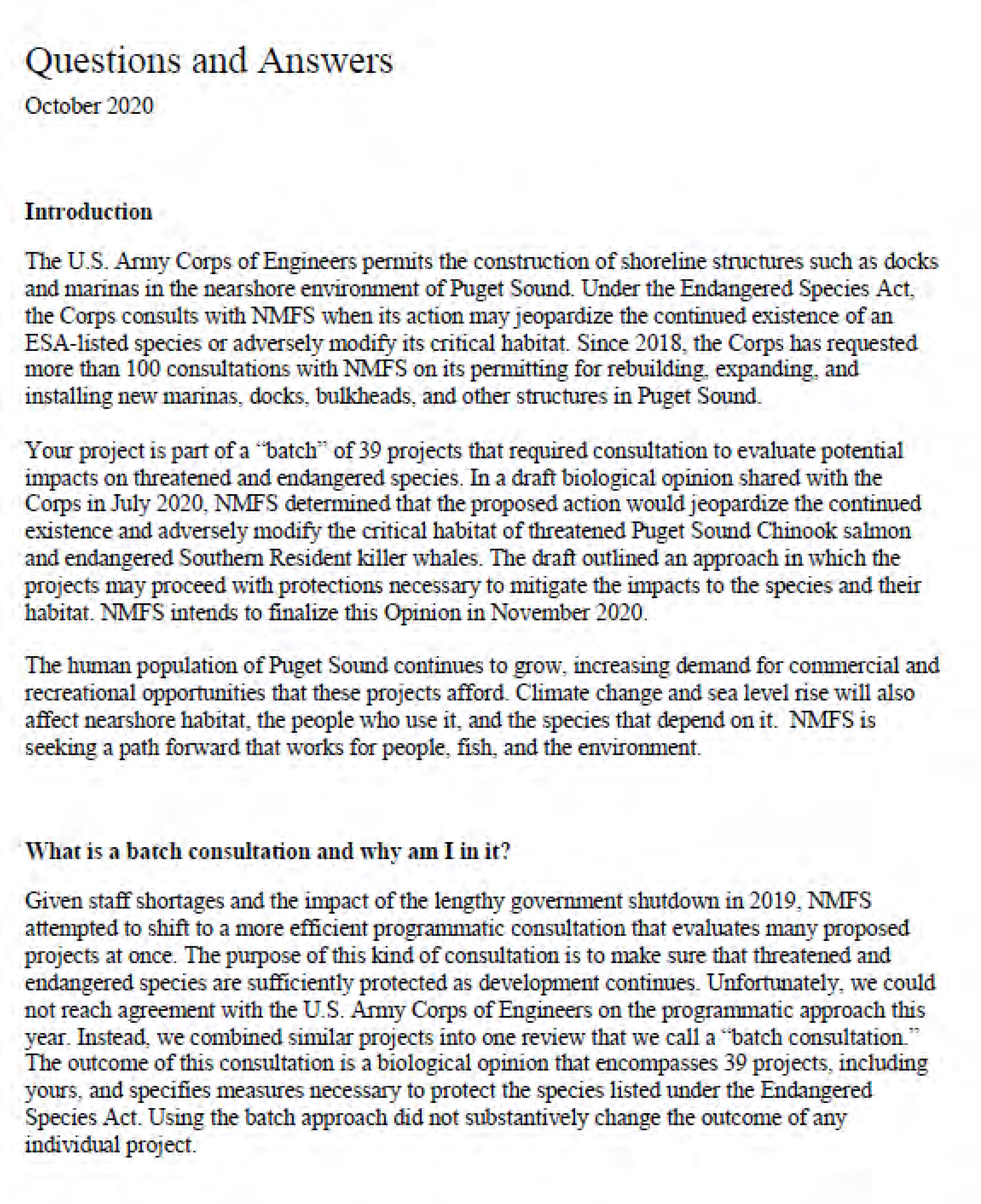
We welcome the opportunity to incorporate continued applicant feedback to result in more applicants being able to accept the RPAs for their individual projects. Thank you again for the opportunity to comment on the revised sections of the BO. If you have any questions, please contact me at michelle.walker@usace.army.mil or (206) 764-6915 or contact Ms. Kristina Tong at kristina.g.tong@usace.army.mil or (206) 764-6913 or Ms. Juliana Houghton at juliana.houghton@usace.army.mil or (206) 764-3768.

Sincerely,

Michelle Walker

Michelle Walker
Chief, Regulatory Branch

cc: Elizabeth Babcock (elizabeth.babcock@noaa.gov) and Jennifer Quan (jennifer.quan@noaa.gov)



Questions and Answers

October 2020

Introduction

The U.S. Army Corps of Engineers permits the construction of shoreline structures such as docks and marinas in the nearshore environment of Puget Sound. Under the Endangered Species Act, the Corps consults with NMFS when its action may jeopardize the continued existence of an ESA-listed species or adversely modify its critical habitat. Since 2018, the Corps has requested more than 100 consultations with NMFS on its permitting for rebuilding, expanding, and installing new marinas, docks, bulkheads, and other structures in Puget Sound.

Your project is part of a "batch" of 39 projects that required consultation to evaluate potential impacts on threatened and endangered species. In a draft biological opinion shared with the Corps in July 2020, NMFS determined that the proposed action would jeopardize the continued existence and adversely modify the critical habitat of threatened Puget Sound Chinook salmon and endangered Southern Resident killer whales. The draft outlined an approach in which the projects may proceed with protections necessary to mitigate the impacts to the species and their habitat. NMFS intends to finalize this Opinion in November 2020.

The human population of Puget Sound continues to grow, increasing demand for commercial and recreational opportunities that these projects afford. Climate change and sea level rise will also affect nearshore habitat, the people who use it, and the species that depend on it. NMFS is seeking a path forward that works for people, fish, and the environment.

What is a batch consultation and why am I in it?

Given staff shortages and the impact of the lengthy government shutdown in 2019, NMFS attempted to shift to a more efficient programmatic consultation that evaluates many proposed projects at once. The purpose of this kind of consultation is to make sure that threatened and endangered species are sufficiently protected as development continues. Unfortunately, we could not reach agreement with the U.S. Army Corps of Engineers on the programmatic approach this year. Instead, we combined similar projects into one review that we call a "batch consultation." The outcome of this consultation is a biological opinion that encompasses 39 projects, including yours, and specifies measures necessary to protect the species listed under the Endangered Species Act. Using the batch approach did not substantively change the outcome of any individual project.

Can I consult individually instead of being part of the batch?

The Corps submitted the request for consultation on your project to NMFS, which is considering it as part of the batch of projects. Starting over with an individual request for consultation is possible but unlikely to make any difference in the outcome, since the impacts of the project and opportunities for conservation offsets would be the same.

This Batch Consultation is currently the quickest route to completing ESA consultation. Given the high volumes of consultation requests, individual consultation could take at least two years.

What did the consultation find?

It found that the proposed action would jeopardize the continued existence and adversely modify the critical habitat for threatened Puget Sound Chinook salmon and endangered Southern Resident killer whales. This means that, according to the Endangered Species Act, the "effects of the proposed action would reasonably 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." Given that conclusion, NMFS developed a Reasonable and Prudent Alternative (RPA) that identifies mitigation for the projects so that they can move forward. The purpose of this consultation is to find ways for the proposed projects to advance while also protecting threatened and endangered species that are vital to the culture and economy of the Northwest.

What is a Reasonable and Prudent Alternative and how does it work?

If we find a proposed action will cause jeopardy or adverse modification, we suggest reasonable and prudent alternatives that can be taken by the federal agency or applicant in implementing the agency action. 16 U.S.C. 1536(b)(3). "Reasonable and prudent alternatives" are alternative actions, identified during formal consultation, that meet certain conditions:

- They can be implemented consistent with the intended purpose of the action;
- They can be implemented consistent with the scope of the federal agency's legal authority and jurisdiction;
- They are economically and technologically feasible; and
- They 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).

In the regulatory definition of RPA, we interpret "feasible" to mean "capable of being done or carried out." This interpretation is consistent with the language of the Act and the Section 7 implementing regulations. In the preamble to the 1986 final rule on the Section 7 implementing regulations (51 FR 19957), NMFS and the US Fish and Wildlife Service stated " Reasonable and prudent alternatives must cover the full gamut of design changes that are economically and technologically feasible for an action, independent of who is sponsoring the action."

What is the Reasonable and Prudent Alternative in this case?

The Reasonable and Prudent Alternative provides for the projects to proceed while avoiding the net loss of nearshore habitat, given its essential value to Puget Sound Chinook salmon and the Southern Resident killer whales that feed on them. This means impacts that reduce the value of the habitat to the species would be offset by compensatory conservation measures or "conservation offsets" such as restoration that increases the value of habitat elsewhere by a comparable amount.

The conservation offsets can take several forms. Individual projects may include actions that increase habitat value, such as removing seawalls. This can offset the project's other impacts. Proponents may also partner to sponsor or support habitat restoration in other areas. They may also purchase credits from approved conservation banks, which often include large habitat restoration projects. Conservation banks sell credits, which in effect represent a share of the restored habitat that can be applied to offset impacts elsewhere. Purchasing credits from authorized conservation banks can also be an effective way to offset impacts. Finally, the RPA allows project proponents the option to amend their proposed project in a way that would reduce impacts, thereby requiring less mitigation.

How will the proposed projects jeopardize Chinook salmon and killer whales?

The nearshore environment where the projects are located provides essential nursery habitat where juvenile Chinook salmon grow before they migrate to the ocean. Research shows that the larger they grow in this productive habitat, the more likely they are to survive their subsequent years in the ocean and return to rivers as adults to spawn. Most nearshore habitat in Puget Sound is gone. More than 95 percent of key tidal wetlands across South and Central Puget Sound have been eliminated, with many river deltas lost to development.

The odds of survival for juvenile Puget Sound Chinook salmon have dwindled as nearshore habitat has declined. Fewer than 1 percent of juvenile Chinook salmon that leave for the ocean typically return as adults. This is not enough to sustain the species, and some populations in South and Central Puget Sound have declined in roughly four of every five years. Southern Resident killer whales are also affected because Puget Sound Chinook salmon are one of the most important Chinook stocks that the fish-eating killer whales depend on as prey.

The availability of prey is considered one of the three main threats to the whales, which also include vessel traffic and noise and toxic pollution.

Is it fair to burden someone who wants to fix or build a dock with saving killer whales?

Recovery of killer whales and the salmon they depend on will take much more than conservation offsets for a specific nearshore project. The required conservation offsets are specific to the impacts of each project, based on what science says about the importance of that habitat to juvenile Chinook salmon, and in turn to Southern Resident killer whales. The conservation responsibility includes only that impact determined based on the design, location, and type of project involved. Some proposed actions might yield a net benefit to the species. That is the case for several projects assessed under this biological opinion: their combined result is a net benefit to juvenile Puget Sound Chinook salmon and therefore they have no conservation offset requirement. For some projects this may increase the cost of the overall project.

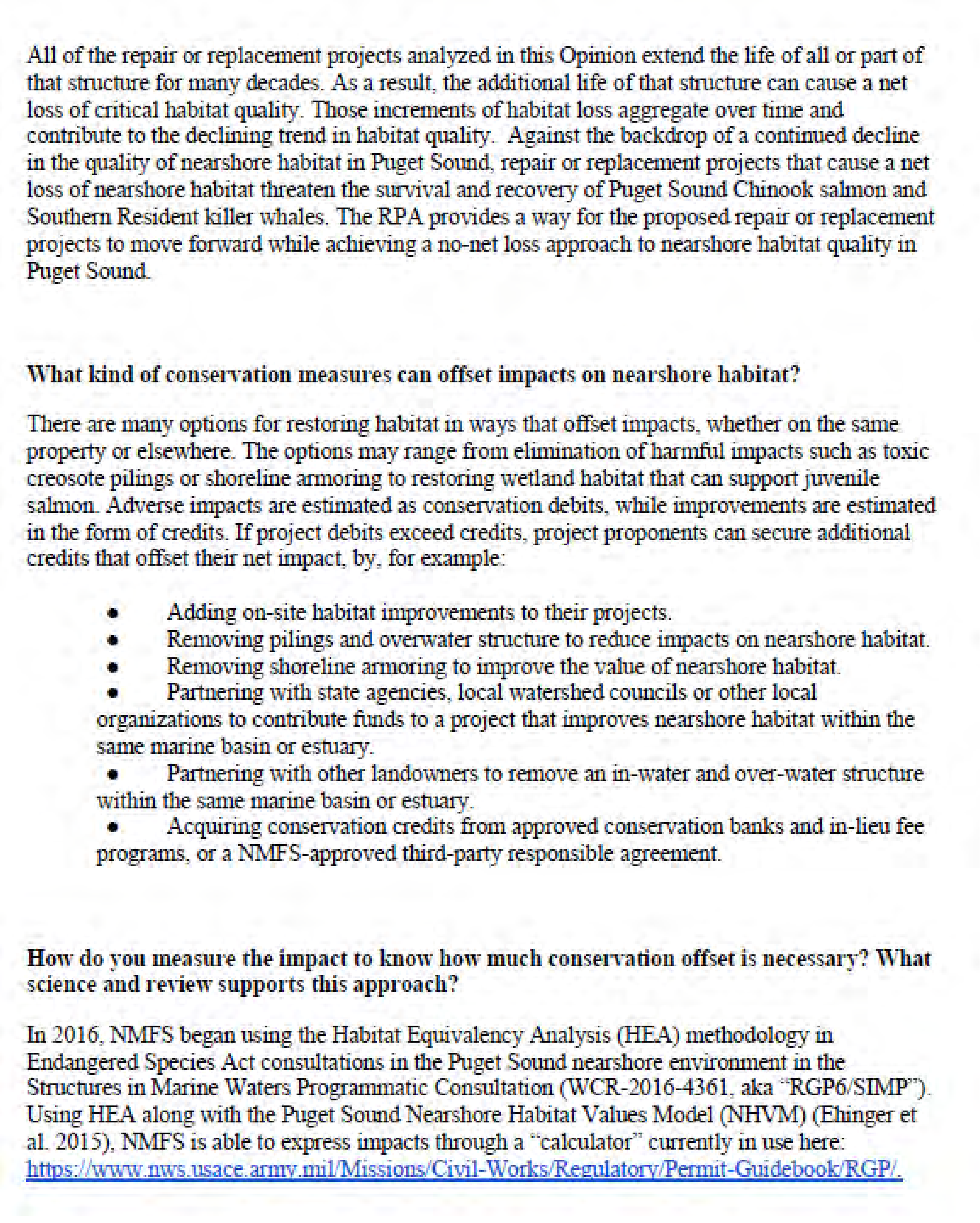
Conservation of endangered species and their habitats requires all sectors to do their part. Halting the species decline is a prerequisite for long-term survival and movement towards recovery. In Puget Sound there has been significant conservation progress made in hatchery production, harvest, and fish passage at large dams. The one remaining but most important piece is focused efforts to facilitate progress in habitat protection and restoration. It is imperative to recognize that the expected benefits of habitat restoration will take years or decades to produce significant improvement in natural population viability.

Doesn't a lot of money already go to habitat restoration?

While the Pacific Coastal Salmon Recovery Fund and other programs do dedicate millions of dollars toward habitat restoration, it is only a fraction of what is necessary to recover Puget Sound Chinook salmon and support the Southern Resident killer whales in both the near and longer term. The Governor's Salmon Recovery Office had reported that in the past 18 years, the Puget Sound region received only about 40 percent of the identified funding needed for habitat restoration. By some estimates the funding going to address the habitat losses we have seen over the decades may be billions of dollars short of what is needed to make progress toward recovery. The provisions of this biological opinion will not come close to making up for that but will help keep us from falling further behind when it comes to essential nearshore habitat especially.

How can a maintenance project that repairs or replaces a structure cause new impacts?

Although some of the 39 projects are described as "maintenance," our review of the projects indicates each of these kinds of projects involves either replacement of existing structures or structural repairs that meaningfully extend the life of all or part of an existing structure. In these circumstances, future impacts of these repaired or replaced structures would be analyzed as effects resulting from the project in an ESA consultation. The Reasonable and Prudent Alternative (RPA) requires that any impacts on nearshore habitat from the proposed projects should be offset, and provides for a range of options from project modifications (soft shore bank armoring, smaller footprints) to incorporation of additional on-site habitat improvements (planting, removal of debris) to obtaining conservation credits.



All of the repair or replacement projects analyzed in this Opinion extend the life of all or part of that structure for many decades. As a result, the additional life of that structure can cause a net loss of critical habitat quality. Those increments of habitat loss aggregate over time and contribute to the declining trend in habitat quality. Against the backdrop of a continued decline in the quality of nearshore habitat in Puget Sound, repair or replacement projects that cause a net loss of nearshore habitat threaten the survival and recovery of Puget Sound Chinook salmon and Southern Resident killer whales. The RPA provides a way for the proposed repair or replacement projects to move forward while achieving a no-net loss approach to nearshore habitat quality in Puget Sound.

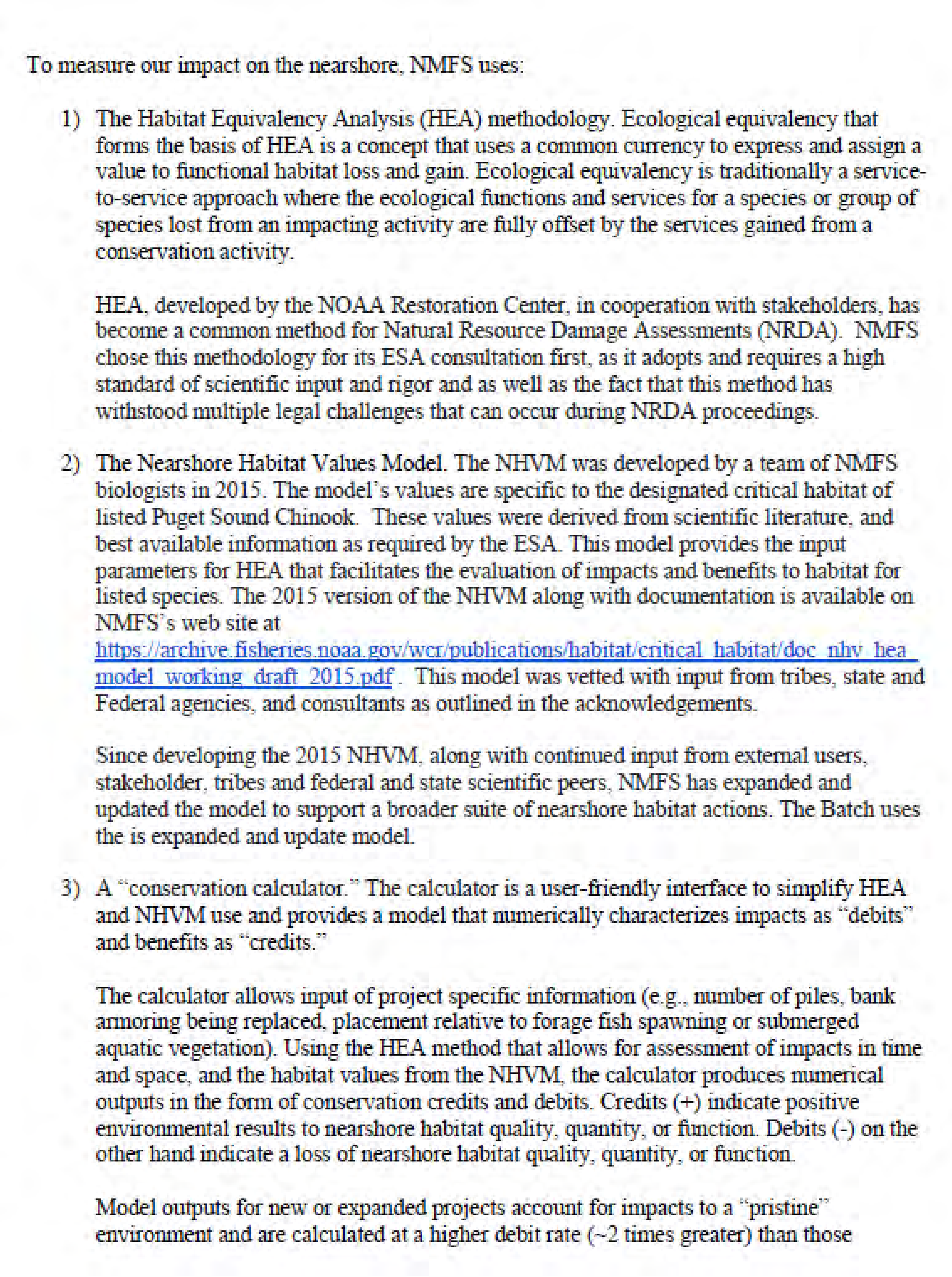
What kind of conservation measures can offset impacts on nearshore habitat?

There are many options for restoring habitat in ways that offset impacts, whether on the same property or elsewhere. The options may range from elimination of harmful impacts such as toxic creosote pilings or shoreline armoring to restoring wetland habitat that can support juvenile salmon. Adverse impacts are estimated as conservation debits, while improvements are estimated in the form of credits. If project debits exceed credits, project proponents can secure additional credits that offset their net impact, by, for example:

- Adding on-site habitat improvements to their projects.
- Removing pilings and overwater structure to reduce impacts on nearshore habitat.
- Removing shoreline armoring to improve the value of nearshore habitat.
- Partnering with state agencies, local watershed councils or other local organizations to contribute funds to a project that improves nearshore habitat within the same marine basin or estuary.
- Partnering with other landowners to remove an in-water and over-water structure within the same marine basin or estuary.
- Acquiring conservation credits from approved conservation banks and in-lieu fee programs, or a NMFS-approved third-party responsible agreement.

How do you measure the impact to know how much conservation offset is necessary? What science and review supports this approach?

In 2016, NMFS began using the Habitat Equivalency Analysis (HEA) methodology in Endangered Species Act consultations in the Puget Sound nearshore environment in the Structures in Marine Waters Programmatic Consultation (WCR-2016-4361, aka "RGP6/SIMP"). Using HEA along with the Puget Sound Nearshore Habitat Values Model (NHVM) (Ehinger et al. 2015), NMFS is able to express impacts through a "calculator" currently in use here: https://www.nws.usace.army.mil/Missions/Civil-Works/Regulatory/Permit-Guidebook/RGP/.



To measure our impact on the nearshore, NMFS uses:

1) The Habitat Equivalency Analysis (HEA) methodology. 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 are fully offset by the services gained from a conservation activity.

   HEA, developed by the NOAA Restoration Center, in cooperation with stakeholders, has become a common method for Natural Resource Damage Assessments (NRDA). NMFS chose this methodology for its ESA consultation first, as it adopts and requires a high standard of scientific input and rigor and as well as the fact that this method has withstood multiple legal challenges that can occur during NRDA proceedings.

2) The Nearshore Habitat Values Model. The NHVM was developed by a team of NMFS biologists in 2015. The model's values are specific to the designated critical habitat of listed Puget Sound Chinook. These values were derived from scientific literature, and best available information as required by the ESA. This model provides the input parameters for HEA that facilitates the evaluation of impacts and benefits to habitat for listed species. The 2015 version of the NHVM along with documentation is available on NMFS's web site at https://archive.fisheries.noaa.gov/wcr/publications/habitat/critical_habitat/doc_nhv_hea_model_working_draft_2015.pdf . This model was vetted with input from tribes, state and Federal agencies, and consultants as outlined in the acknowledgements.

   Since developing the 2015 NHVM, along with continued input from external users, stakeholder, tribes and federal and state scientific peers, NMFS has expanded and updated the model to support a broader suite of nearshore habitat actions. The Batch uses the is expanded and update model.

3) A "conservation calculator." The calculator is a user-friendly interface to simplify HEA and NHVM use and provides a model that numerically characterizes impacts as "debits" and benefits as "credits."

   The calculator allows input of project specific information (e.g., number of piles, bank armoring being replaced, placement relative to forage fish spawning or submerged aquatic vegetation). Using the HEA method that allows for assessment of impacts in time and space, and the habitat values from the NHVM, the calculator produces numerical outputs in the form of conservation credits and debits. Credits (+) indicate positive environmental results to nearshore habitat quality, quantity, or function. Debits (-) on the other hand indicate a loss of nearshore habitat quality, quantity, or function.

   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. The calculator outputs account for:

- 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 the remaining "useful life period."
- Minimization incorporated through project design improvements (e.g., credit is given for removal replacing 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).

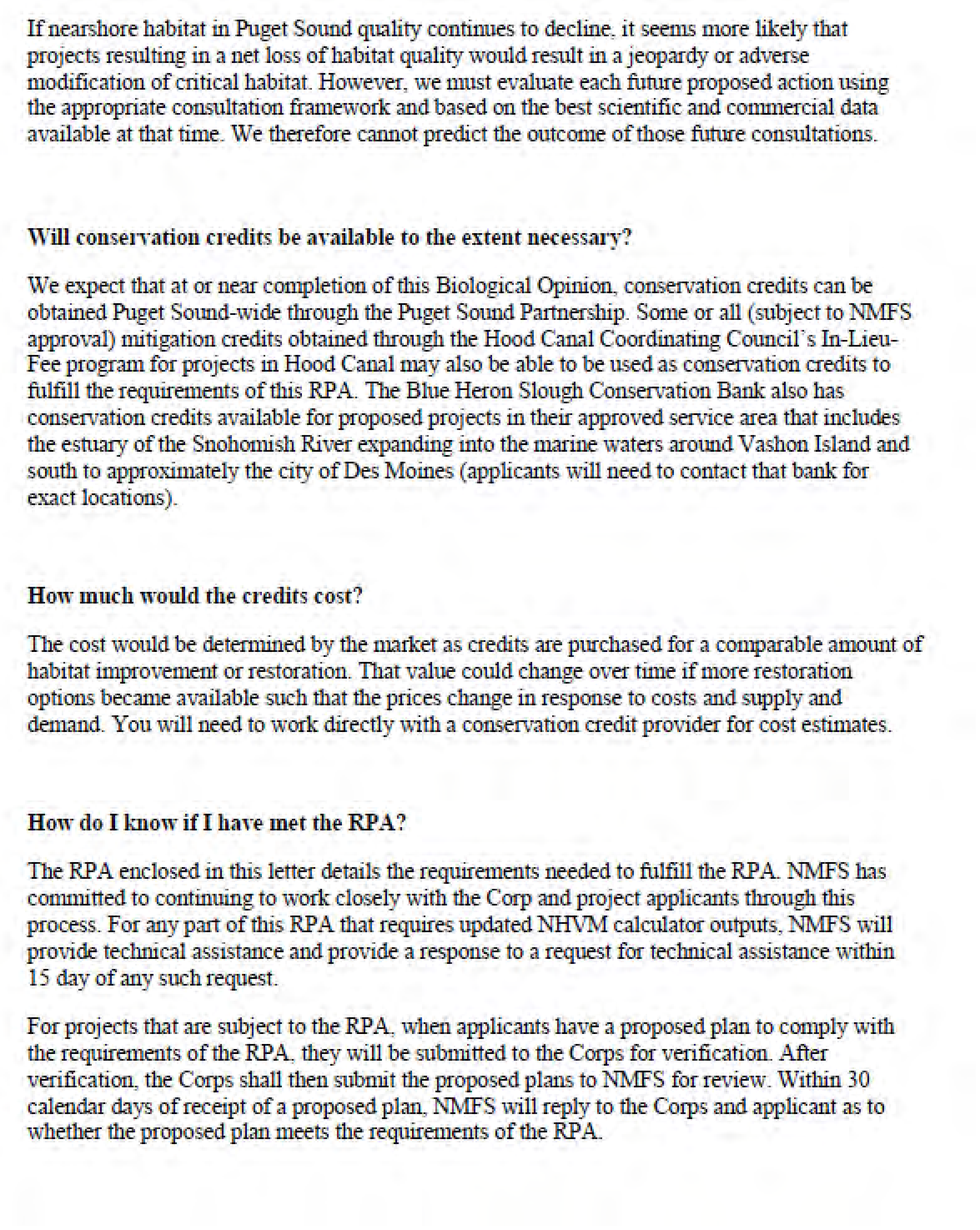
Why would similar projects cause different degrees of impacts?

The number of conservation credits needed for each project is determined by the NHVM conservation calculator. The number of credits needed corresponds to the impact of the project. The Calculator also considers the importance to species of the specific habitat affected by a proposed project. Projects occurring in an important nearshore habitat type will typically incur more debits, and thus need more credits. For instance, development of a pocket estuary will incur more debits due to the importance of these areas to juvenile Puget Sound Chinook salmon. Conversely, the calculator assigns "credits" to many repair or replacement projects for the positive impacts of removing that structure, along with credits for conservation improvements, for a certain period of time. And finally, the model assigns a reduced debit/credit factor to habitat impacted by repaired or replaced projects compared with habitat impacted by new construction to account for the fact that impacts to habitat already impaired by existing structures is less detrimental to species than future impacts to unimpaired habitat.

Does this mean future projects in nearshore habitat will face similar conditions?

Nearshore habitat in Puget Sound continues to decline. This negatively affects the survival and recovery of Puget Sound Chinook salmon and Southern Resident killer whales. We cannot predict the outcome of future consultations in Puget Sound. For instance, an action that had only minor short-term adverse effects combined with long-term beneficial effects on the quality of nearshore habitat may not result in a jeopardy or adverse modification of critical habitat finding.

As explained in the preamble to the 2019 revision of the ESA Section 7 regulations, the concept of 'baseline' jeopardy does not apply to a section 7 consultation. A jeopardy finding can only be reached if the effects of the proposed action would reasonably 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. A poor baseline condition in and of itself cannot cause jeopardy.



If nearshore habitat in Puget Sound quality continues to decline, it seems more likely that projects resulting in a net loss of habitat quality would result in a jeopardy or adverse modification of critical habitat. However, we must evaluate each future proposed action using the appropriate consultation framework and based on the best scientific and commercial data available at that time. We therefore cannot predict the outcome of those future consultations.

Will conservation credits be available to the extent necessary?

We expect that at or near completion of this Biological Opinion, 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 may also be able to be used as conservation credits to fulfill the requirements of this RPA. The Blue Heron Slough Conservation Bank also has conservation credits available for proposed projects in their 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).

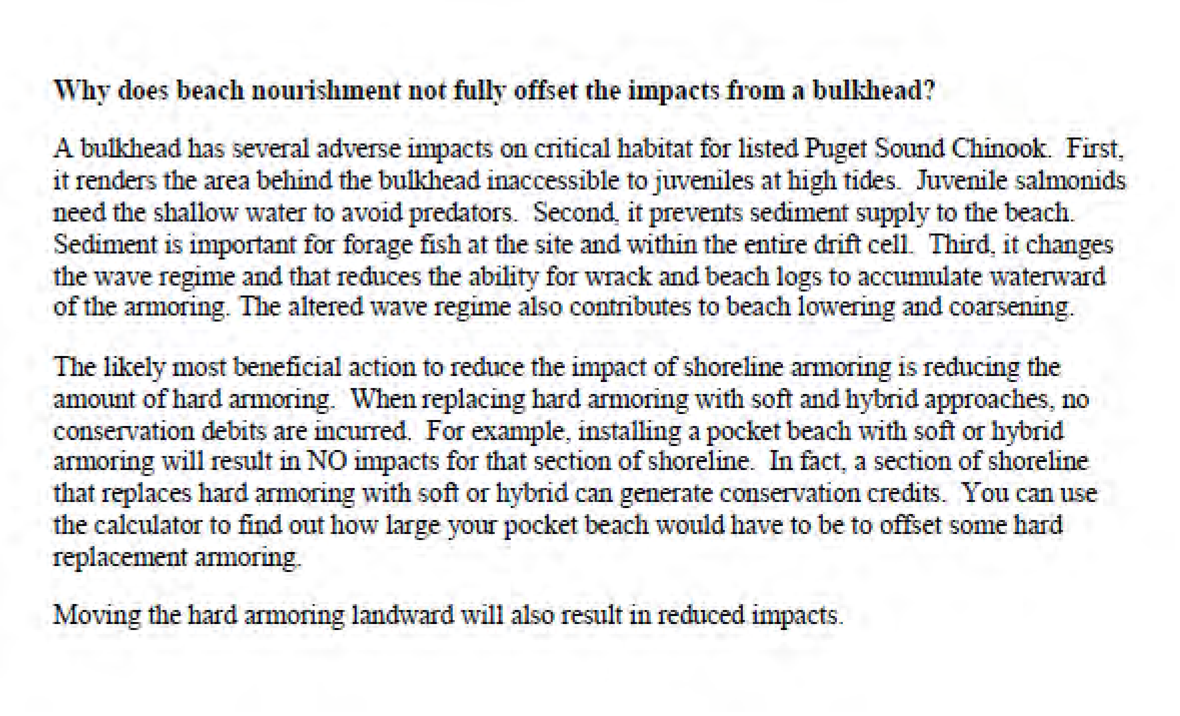
How much would the credits cost?

The cost would be determined by the market as credits are purchased for a comparable amount of habitat improvement or restoration. That value could change over time if more restoration options became available such that the prices change in response to costs and supply and demand. You will need to work directly with a conservation credit provider for cost estimates.

How do I know if I have met the RPA?

The RPA enclosed in this letter details the requirements needed to fulfill the RPA. NMFS has committed to continuing to work closely with the Corp and project applicants through this process. For any part of this RPA that requires updated NHVM calculator outputs, NMFS will provide technical assistance and provide a response to a request for technical assistance within 15 day of any such request.

For projects that are subject to the RPA, when applicants have a proposed plan to comply with the requirements of the RPA, they will be submitted to the Corps for verification. After verification, the Corps 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 Corps and applicant as to whether the proposed plan meets the requirements of the RPA.



Why does beach nourishment not fully offset the impacts from a bulkhead?

A bulkhead has several adverse impacts on critical habitat for listed Puget Sound Chinook. First, it renders the area behind the bulkhead inaccessible to juveniles at high tides. Juvenile salmonids need the shallow water to avoid predators. Second, it prevents sediment supply to the beach. Sediment is important for forage fish at the site and within the entire drift cell. Third, it changes the wave regime and that reduces the ability for wrack and beach logs to accumulate waterward of the armoring. The altered wave regime also contributes to beach lowering and coarsening.

The likely most beneficial action to reduce the impact of shoreline armoring is reducing the amount of hard armoring. When replacing hard armoring with soft and hybrid approaches, no conservation debits are incurred. For example, installing a pocket beach with soft or hybrid armoring will result in NO impacts for that section of shoreline. In fact, a section of shoreline that replaces hard armoring with soft or hybrid can generate conservation credits. You can use the calculator to find out how large your pocket beach would have to be to offset some hard replacement armoring.

Moving the hard armoring landward will also result in reduced impacts.

APPENDIX 4. ADDITIONAL RESPONSES TO APPLICANT QUESTIONS

Appendix 3 addresses comments that were commonly received throughout the applicant review process. The following, more project specific comments were also received. Below, we provide a response to those comments.

1. **Comment:** One applicant noted that the areas immediately surrounding their proposed project did not have the limiting baseline conditions impacting PS Chinook salmon described in the opinion.

   Response: We agree that habitat conditions vary at the 39 project sites addressed in this opinion. Some projects are located in relatively undisturbed areas, where habitat quality for salmon remains high. However, many of the projects are located in highly developed areas with low habitat quality.

   Given current risk levels for PS Chinook salmon and SRKWs, protecting habitat quality and offsetting adverse effects on habitat quality at both types of sites is necessary to avoid jeopardy. In areas where habitat quality is high, our analysis shows that the proposed projects still result in a loss of nearshore habitat function. Given the importance of the small amount of remaining high quality nearshore habitat in Puget Sound, the RPA's no-net loss approach to habitat quality is appropriate and consistent with conservation principles stressing the need to protect high quality habitat when there is only a small amount of such habitat remaining.

2. **Comment:** One applicant asserted their project is "not likely to adversely affect" salmon and SRKWs. Their assertion is based on the idea that project sites are currently developed and the proposed action reduces the impact of the development by replacing existing near- and in-water structures with structures having less effect on the quality of nearshore habitat.

   Response: We disagree that environmentally friendly design improvements always result in a project that is not likely to adversely affect listed species. Effects of an 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. 50 CFR § 402.02.

   Existing structures form part of the environmental baseline for our analysis in this opinion. However, as explained within this Opinion (see. e.g., Sections 1.3 Proposed Federal Action and 2.3.2 Distinguishing Baseline from Effects of the Action), when an applicant repairs or replaces part or all of a structure, that action extends the life of that structure (or the part repaired or replaced). Here, we have described that extension as equivalent to an additional 40 or 50 years of useful life. The extension of life, and the associated impacts caused by those structures during that extended life, would not occur but for the proposed action. Thus, impacts caused by those repaired or replaced structures during its extended useful life period are addressed by this opinion as consequences of the proposed actions(further detailed in Section 2.3.2 Distinguishing Baseline form Effects of the Action and Section 2.4 Effects of the Action).

As established by the ESA Section 7 implementing regulations (50 CFR 402), consequences of an action, both positive and negative, on listed species and critical habitat, are analyzed as effects of the proposed action. If the proposed action reduces the overall impact of structures at a project site by replacing existing structures with structures that have less impact on listed species, those positive effects are accounted for in our analysis. Any negative impacts of the structure during its extended, or new, useful life, including impacts from construction, are also considered effects of the proposed action. As described in our opinion, those effects can include underwater sound from pile driving, migration delays and predation caused by overwater structures, and interruption of habitat forming processes resulting from shoreline bulkheads. If these effects are not insignificant, discountable, or wholly beneficial (the standard for not likely to adversely affect), the appropriate determination would be that the proposed action is “likely to adversely affect” listed species or critical habitat. In other words, the net effects of the repaired or replaced structure can be “less than” what might have been caused by a structure in its current form over the same time period; however, the effects are typically not “wholly beneficial.”

3. **Comment:** One applicant stated that without the proposed repairs and maintenance included in the proposed action, structures at the project site will create continued and increasing long-term impacts to juvenile PS Chinook salmon and SRKWs greater than would occur without the proposed action.

Response: Section 7 of the ESA requires us to evaluate the consequences of actions funded, authorized, or carried out by federal agencies (50 CFR 402.02). In a Section 7 consultation, we add the consequences of the proposed action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, determine whether the proposed action is likely to jeopardize the continued existence of listed species or adversely modify critical habitat. This is an additive analysis focusing on the consequences, also referred to as the “effects,” of proposed federal actions. Section 7 does not require us to analyze a range of outcomes that would occur if the proposed federal action did not occur.

In the context of the 39 projects addressed by this opinion, we analyze the consequences of the actions as proposed by the Corps. Here the Corps has proposed to authorize the construction of, repair of, or replacement of structures. As explained in our previous response, the Corps’ authorization will extend the life of structures (or their parts) by 40 to 50 years. The associated impacts caused by those structures during that extended life, would not occur but for the proposed action. Thus, impacts caused by those repaired or replaced structures during its extended useful life period are addressed by this opinion as consequences of the proposed actions. Thus, as required by 50 CFR 402.02, we analyze what would not occur <u>but for</u> the proposed action. The focus of this inquiry is the proposed action and what is <u>caused by</u> the proposed action. Stated differently, the Corps’ proposal to authorize specific actions as described in the consultation initiation packages does not give rise to the need to analyze a range of actions the Corps is *not* proposing to take.

Further, and as articulated in Section 2.3.2 of this Opinion, even if we were to consider what might happen to a structure absent the proposed repair or replacement, and such effects should be attributed to the baseline, those effects are in fact 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 actions is to extend the life of the part of the structure being worked on. Any effects of a possible degradation (or other possible scenario), instead of occurring now, will occur, if at all, after the new useful life expires.

4. **Comment:** One applicant stated that the opinion utilizes a flawed impact calculus through "batching" the 39 projects in Puget Sound. They also state that the environmental baseline and action area should be more tailored to fit specific projects and that our analysis should give greater consideration to these more specific baselines and action areas. The applicant goes on to state that cumulative impacts, referred to as cumulative effects in the Opinion, should not include the other 38 projects, which all involve federal actions, namely the potential issuance of a Corps permit.

Response: We disagree that batching these projects into a single Opinion was improper. Batching is specifically allowed under the regulations. 50 CFR 402.14(c)(4). More specifically, we disagree that a project's action area would necessarily be limited to the immediate area impacted by the structure or the construction that would be authorized even if we evaluated the project in an individual consultation. As explained in Section 1.4 discussing the Action Area, the "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. In this instance, the construction of new overwater structures and the repair or replacement of existing overwater structures is included in many of the 39 projects. The purpose of many of these structures is to provide mooring locations for 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 in the Opinion, vessel impacts include noise, propeller wash, and the introduction of a small amount of contaminants (i.e., fuel). Although vessel use caused by the proposed structures would be most concentrated around the structures themselves, we expect many vessels to travel throughout Puget Sound. In addition, as explained in this Opinion, 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. The reduction in forage for SRKWs that would be caused by the proposed action manifests predominantly within Puget Sound. For these reasons, Puget Sound proper is the appropriate action area for this consultation.

Moreover, as we describe in Section 2.6.1, the Integration and Synthesis for Critical Habitat, even if we had given greater consideration to the quality of habitat at each project site, we disagree that such consideration would have lead us to a different conclusion in light of the status of the species and the value of high quality habitat.

DISTINGUISHING BASELINE FROM EFFECTS OF THE ACTION

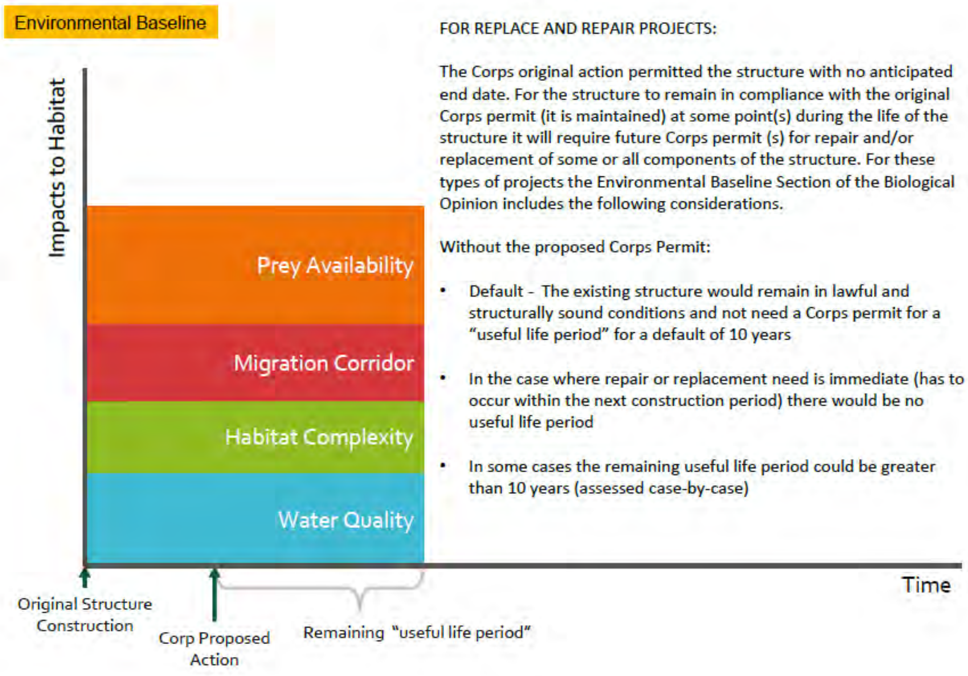
FOR REPLACE AND REPAIR PROJECTS:

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.

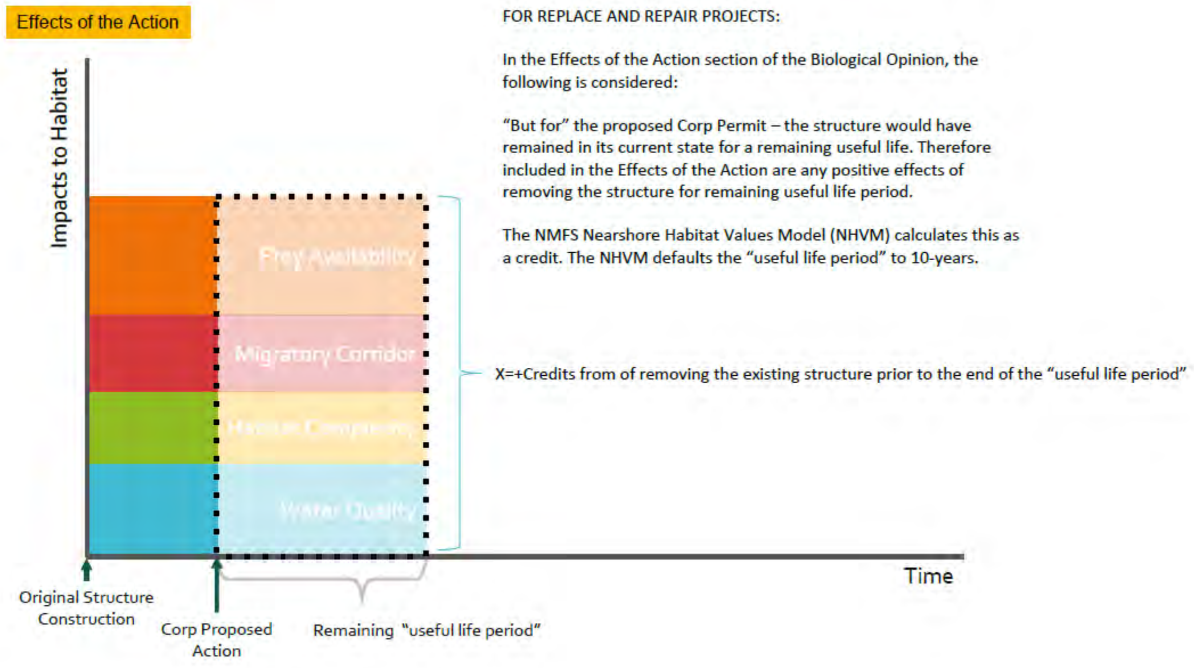


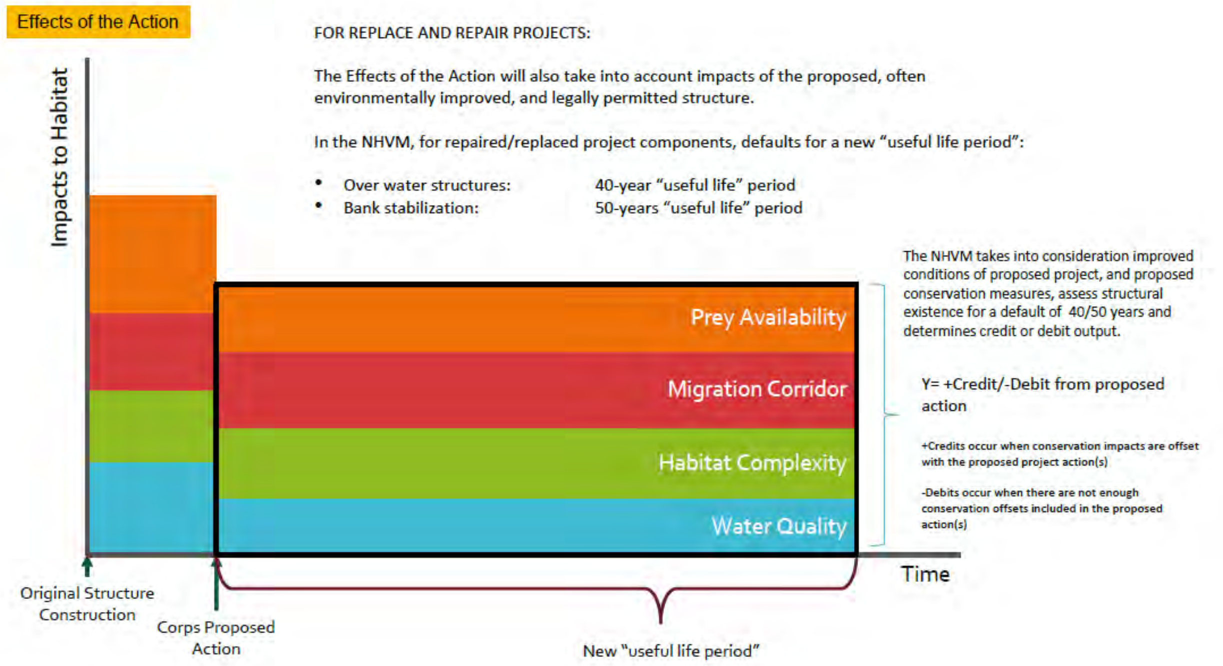
FOR REPLACE AND REPAIR PROJECTS:

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.





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":

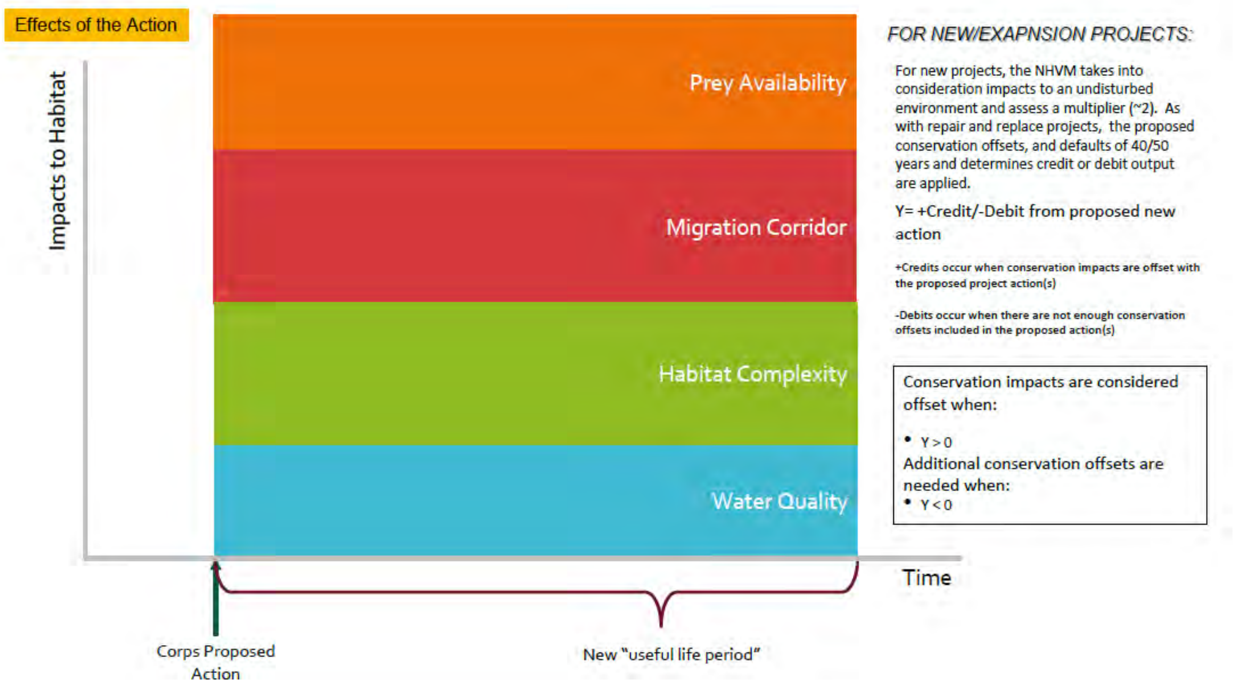
- Over water structures: 40-year "useful life" period
- Bank stabilization: 50-years "useful life" period

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)



FOR NEW/EXAPNSION PROJECTS:

For new projects, the NHVM takes into consideration impacts to an undistrubed 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