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 Nos.:
WCRO-2020-01295 (Eagle Harbor)
WCRO-2021-00669 (Pt. Defiance, Tahlequah, Vashon)
WCRO-2021-01434 (Edmonds)
WCRO-2021-01003 (Edmonds Emergency)

April 22, 2022

Jacalen Printz
Chief, Regulatory Branch
U.S. Army Corps of Engineers, Seattle District
4735 East Marginal Way South, Bldg. 1202
Seattle, Washington 98134-2388

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Eagle Harbor Maintenance Facility Slip F Drive-on Improvement Project, the Point Defiance, Tahlequah, Vashon Ferry Terminals Trestle Repairs Project, the Edmonds Ferry Terminal Trestle Repair Project, and the Edmonds Ferry Terminal Trestle Emergency Repair Project in Kitsap, Pierce, King and Snohomish Counties, Washington (COE Nos. NWS-2016-545, NWS-2021-162, and NWS-2010-38) (Puget Sound, HUC5 1711001912)

Dear Ms. Printz:

Thank you for your letters of May 12, 2020, March 18, 2021, May 17, 2021, and March 16, 2021, 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 U.S. Army Corps of Engineers' (COE) authorization of the proposed Eagle Harbor Maintenance Facility Slip F Drive-on Improvement Project, the Point Defiance, Tahlequah, Vashon Ferry Terminals Trestle Repairs Project, and the Edmonds Ferry Terminal Trestle Repair and Emergency Trestle Repair Projects. 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.

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)) for this action.

The enclosed document contains the biological opinion (opinion) prepared by the NMFS pursuant to section 7 of the ESA on the effects of the proposed action. In combination, the proposed projects achieve the goal of offsetting the permanent loss of nearshore habitat quality and quantity.

Therefore, in this opinion, the NMFS concludes that the proposed action would adversely affect but is not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon, PS steelhead, Georgia Basin (GB)/PS boccacio, and Southern Resident killer whale (SRKW). The NMFS also concludes that the proposed action is likely to adversely affect designated critical habitat for PS Chinook, GB/PS boccacio and SRKW but is not likely to result in the destruction or adverse modification of that designated critical habitat. This document also provides our conclusion that the proposed action is not likely to adversely affect GB/PS yelloweye rockfish and their designated critical habitat, or humpback whales from Central America and Mexico.

This opinion includes an incidental take statement (ITS) that describes reasonable and prudent measures (RPMs) the NMFS considers necessary or appropriate to minimize the incidental take associated with this action, and sets forth terms and conditions to reduce the impacts of incidental take. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of listed species.

Section 3 of this document includes our analysis of the action's likely effects on EFH pursuant to Section 305(b) of the MSA. Based on that analysis, the NMFS concluded that the action would adversely affect designated EFH for Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species. Therefore, we have provided two conservation recommendations that can be taken by the COE to avoid, minimize, or otherwise offset potential adverse effects on EFH. Section 305(b) (4) (B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving this recommendation.

Please contact Stacie Smith in the Central Puget Sound Branch of the Oregon Washington Coastal Office (Stacie.Smith@noaa.gov or 916-259-3648), if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

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

cc: Kevin Bartoy, WSF
Adrienne Stutes, WSF
Jennifer Lang, COE
Susan Buis, COE

WCRO-2020-01295 (Eagle Harbor)
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Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the

Eagle Harbor Maintenance Facility Slip F Drive-on Improvement Project,
Kitsap County, Washington
Point Defiance, Tahlequah, Vashon Ferry Terminals Trestle Repairs Project,
Pierce and King Counties, Washington
Edmonds Ferry Terminal Trestle Repair Project,
Snohomish County, Washington
Edmonds Ferry Terminal Trestle Emergency Repair Project,
Snohomish County, Washington

NMFS Consultation Numbers: WCRO-2020-01295 (Eagle Harbor)
WCRO-2021-00669 (Pt. Defiance, Tahlequah, Vashon)
WCRO-2021-01434 (Edmonds)
WCRO-2021-01003 (Edmonds Emergency)

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Puget Sound DPS Chinook Salmon	T	Yes	No	Yes	No
Puget Sound DPS Steelhead	T	Yes	No	N/A	N/A
Puget Sound/Georgia Basin DPS bocaccio rockfish	E	Yes	No	Yes	No
Puget Sound/Georgia Basin DPS yelloweye rockfish	T	No	No	No	No
Humpback whale; Mexico DPS	T	No	No	N/A	N/A
Humpback whale; Central America DPS	E	No	No	N/A	N/A
Southern Resident Killer Whales	E	Yes	No	Yes	No

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific groundfish	Yes	Yes
Pacific coast salmon	Yes	Yes
Coastal pelagic species	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service
West Coast Region

Issued By:

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

Date: April 22, 2022

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LIST OF ABBREVIATIONS AND ACRONYMS

BA	Biological Assessment
BMP	Best Management Practices
CHARTs	Critical Habitat Analytical Review Teams
CFR	Code of Federal Regulations
COE	U.S. Army Corps of Engineers
dB	Decibel
DIP	Demographically independent populations
DPS	Distinct Population Segment
DO	Dissolved Oxygen
DQA	Data Quality Act
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
GB	Georgia Basin
HAT	Highest Astronomical Tide
HEA	Habitat Equivalency Analysis
HTL	High Tide Line
ITS	Incidental Take Statement
MLLW	Mean Lower Low Water
MHHW	Mean Higher High Water
MPG	Major Population Group
MSA	Magnuson-Stevens Act
MSGP	Multi-Sector General Permit
NHVM	Nearshore Habitat Values Model
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OWS	Overwater Structures
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PBF	Physical or Biological Features
PS	Puget Sound
PCE	Primary Constituent Element
RPM	Reasonable and Prudent Measure
RMS	Root Mean Square
SAV	Submerged Aquatic Vegetation
SEL	Sound Exposure Level
SPL	Sound Pressure Levels
SRKW	Southern Resident Killer Whales
TTS	Temporary Threshold Shift
WAC	Washington Administrative Code
WDFW	Washington State Department of Fish and Wildlife
WSDOT	Washington State Department of Transportation
WSF	Washington State Ferries
WRIA	Water Resource Inventory Area

1. INTRODUCTION

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

1.1 Background

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

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

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

1.2 Consultation History

Eagle Harbor

NMFS and Washington State Department of Transportation, Ferries Division (WSF) staff (applicant) held a pre-consultation meeting on the proposed project on December 18, 2019. On May 12, 2020, the U.S. Army Corps of Engineers (COE) requested formal consultation for the Eagle Harbor Maintenance Facility Slip F Drive-on Improvement Project. At that time the COE provided NMFS a Biological Assessment (BA) and a letter requesting formal consultation and concurrence with its findings, Table 1, including the finding of *may adversely affect* EFH for Pacific Coast groundfish, Pacific Coast salmon, and coastal pelagic species.

Table 1. Effect determinations made by the COE

Species	Listed Species Determination	Critical Habitat Determination
PS Chinook	LAA	NLAA
PS Steelhead	LAA	N/A
PS/GB Bocaccio	NLAA	NLAA
PS/GB Yelloweye Rockfish	NLAA	No Effect
SRKW	NLAA	NLAA
Humpback Whales	LAA	N/A

On June 20, 2020, WSF emailed the COE and NMFS to inform them that the project schedule was delayed by one year. On December 10, 2020, the WSF notified the COE and NMFS by email that the project was moving forward with the schedule for construction in 2022.

On February 23, 2021 NMFS informed WSF by phone of additional information needed for the project analysis in the nearshore environment. Additional information was provided by WSF on March 15, 2021. On April 2, 2021, NMFS asked the COE and WSF for clarification on the effect determinations for humpback whale and PS Chinook critical habitat. On April 8, 2021, the WSF responded that the effect determination for humpback whales should be "may affect, not likely to adversely affect", and that they would request formal consultation for PS Chinook critical habitat.

On July 16, 2021, NMFS sent another email asking the COE and WSF about the effect determination for PS Chinook critical habitat and whether or not they would include the Southern Resident killer whale (SRKW) and its designated critical habitat under the "may affect, likely to adversely affect" determination. On July 22, 2021, the NMFS suggested that it would like to pursue a batched biological opinion with the COE on WSF open consultations. On a virtual call on July 29, 2021, the COE and WSF restated to NMFS that they preferred to move forward with the individual informal consultation and maintain their original effects determinations. Also, on August 11, 2021, the COE and WSF responded via email that they did not agree and would not be revising the initial effect determinations that were provided in the BA. NMFS has conveyed to the COE and WSF that the final opinion would contain an analysis for these species and habitats.

Pt. Defiance, Tahlequah, Vashon

NMFS, COE representative, and the WSF staff held a pre-consultation meeting on the proposed project on November 19, 2020. The likelihood that the project has potentially adverse effects to Chinook salmon and their nearshore critical habitat was discussed. On March 18, 2021, the COE requested formal consultation for the Point Defiance, Tahlequah, Vashon Ferry Terminals Trestle Repairs Project. At that time the COE provided NMFS a BA and a letter requesting formal consultation and concurrence with its findings, Table 2, including the finding of *may adversely affect* EFH for Pacific Coast groundfish, Pacific Coast salmon, and coastal pelagic species.

Table 2. Effect determinations made by the COE.

Species	Listed Species Determination	Critical Habitat Determination
PS Chinook	LAA	NLAA
PS Steelhead	LAA	N/A
PS/GB Bocaccio	NLAA	NLAA
PS/GB Yelloweye Rockfish	NLAA	No Effect
SRKW	NLAA	NLAA
Humpback Whales	NLAA	N/A

On April 27, 2021, the NMFS notified the COE and WSF via email that we would be unable to concur with the effect determinations as submitted and would need a revision for PS Chinook critical habitat and are looking at possible revisions to the effect determinations for bocaccio and their critical habitat. Additional information on stormwater and contaminant exposure in the nearshore environment was also requested, in order to analyze if there is the potential for adverse effects to bocaccio and their critical habitat. Additional information was provided to NMFS on April 29, 2021, however, no revisions to effect determinations were included.

On July 19, 2021, the NMFS sent an email to the COE and WSF requesting the action agency/applicant make revisions to effect determinations due to adverse effects of perpetuating the existence of the structures. At that time, NMFS requested that the COE modify the effect determinations for PS Chinook critical habitat, SRKW and SRKW critical habitat to "may affect, likely to adversely affect" in writing. It was also conveyed to the COE and WSF that the final Opinion would contain an analysis for these species and habitats. On July 22, 2021, the NMFS informed the WSF that we would like to pursue a batched biological opinion.

<u>Edmonds</u>

NMFS and the WSF staff held a pre-consultation meeting on the proposed project on March 18, 2021. At that time, NMFS expressed that impacts in the nearshore of Puget Sound would require a formal consultation. On May 17, 2021, the WSF provided NMFS with a BA and a letter requesting informal consultation, as the non-federal designee, on behalf of the COE. They requested concurrence with their findings, Table 3, including the finding of *may adversely affect* EFH for Pacific Coast groundfish, Pacific Coast salmon, and coastal pelagic species.

Table 3. Effect determinations made by the COE.

Species	Listed Species Determination	Critical Habitat Determination
PS Chinook	NLAA	NLAA
PS Steelhead	NLAA	N/A
PS/GB Bocaccio	NLAA	NLAA
PS/GB Yelloweye Rockfish	NLAA	No Effect
SRKW	NLAA	NLAA
Humpback Whales	NLAA	N/A

On June 24, 2021, NMFS provided the WSF with information that the Puget Sound Nearshore Habitat Values Models (NHVM) output or "Conservation Calculator" results determined that the project, as proposed would result in permanent loss of nearshore habitat quality and quantity (see Section 2.1 for information on the use of the NHVM). Additionally, NMFS requested additional project specifics to determine the final debit/credit output, and informed WSF that there will have to be some habitat conservation offsets for the debits or some other added conservation to get to zero or better. The additional project details requested were provided to NMFS on June 25, 2021.

On July 2, NMFS provided the WSF with a spreadsheet of conservation calculator outputs for several "typical maintenance" activities, including Edmonds trestle repairs, and informed them that repair and replacement activities in the nearshore of Puget Sound result in adverse effects to Chinook salmon and their critical habitat.

Edmonds Emergency

On February 10, 2021, the COE sent an email notification to NMFS' Washington consultation request inbox regarding an emergency action at the WSF Edmonds Terminal. At that time, the COE made initial contact, declared an emergency action (pile repair) , and made a request for recommendations to minimize effects from the emergency response. The COE stated the work would proceed on February 11, 2021 and that a request for Section 7 consultation would be made after the emergency action took place (i.e., after-the-fact).

On March 16, 2021, the WSF provided NMFS with a BA and a letter requesting informal consultation, as the non-federal designee, on behalf of the COE. They requested concurrence with their findings, same as Table 3 above, including the finding of may adversely affect EFH for Pacific Coast groundfish, Pacific Coast salmon, and coastal pelagic species.

Due to high workload among NMFS staff and that the work had already been completed, the consultation request was placed on hold by NMFS.

All

On August 3, 2021, under regulations 50 CFR 402.14(c)(4), the NMFS sent an email asking if the COE would consider the possibility of batching these projects into a single Opinion. On August 4, the COE informed NMFS via email that they prefer that NMFS completes individual consultations on these projects.

On August 25, 2021, after an additional conversation with the COE, it was determined by NMFS that batching would be the most efficient and expedient path forward to clear the existing individual WSF consultations. NMFS also determined it would not be necessary to provide insufficiency or non-concurrence letters to the COE, understanding that portions of the biological opinion would be contrary to the determinations expressed in their original consultation request letters. On September 3, 2021, the NMFS determined that the best option to complete the consultation request for the Edmonds Emergency Repair would be to add it to this opinion.

As part of the batched Biological Opinion process, the NMFS calculated final project impacts and the value of proposed conservation offsets using the Conservation Calculator. The goal of utilizing the Conservation Calculator was to ensure that the accompanying offsets would result in neutral or positive habitat impacts (credits) rather than negative impacts (debits) and ensure the project would not jeopardize listed species recovery or adversely modify critical habitat.

On September 8, 2021, the Northwest Fisheries Science Center presented data on the stormwater effects on fish from recent studies, which concluded that exposure to polycyclic aromatic hydrocarbons (PAHs) result in massive cardiac effects to all fish species at very low concentrations, especially in early life stages with developing hearts. Based on the potential ongoing exposure of larval bocaccio and their critical habitat to stormwater runoff, as well as (legacy) creosote as described in the BA and additional documentation, NMFS determined that the proposed actions, alone and in combination, are likely to adversely affect boccacio and their nearshore critical habitat.

Once the process decisions, inputs to the conservation calculator and effect determinations were finalized, NMFS determined the information provided by the COE and the WSF was sufficient to initiate formal ESA consultation on September 10, 2021.

1.3 Proposed Federal Action

Under the ESA, “action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (see 50 CFR 402.02). Under the MSA, “Federal action” means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (see 50 CFR 600.910).

The COE proposes to issue a Clean Water Act (CWA) (33 U.S.C. 1344) Section 404 permit to the WSF for the purpose of improving an access slip at the Eagle Harbor Maintenance Facility to accommodate testing and maintenance of passenger evacuation slides. The proposed system is designed to accommodate operation at all tide elevations (current conditions and accounting for future sea level rise) and for all types of vessels. The COE also proposes to issue CWA Section 404 and/or Section 10 of the Rivers and Harbor Act permits to the WSF for maintenance and repair of the Pt. Defiance, Tahlequah, Vashon, and Edmonds Ferry Terminals’ trestles, which is necessary to ensure the safety and functionality of the terminals. Each of the projects is located within the nearshore marine zone of Puget Sound (Figure 1).

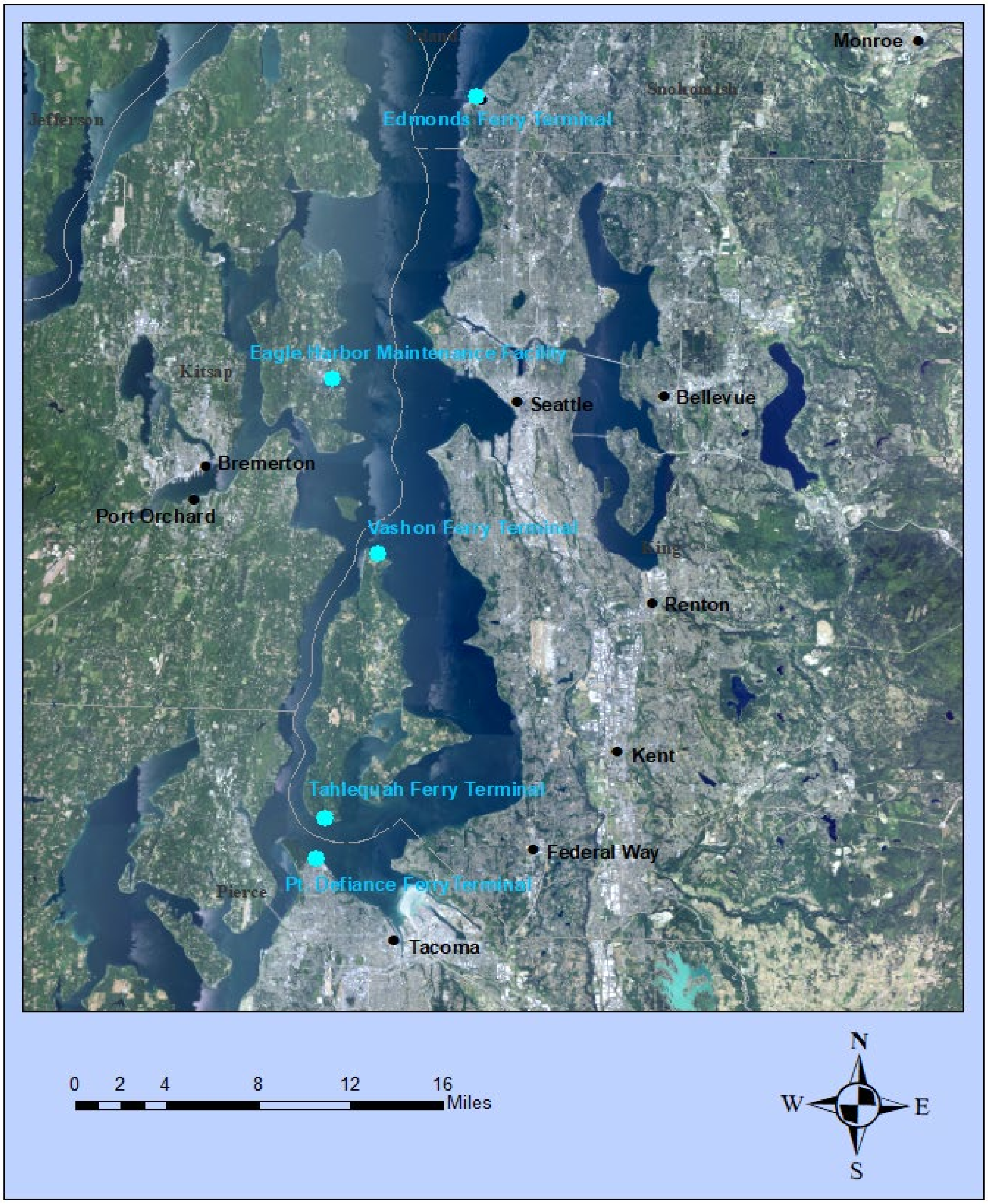

Figure 1. Project Location Overview Map.

Eagle Harbor

At the Eagle Harbor Maintenance Facility (Figure 2), project elements include the following:

- Replacement of an existing gangplank system with a new pile-supported trestle that has a mechanically adjustable transfer span. The new structure will be approximately 140 feet (ft) long by up to 15 ft wide and have a grated deck that provides 82 percent light penetration. The majority of the structure will be at least 12 ft above Mean Lower Low Water (MLLW), with a headframe located 40 ft above MLLW. When complete, the new slip will allow vessels to berth in deeper water than they currently do.
- Replacement of 2 timber dolphins with 2 new wingwalls.
- Installation of 2 new fixed pile dolphins.
- Relocation of floats within the same shore zone.
- Removal of an existing timber walkway/trestle, 4 existing timber dolphins, and a U-shaped float. Removal of these structures will result in removal of an estimated 149 tons of creosote-treated timber piles and decking from substrate and in and over marine waters.

The construction activities listed above will involve installation of 38 steel piles ranging in size from 18- to 36-inches in diameter and removal of 194 piles (186, 12-inch diameter timber and 8, 18-inch diameter steel piles). A permanent net increase of 8 square ft of marine benthic habitat will result from the change in area associated with the proposed pile placement and removal. Completion of project construction will result in a permanent net decrease of 138 square ft of overwater coverage. Figure 3 shows structural elements for removal and replacement and the location of MLLW. Figure 4 identifies details of the proposed trestle and transfer span design.

Construction is planned for a 24 week period with in-water work window occurring during one in-water work window for Tidal Reference Area 5 (Washington Administrative Code [WAC] 220-660-330, Table 4) from August 1 to February 15. Pile driving will occur for approximately 34 days with a maximum of 107 hours of pile driving (vibratory and impact combined). Best management practices (BMPs) for pile driving will be implemented, including use of a bubble curtain during impact driving for pile proofing and marine mammal monitoring. Additional details associated with the proposed action are not discussed in detail here, but can be found in the BA (WSF 2020, pp. 4-10) and supplemental documentation provided to NMFS by WSF that have been added to the administrative record.

Activities performed by the WSF are subject to federal, state, and local permit regulations. The WSF have developed and routinely use the best guidance available (BMP's and minimization measures) to avoid and minimize (to the greatest extent possible) impacts on the environment, ESA listed species, and designated critical habitats. A document has been developed by the WSF titled the Washington State Ferries Biological Assessment Reference (BAR)[1] to supplement ESA consultation which provides detailed descriptions of construction methods used as well as general and activity specific minimization measures.

The COE and WSF propose, but are not limited to, the following measures to avoid and minimize effects of the action. The full list of minimization measures used during construction at all WSF facilities can be found in the BAR (WSF 2019, Chapter 2.3), and is incorporated here by reference. All applicable measures will be implemented for Eagle Harbor and the terminal repair actions below.

- The new trestle and transfer span at Eagle Harbor were designed to minimize the amount of disturbance to the seabed and amount of overwater shading as much as practical.
- A construction inspector and/or environmental staff will be present for monitoring and to ensure compliance with permit and consultation commitments.
- The contractor will be provided with plan sheets identifying eelgrass boundaries and will required to adhere to restrictions when working near eelgrass beds to avoid damage to beds and substrates.
- A Spill Prevention, Control and Countermeasures (SPCC) Plan will be prepared and implemented for the entire project duration. No debris, petroleum products, fresh cement, or other toxic or deleterious material shall be allowed to enter surface water. Debris will be disposed of at an upland disposal site.
- In water construction activities will comply with marine water designated uses and criteria (WAC 173-201A-210) imposed by Washington State Department of Ecology (Ecology), which specifies aquatic life turbidity criteria [Table 210(1)(e)] where the point of compliance for a temporary area of mixing for estuaries or marine waters shall be at a radius of 150 feet from the activity causing the turbidity.
- Pile driving of steel piles will be done using vibratory rather than impact methods whenever feasible.

[1] The BAR is authored by WSF staff biologists and was updated in August 2019. The document is available online here: https://wsdot.wa.gov/engineering-standards/design-topics/environment/environmental-disciplines/fish-wildlife/endangered-species-act-and-essential-fish-habitat/biological-assessment-preparation-manual-template#BAR

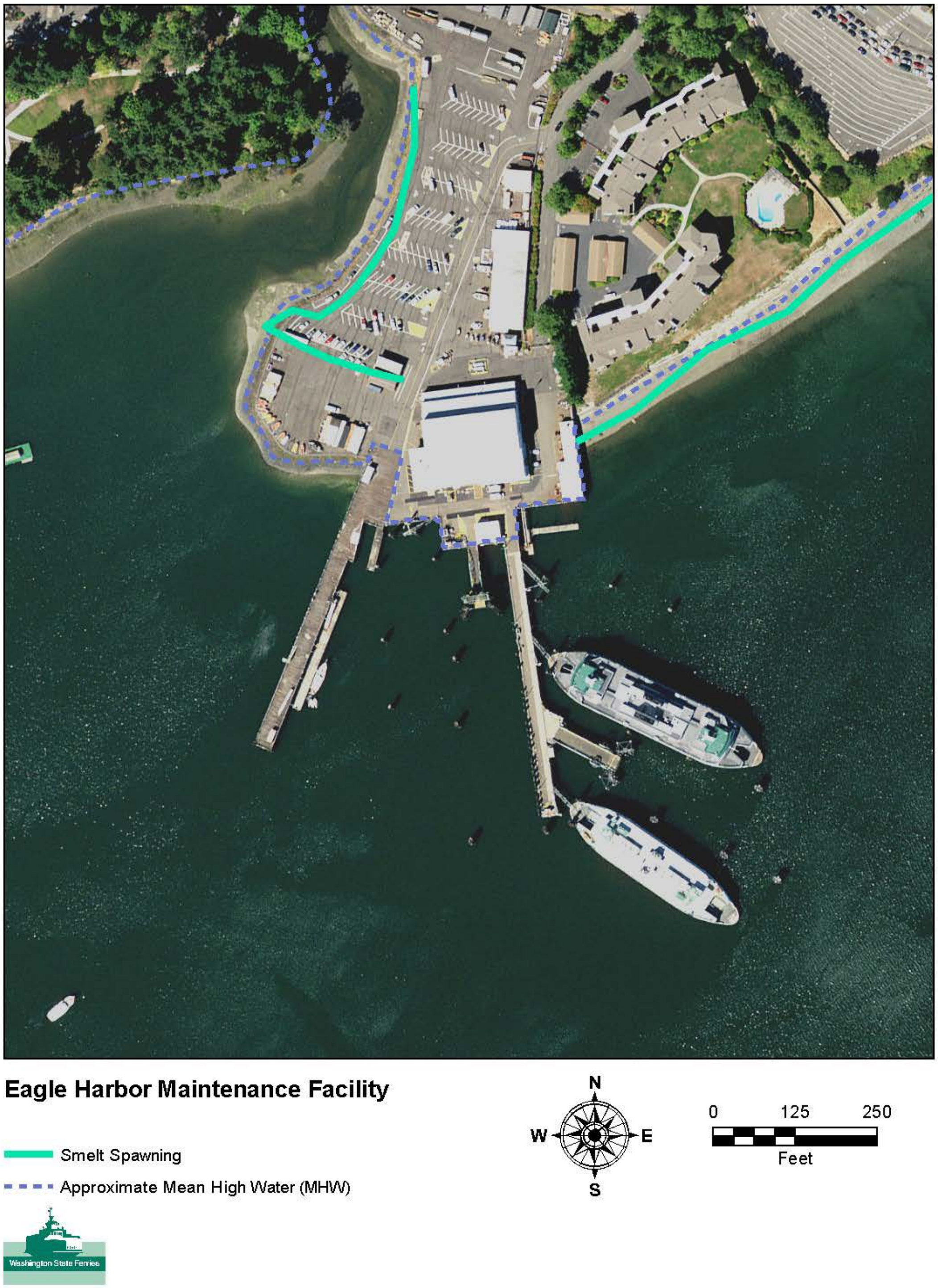

Figure 2. Aerial View of Eagle Harbor Maintenance Facility

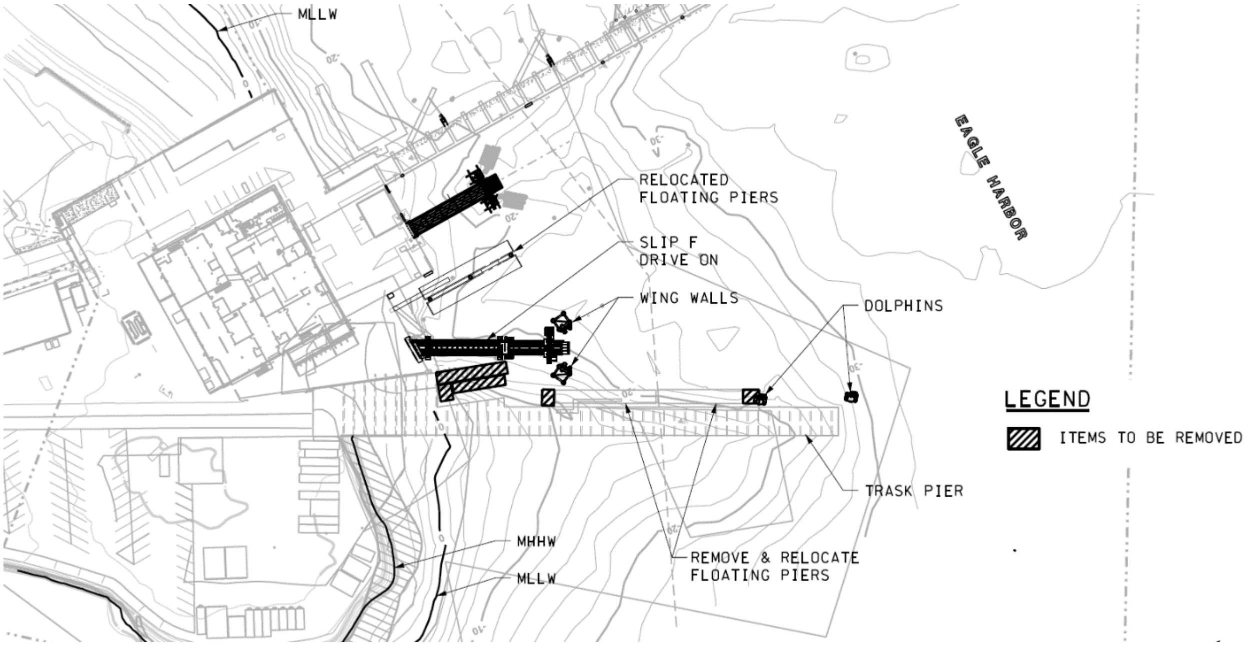

Figure 3. Overview of overwater structures to be removed, relocated or replaced

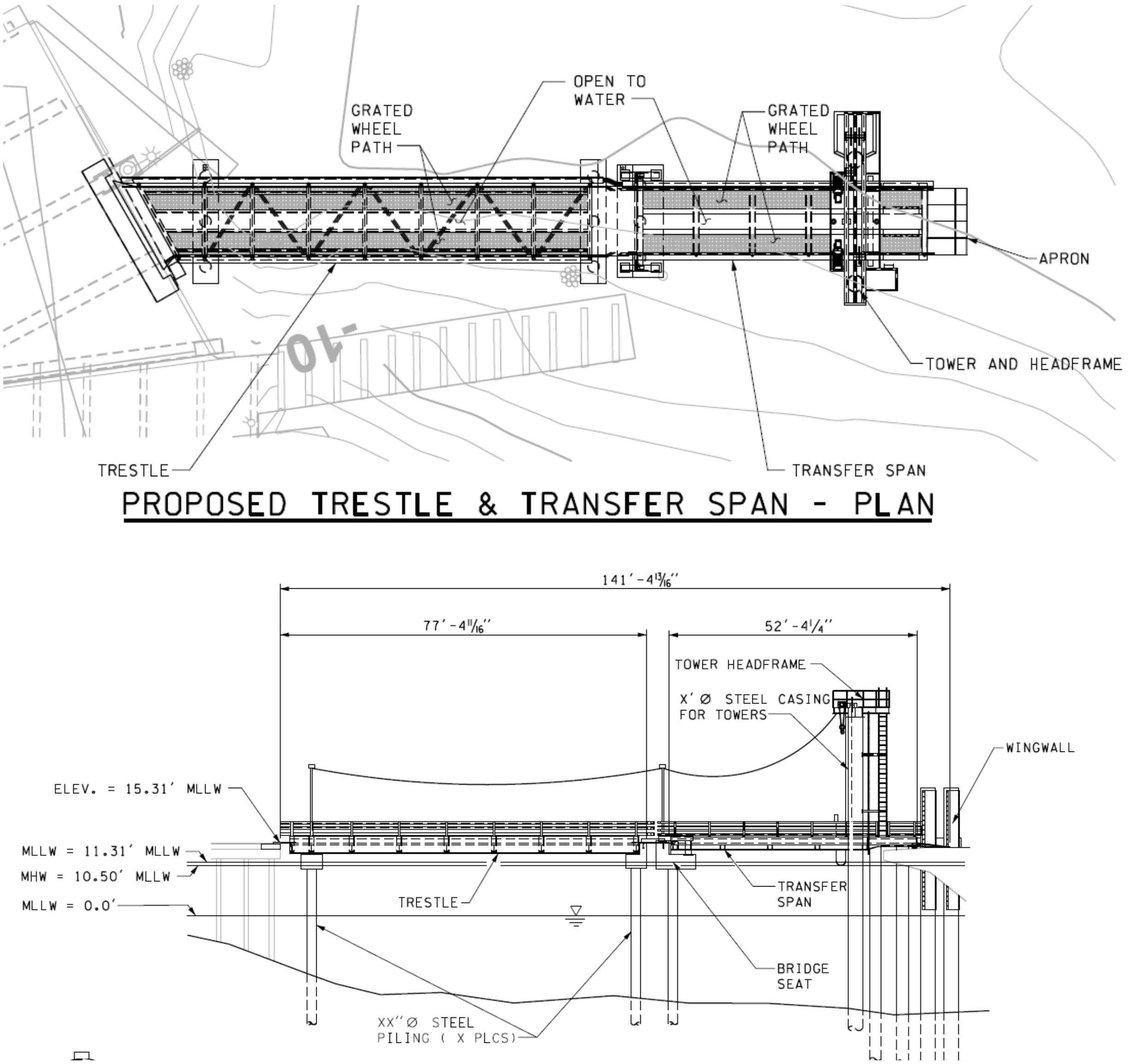

Figure 4. Trestle and Transfer Span Details

Pt. Defiance, Tahlequah, Vashon

The WSF proposes to conduct repairs at the three ferry terminals. The locations and proposed project elements are shown for each terminal in Figures 5-7 and described below. The proposed repairs will not result in new overwater structure/coverage or require pile driving, and no other projects are dependent on these repairs.

Pt. Defiance Terminal - Repair work at Pt. Defiance (Figure 5) includes filling voids in rip-rap reinforcement in front of the large parking lot bulkhead (wall) with three cubic yards of 6-inch quarry spalls, replacement of cross-bracing at six locations on the terminal, minor timber deck repairs, pile repairs, and bituminous pavement (chip seal) treatment of existing asphalt. The shoreline abutment repairs under the passenger walkway will be 3 feet long by 20 feet wide below mean higher high water (MHHW) and highest astronomical tide (HAT)[2], which are defined by the wall in this location. Piles will be repaired using encapsulation consisting of a fiberglass jacket and epoxy grout infill. This project element requires excavation around the piles to a depth of 1 to 2 ft. and backfilling after encapsulation. The number, type, and diameters of piles, and associated benthic impacts, are listed below:

- Seven 12-inch diameter timber piles. Excavation will result in a total benthic impact of approximately 29 square ft. Approximately 2 square ft. of the benthic impact will be permanent.
- Three 20-inch diameter steel piles. The repaired piles will be reinforced with quarry spall (approximately 2 cubic yards). Excavation will result in a total benthic impact of approximately 27 square ft. Approximately 1.4 square ft. of the benthic impact will be permanent.

[2] NMFS recognizes HAT as the upland extent of shoreline habitat—critical habitat in areas where it is designated—that supports both life history functions of listed PS Chinook salmon.

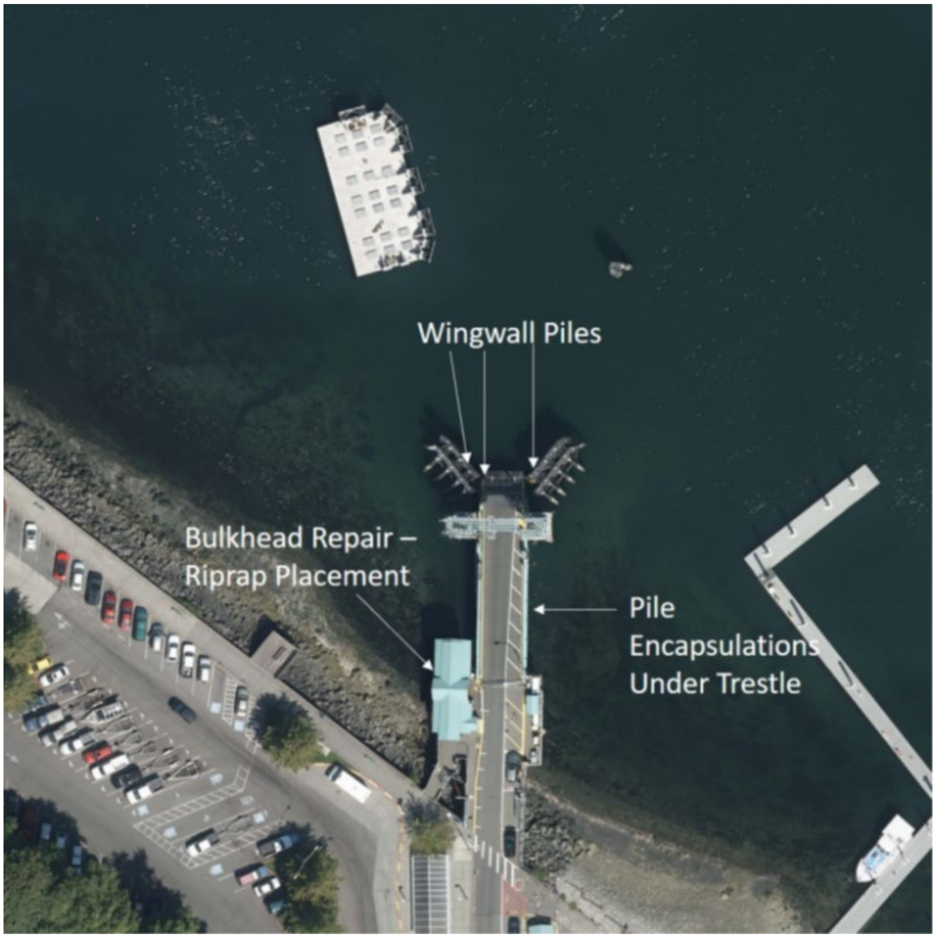

Figure 5. Project elements at the Point Defiance Ferry Terminal.

Tahlequah Terminal - Repair work at Tahlequah (Figure 6) includes addition of a support beam, addition of bolts, and pile repair using encapsulation as described previously. The number, type, and diameter of piles, and associated benthic impacts, are listed below:

- One 12-inch diameter timber trestle pile with a total benthic impact of approximately 7 square ft. Approximately 0.3 square ft. of the benthic impact will be permanent.

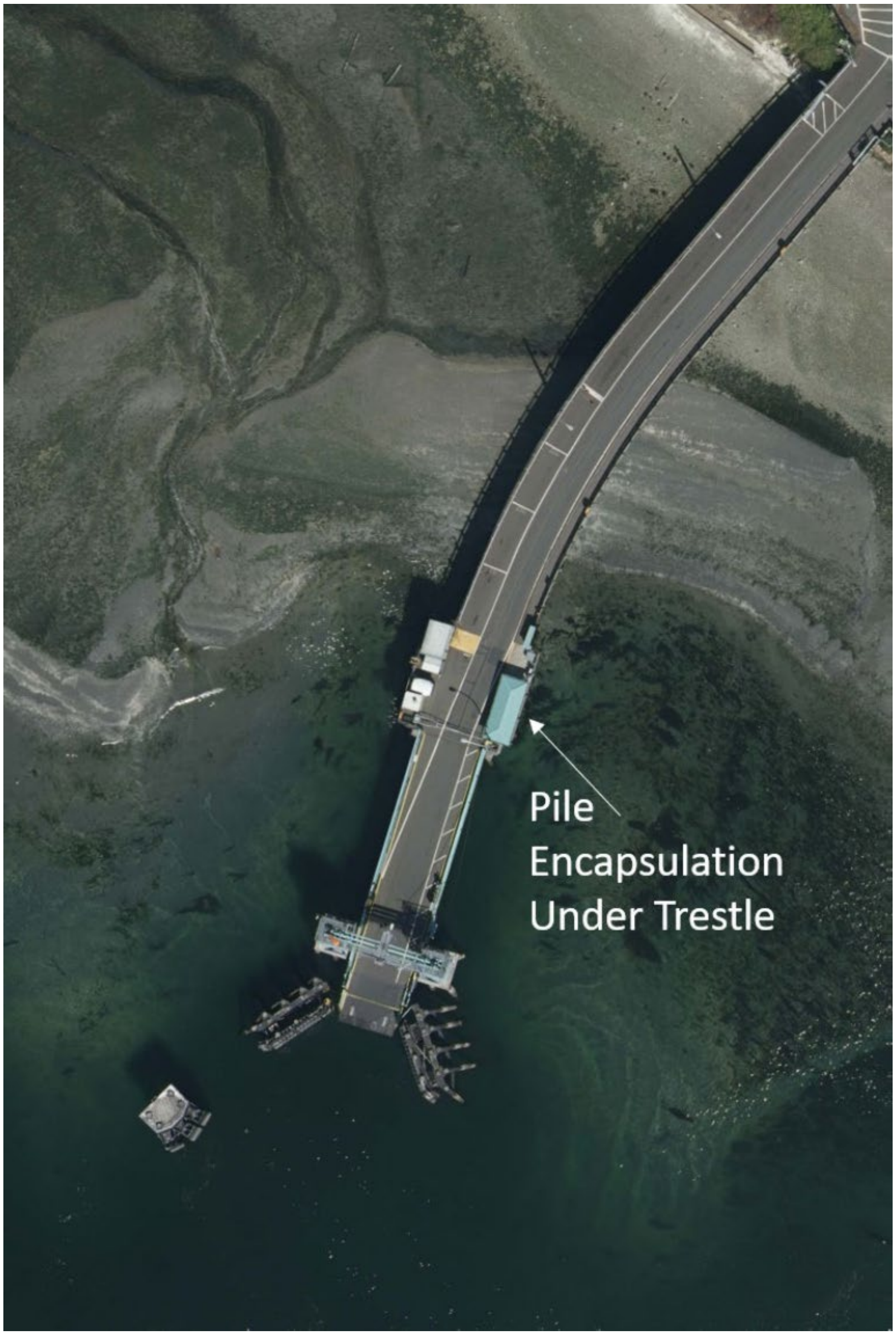

Figure 6. Project element at the Tahlequah Ferry Terminal.

Vashon Terminal - Pile repairs at Vashon (Figure 7) will be conducted using encapsulation as described previously. The number, type, and diameter of piles, and associated benthic impacts, are listed below:

- One 12-inch diameter timber trestle pile with a total benthic impact of approximately 7 square ft. Approximately 0.3 square ft. of the benthic impact will be permanent.
- Two 24-inch diameter steel piles with a total benthic impact of approximately 20 square ft. Approximately 1.1 square ft. of the benthic impact will be permanent.
- Four 36-inch diameter steel piles with a total benthic impact of approximately 52 square ft. Approximately 3.2 square ft. of the benthic impact will be permanent.
- Four 16-inch diameter steel piles with a total benthic impact of approximately 31 square ft. Approximately 1.5 square ft. of the benthic impact will be permanent.

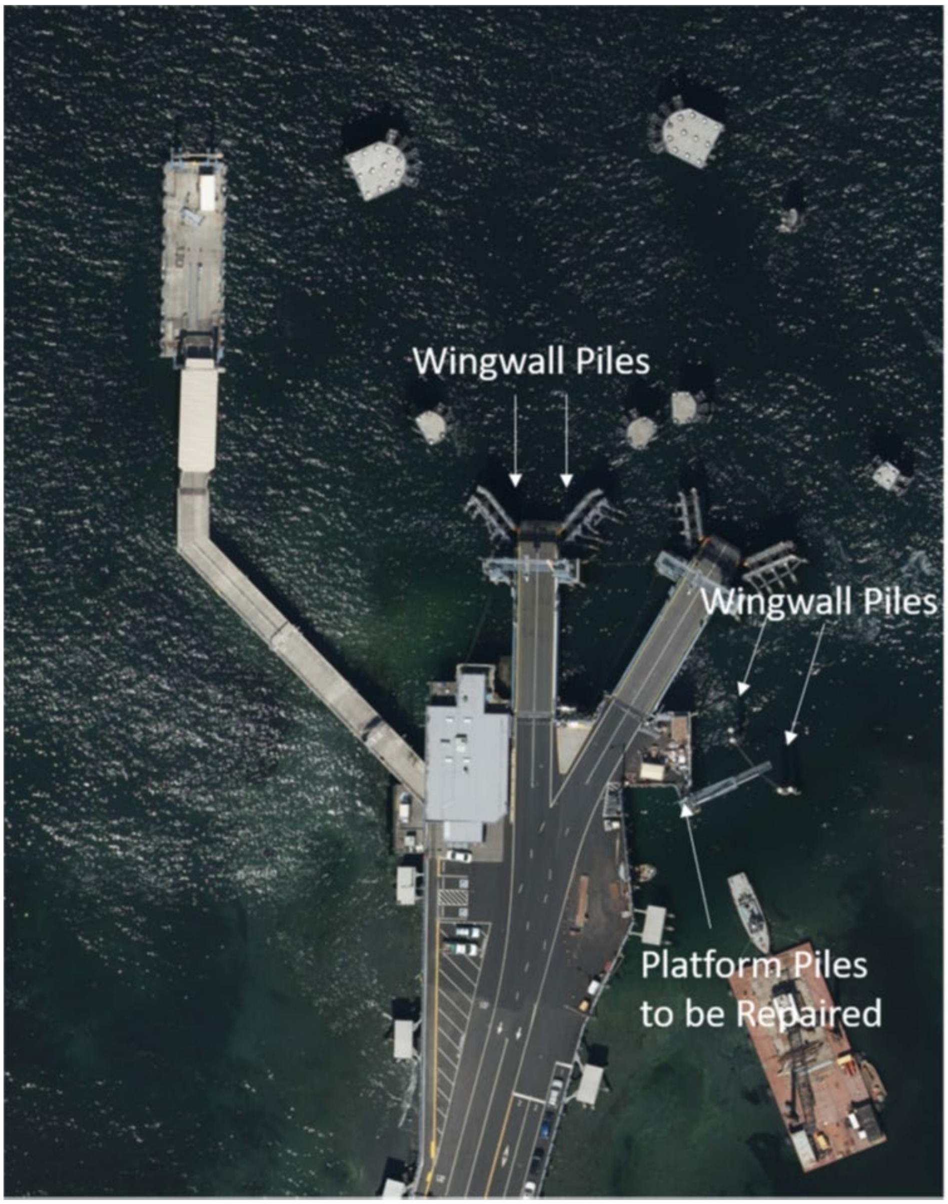

Figure 7. Project elements at the Vashon Ferry Terminal.

Construction is planned for approximately 24 weeks, with in-water work occurring within one in-water work window for Tidal Reference Area 4 (WAC 220-660-330, Table 4), August 1 to February 15. BMPs will be implemented, including sediment sampling in the excavation areas at the Pt. Defiance Terminal, where the terminal is located within the Commencement Bay Nearshore/Tide Flats Superfund Site. If contamination is identified above the Environmental Protection Agency clean-up levels, the contaminated sediment will be removed and disposed of at an approved disposal facility.

Edmonds

Repair work at Edmonds (Figure 8) includes removal of a creosote timber pile and replacement with a steel H-pile, and pile repair using encapsulation as described previously. Encapsulation work will occur during low tide, when the site is dry, to minimize turbidity, and for ease of worker access. The number, type, and diameter of piles, and associated benthic impacts, are listed below:

- One 12-inch diameter timber trestle pile with a total benthic impact of approximately 7 square ft. None of the benthic impact will be permanent.
- Three 12-inch diameter timber trestle piles with a total benthic impact of approximately 21 square ft. Approximately 0.9 square ft. of the benthic impact will be permanent.

The timber pile removal and H-pile replacement will require vibratory pile driving only, and will occur for a maximum of 2 hours over two days, and will be accessed by cutting a hole in the deck of the trestle. This estimate includes mobilization and set up and actual vibratory pile driving is likely to take 10 minutes or less. The overall project is expected to take less than one week, with in-water work occurring within one in-water work window for Tidal Reference Area 5 (WAC 220-660-330, Table 4), August 1 to February 15.

Figure 8. Project elements at the Edmonds Ferry Terminal.

Edmonds Emergency

In February 2021, the COE authorized the WSF to conduct repair work under their emergency permit approval process. At that time, the WSF Terminal Engineering Structures Department determined that two piles were significantly damaged, and that the south lane of the Edmonds trestle needed to be closed until repairs could be made to the piles. The repair work occurred on February 12, 2021, prior to the close of the authorized in water work window for the project area on February 15 [Tidal Reference Area 5 (WAC 220-660-330)].

Emergency pile repairs at Edmonds (Figure 9) were conducted using encapsulation as described previously. The number, type, and diameter of piles, and associated benthic impacts, are listed below:

- Two 12-inch diameter timber trestle piles with a total benthic impact of approximately 14 square ft. Approximately 0.6 square ft. of the benthic impact is permanent.

Figure 9. Emergency project elements at the Edmonds Ferry Terminal.

None of the proposed activities will add new impervious surface or increase over-water cover. Stormwater management at each of the Ferry Terminals and the Eagle Harbor Maintenance facility consists of treated and untreated discharges into Puget Sound which will not be modified in any way by the proposed action.

Where required by the Washington Department of Fish and Wildlife (WDFW), forage fish surveys will occur prior to the start of repairs, and in-water work will only proceed when forage fish eggs are no longer present. The proposed action includes implementation of a marine mammal monitoring plan (MMMP) to ensure that listed marine mammals would not be exposed to harmful noise effects. The WSF will obtain an Incidental Harassment Authorization, as necessary, under the Marine Mammal Protection Act for non-listed species including seals, sea lions, and porpoise. Derelict fishing gear, and other debris that is in the vicinity of the piles to be repaired, will be removed and disposed of offsite.

Based on the conservation calculator, described in more detail below, the proposed removal of nearly 150 tons of creosote and solid floats, as well as the replacement of the trestle from solid to grated decking and overall reduction in over water coverage at the Eagle Harbor Project, will result in the generation of 242 conservation credits comprised of both removal and replacement of structures (+172 credits) and permanent removal of stand-alone structures (+70 credits). These credits will help offset the loss of ecosystem functions due to the modification of nearshore habitats (including substrates, water column, and shorelines) for the other 3 WSF projects within this batched opinion. +221 conservation credits remain after these 3 project's debits have been offset (Table 4). Calculator outputs for each of the projects in Table 4 are provided in Appendix A.

Table 4. Conservation credits accrual and use for the Washington State Ferries.

Action	WCRO#	NWS #	Project	Basin	Year	Credits Used	Credits Accrued	Credits Remaining
Credits Generated –	2020-01295	2016-545	EH Slip F	South Central PS	2022	-	242	242
Used Credits –	2021-00669	2021-162	Pt. Defiance, Tahlequah, Vashon	South Central PS	2022	-18	0	224
	2021-01434	2010-38	Edmonds	South Central PS	2022	-2	0	222
	2021-1003	2010-38	Edmonds Emergency	South Central PS	2021	-1	0	221

Other Consequences Caused by the Proposed Action

We considered whether or not the proposed action would cause any other activities and determined that replacement or repair of structures in each project would cause their enduring presence in the environment for the lifespan of the structures that would not occur but for the permit issued by the COE. Conservation credits calculated using a habitat model will be used to offset the enduring effects of replaced or repaired structures. The habitat model and use of conservation credits is discussed in Section 2.1, Analytical Approach. The enduring effects of these structures on the environment through their new design life span is analyzed in Section 2.5, Effects of the Action.

We considered, under the ESA, whether or not each of the proposed projects would cause any other activities and determined that they would not. The Point Defiance, Tahlequah, Vashon, Edmonds, and Edmonds Emergency are repairs to existing structures and have independent utility not tied to other actions or projects at WSF. The expected design lives of individual structures ranges between 40 and 75 years. Relocating and upgrading infrastructure at the Eagle Harbor facility is not expected to result in additional ferry trips or increase capacity of the ferry system, but will reduce the amount and frequency of future maintenance. Structure repairs at the Edmonds, Point Defiance, Tahlequah, and Vashon terminals and the one pile replacement at the Edmonds Terminal will not result in additional ferry trips or increase the capacity of the ferry system. Future repair and maintenance of the Eagle Harbor facility and the other terminals may be covered under the Region Road Maintenance Program (Limit 10 of the 4(d) Rule, NMFS Tracking No. 2003/00313). A programmatic consultation for Federal maintenance actions conducted by WSFs is currently being developed and will also be used when and where appropriate or these actions will undergo separate Section 7 consultation, where necessary.

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

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species or to adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

The COE determined the proposed action is not likely to adversely affect GB/PS yelloweye rockfish and its designated critical habitat, or humpback whales. Our concurrence is documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.13).

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 designations of critical habitat for most species in this opinion use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414, February 11, 2016) that revised the critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

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

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

- Evaluate the rangewide status of the species and critical habitat 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 the four proposed actions located in the central area of Puget Sound using a Habitat Equivalency Analysis (HEA)[3] 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-accessible 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 action, as well as the impacts of the existing environmental baseline, using the NHVM.

[3] 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 2015)), from which "withdrawals" can be made to address mitigation for adverse impacts to ESA species and their designated CH.

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 would be, for example, 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). More recently, on November 9, 2020, and September 30, 2021, NMFS issued biological opinions (NMFS 2020, NMFS 2021) for 39 and 11, respectively, over-, in- and near-shore projects in the marine shoreline of Puget Sound that used the NHVM to establish a credit/debit target of no-net-loss of critical habitat functions.

Use of the NHVM requires an assumption of the amount of time the proposed structure, and thus the resulting habitat impacts, will persist. For this consultation and consistent with our application in NMFS 2020 and 2021 batched biological opinions on COE actions, we have applied an assumption that the all structures will persist for a minimum of 40 years[4] before requiring an additional action to maintain their structural integrity, which is likely an underestimation based on the 75-year base design lives modeled for trestles and transfer spans[5] (WSDOT 2016).

As explained above, model outputs for new or expanded projects account for impacts to an undeveloped 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 four proposed actions:

- Beneficial aspects of the proposed action, including any positive effects that would result from removing debris;
- Minimization incorporated through project design improvements [e.g., credit is given for grating over water structures (OWS)];

[4] Assumption based on available input parameters of the NHVM model. The design life is 75-years for trestles and transfer spans (WSF 2016).
[5] Multiple factors will affect the actual design life, but WSF Life Cycle Cost Model has a base design life of 75-years for trestles and transfer spans and this is based on required design standards. See WSDOT 2016.

- Adverse effects that would occur from the persistence of existing OWS.

2.2 Rangewide Status of the Species and Critical Habitat

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

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. 2014). 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 3.5-5.3ºC 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 (DO), may also cause earlier onset of stratification, and reduced mixing between layers in lakes and reservoirs, which can 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 because 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 CO2 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 Critical Habitat

This section describes the status of designated critical habitat affected by the proposed action by examining the condition and trends of the essential physical and biological features of that habitat throughout the designated areas. These features are essential to the conservation of the ESA-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). Critical habitat is not designated for Puget Sound steelhead in marine waters nor for humpback whale DPSs, and is not designated in nearshore marine waters for PS/GB yelloweye rockfish.

Puget Sound Chinook Salmon
As part of the process to designate critical habitat within the PS Chinook salmon ESU, NMFS's critical habitat analytical review teams (CHARTs) 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 ESA-listed species that they support (NOAA Fisheries 2005). The conservation rankings were high, medium, or low. To determine the conservation value of each watershed to species viability, the CHARTs evaluated the quantity and quality of habitat features, 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. Even if a location had poor habitat quality, it could be ranked with a high conservation value if it were essential due to factors such as limited availability, a unique contribution of the population it served, or serving another important role. No critical habitat in marine areas has been designated for PS steelhead, and so the action areas do not include critical habitat for this Distinct Population Segment (DPS).

In designating critical habitat (CH) for PS Chinook salmon in estuarine and nearshore marine areas, NMFS determined that the area from extreme high water extending out to the maximum depth of the photic zone (no greater than 30 meters relative to MLLW) contain essential features that require special protection. For nearshore marine areas, NMFS designated the area inundated by extreme high tide because it encompasses habitat areas typically inundated and regularly occupied during the spring and summer when juvenile salmon are migrating in the nearshore zone and relying heavily on forage, cover, and refuge qualities provided by these occupied habitats.

Based on the natural history of Puget Sound Chinook salmon and their habitat needs, NMFS identified the following PBFs essential to conservation located within the action areas:

> PBF 4 – Estuarine areas free of obstruction and excessive predation with: 1) water quality, water quantity, and salinity conditions that support juvenile and adult physiological transitions between fresh water and salt water; 2) natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and 3) juvenile and adult foraging opportunities, including aquatic invertebrates and prey fish, supporting growth and maturation.
>
> PBF 5 – Nearshore marine areas free of obstruction and excessive predation with: 1) water quality and quantity conditions and foraging opportunities, including aquatic invertebrates and fishes, supporting growth and maturation; and 2) natural cover including submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

All physical and biological features (or primary constituent elements) of estuarine and nearshore marine critical habitat for the Chinook salmon critical habitat have been degraded throughout the Puget Sound region. The causes for these losses of critical habitat value include human development, including diking, filling of wetlands and bays, channelization, and nearshore and floodplain development. Continuing development contributes to the anthropogenic modification of the Puget Sound shorelines and is the major factor in the cumulative degradation and loss of nearshore and estuarine habitat. The development of shorelines includes bank hardening and the introduction of obstructions in the nearshore area. Each obstruction is a source of structure and shade, which can interfere with juvenile salmonid migration and diminish aquatic food supply, and is a potential source of water pollution from boating uses (Shipman *et al.* 2010; Fresh *et al.* 2011; Morley *et al*. 2012).

Critical habitat throughout the Puget Sound basin has been degraded by numerous activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large woody debris, intense urbanization, agriculture, alteration of floodplain and stream morphology, riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, timber harvest, and mining. Changes in habitat quantity, availability, diversity, stream flow, temperature, sediment load, and channel instability are common limiting factors of critical habitat.

Puget Sound/Georgia Basin Bocaccio

Critical habitat for PS/GB bocaccio includes 590.4 square miles of nearshore habitat and 414.1 square miles of deepwater habitat. Critical habitat is not designated in areas outside of United States jurisdiction; therefore, although waters in Canada are part of the DPSs' range for bocaccio, critical habitat was not designated in that area. The U.S. portion of the Puget Sound/Georgia Basin that is occupied by 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.

Nearshore critical habitat includes settlement habitats with sand, rock, and/or cobble substrates that also support kelp. Important site attributes include: (1) Quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; and (2) Water quality and sufficient levels of dissolved oxygen (DO) to support growth, survival, reproduction, and feeding opportunities.

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

Based on the natural history of 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; 2) Nearshore juvenile rearing sites with sand, rock and/or cobbles to support forage and refuge.

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, including PS/GB bocaccio nearshore and deepwater critical habitat. It 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 farmland 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.

Southern Resident Killer Whale
On August 2nd, 2021, NMFS revised the critical habitat designation for the SRKW DPS under the ESA by designating six new areas along the U.S. West Coast (86 FR 41668). Specific new areas proposed along the U.S. West Coast include approximately 15,910 square miles (mi2) (41,207 square kilometers (km2)) 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). We have excluded one area, the Quinault Range Site. In the final rule (86 FR 41668), NMFS states that the "designated areas are occupied and contain physical or biological features that are essential to the conservation of the species and that may require special management considerations or protection." The three physical or biological features essential to conservation in the 2006 designated critical habitat were also identified for the six new areas along the U.S. West Coast. Based on the natural history of SRKWs and their habitat needs, NMFS identified the following PBFs 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.

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 (2019), 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 – 2019 (Ecology 2020). Despite the existence of preparedness programs and the scarceness of oil spills, when they have occurred, they have been large, unpredictably episodic, and have long-lasting impacts to SRKW critical habitat.

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 salmon 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 Resident killer whales 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 (Ferrara et al. (2017).

All physical and biological features (or primary constituent elements) of estuarine, and nearshore marine critical habitat for the affected SRKW, Chinook salmon and bocaccio critical habitat have been degraded throughout the PS region. The causes for these losses of critical habitat value include human development, including diking, filling of wetlands and bays, channelization, nearshore and floodplain development. The continued growth contributes to the anthropogenic modification of the PS shorelines and is the major factor in the cumulative degradation and loss of nearshore and estuarine habitat. The development of shorelines includes bank hardening and the introduction of obstructions in the nearshore, each a source of structure and shade, which can interfere with juvenile salmonid migration, diminish aquatic food supply, and is a potential source of water pollution (Shipman et al. 2010; Morley et al. 2012; Fresh et al. 2011).

The degradation of multiple aspects of PS Chinook, PS/GB bocaccio, and SRKW critical habitat in the nearshore indicates that the conservation potential of the critical habitat is not being reached, even in areas where the conservation value of habitat is ranked high.

Table 5 provides a summary of critical habitat information for the species addressed in this opinion. More information can be found in the Federal Register notices available at NMFS' West Coast Region website (http://www.westcoast.fisheries.noaa.gov/).

Table 5. Critical habitat, designation date, federal register citation, and status summary for critical habitat considered in this opinion

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Puget Sound Chinook salmon	9/02/05 70 FR 52630	Critical habitat for Puget Sound Chinook salmon 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.
Puget Sound/Georgia Basin DPS of bocaccio	11/13/2014 79 FR68042	Critical habitat for bocaccio includes 590.4 square miles of nearshore habitat and 414.1 square miles of deepwater habitat. Critical habitat is not designated in areas outside of United States jurisdiction; therefore, although waters in Canada are part of the DPSs' ranges for all three species, critical habitat was not designated in that area. Based on the natural history of 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; 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 as specific threats to rockfish habitat in the Georgia Basin.
Southern resident killer whale	08/02/21 86 FR 41668	Critical habitat includes approximately 2,560 square miles of marine inland waters of Washington: 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. Six additional areas include 15,910 square miles of marine waters between the 20-feet (ft) (6.1-meter (m)) depth contour and the 656.2-ft (200-m) depth contour from the U.S. international border with Canada south to Point Sur, California. We have excluded the Quinault Range Site. Based on the natural history of the Southern Residents and their habitat needs, NMFS identified three PCEs, or physical or biological features, essential for the conservation of Southern Residents: 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 Water quality in Puget Sound, in general, is degraded. Some pollutants in Puget Sound persist and build up in marine organisms including Southern Residents and their prey resources, despite bans in the 1970s of some harmful substances and cleanup efforts. The primary concern for direct effects on whales from water quality is oil spills, although oil spills can also have long-lasting impacts on other habitat features In regards to passage, human activities can interfere with movements of the whales and impact their passage. In particular, vessels may present obstacles to whales' passage, causing the whales to swim further and change direction more often, which can increase energy expenditure for whales and impacts foraging behavior. Reduced prey abundance, particularly Chinook salmon, is also a concern for critical habitat.

2.2.2 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).

On October 4, 2019, NMFS published notice of NMFS' intent to initiate a new 5-year status review for 28 listed species of Pacific salmon and steelhead and requesting updated information from the public to inform the status review (84 FR 53117). On March 24, 2020, NMFS extended the public comment period, from the original March 27, 2020, through May 26, 2020 (85 FR 16619). The Northwest Fishery Science Center (NWFSC), and NMFS' West coast Regional Office (WCRO) are currently preparing the final status review documents, with anticipated completion in 2022. In this section, we utilize some of the information in the draft 2020 status review, in order to provide the most recent information for our evaluation in this Opinion.

Where possible, particularly as new material becomes available, the latest final (2016) status review information is supplemented with more recent information and other population specific data that may not have been available during the 2016 status review, so that NMFS is assured of using the best available information for this Opinion.

The summaries that follow describe the status of the ESA-listed species, and their designated critical habitats, that occur within the geographic area of the proposed projects 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 (Table 6).

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

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

Status of Puget Sound Chinook Salmon

The recovery plan for PS Chinook salmon 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). A critical component of recovery requires 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. 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 PS Chinook salmon ESU includes all naturally spawning populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. The PSTRT identified 22 extant populations, grouped into five major geographic regions, based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity. The PSTRT distributed the 22 populations among five major biogeographical regions, or major population groups (MPG), that are based on similarities in hydrographic, biogeographic, and geologic characteristics (Table 7).

Table 7. Extant PS Chinook salmon populations in each biogeographic region and percent change between the most recent two 5-year periods (2010-2014 and 2015-2019). Five-year geometric mean of raw natural-origin spawner counts. This is the raw total spawner estimate times the fraction natural-origin estimate, if available. In parentheses, 5-year geometric mean of raw total spawner estimates (i.e., hatchery and natural) are shown. A value only in parentheses means that a total spawner estimate was available but no (or only one) estimate of natural-origin spawners was available. The geometric mean was computed as the product of estimates raised to the power 1 over the number of counts available (2 to 5). A minimum of 2 values were used to compute the geometric mean. Percent change between the most recent two 5-year periods is shown on the far right (Ford, in press).

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

Since 1999, most PS Chinook populations have mean natural-origin spawner escapement levels well below levels identified as required for recovery to low extinction risk. Long-term, natural-origin mean escapements for eight populations are at or below their critical thresholds. Both populations in three of the five biogeographical regions are below or near their critical threshold: Georgia Strait, Hood Canal and Strait of Juan de Fuca. When hatchery spawners are included, aggregate average escapement is over 1,000 for one of the two populations in each of these three regions, reducing the demographic risk to the populations in these regions. Additionally, hatchery spawners help two of the remaining three of these populations achieve total spawner abundances above their critical threshold, reducing demographic risk. Nine populations are above their rebuilding thresholds, seven of them in the Whidbey/Main Basin Region. In 2018 NMFS and the NWFSC updated the rebuilding thresholds for several key Puget Sound populations. These thresholds represent the Maximum Sustained Yield estimate of spawners based on available habitat. The new spawner-recruit analyses for several populations indicated a significant reduction in the number of spawners that can be supported by the available habitat when compared to analyses conducted 10 to 15 years ago. This may be due to further habitat degradation or improved productivity assessment or, more likely, a combination of the two. For example, the updated rebuilding escapement threshold for the Green River is 1,700 spawners compared to the previous rebuilding escapement threshold of 5,523 spawners. So, although several populations are above the updated rebuilding thresholds, indicating that escapement is sufficient for the available habitat in many cases, the overall abundance has declined.

Abundance and Productivity.
The abundance of the PS Chinook salmon over time shows that individual populations have varied with increasing or decreasing abundance. Generally, many populations experienced increases in total abundance during the years 2000-2008, and more recently in 2015-2017, but general declines during 2009-2014, and a downturn again in the two most recent years available for the current status review, 2017-2018. Abundance across the Puget Sound ESU has generally increased since the last status review, with only 2 of the 22 populations (Cascade and North Fork and South Fork Stillaguamish) showing a negative percent change in the 5-year geometric mean natural- origin spawner abundances since the prior status review. However, 15 of 20 populations with positive percent change in the 5-year geometric mean natural-origin spawner abundances since the prior status review have relatively low population abundances of <1000 fish, so some of these increases represent small changes in total abundance (Ford in press). Also, given lack of high confidence in survey techniques, particularly with small populations, there is substantial uncertainty in quantifying fish and detecting trends in small populations (Gallagher et al. 2010).

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

Across the Puget Sound ESU, 10 of 22 Puget Sound populations show natural productivity below replacement in nearly all years since the mid-1980's. These include the North and South Forks Nooksack in the Strait of Georgia MPG, North and South Forks Stillaguamish and Skykomish in Whidbey Basin MPG, Sammamish, Green and Puyallup in the Central/South MPG, the Skokomish in the Hood Canal MPG, and Elwha in the Strait of Juan de Fuca MPG. Productivity in the Whidbey Basin MPG populations was above zero in the mid-late 1990's, with the exception of Skykomish and North and South Forks Stillaguamish populations. White River population in the Central/South MPG was above replacement from the early 1980's to 2001, but has dropped in productivity consistently since the late 1980's. In recent years, only 5 populations have had productivities above zero. These are Lower Skagit, Upper Skagit, Lower Sauk, Upper Sauk, and Suiattle, all Skagit River populations in the Whidbey Basin MPG. This is consistent with, and continues the decline reported in the 2015 Status Review (NWFSC 2015).

All Puget Sound Chinook salmon populations continue to remain well below recovery levels (Ford in press). Most populations also remain consistently below the spawner-recruit levels identified by the TRT as necessary for recovery. Across the ESU, most native-origin populations have slightly increased in abundance since the last status review in 2016, but have small negative trends over the past 15 years (Figure 10). Productivity remains low in most populations. Hatchery-origin spawners are present in high fractions in most populations outside the Skagit watershed, and in many watersheds the fraction of spawner abundances that are natural-origin have declined over time. Habitat protection, restoration and rebuilding programs in all watersheds have improved stream and estuary conditions despite record numbers of humans moving into the Puget Sound region in the past two decades. Bi-annual four year work plans document the many completed habitat actions that were initially identified in the Puget Sound Chinook salmon recovery plan. However, the expected benefits from restoration actions is likely to take years or decades to produce significant improvement in natural population viability parameters (see Roni et al. 2010).

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

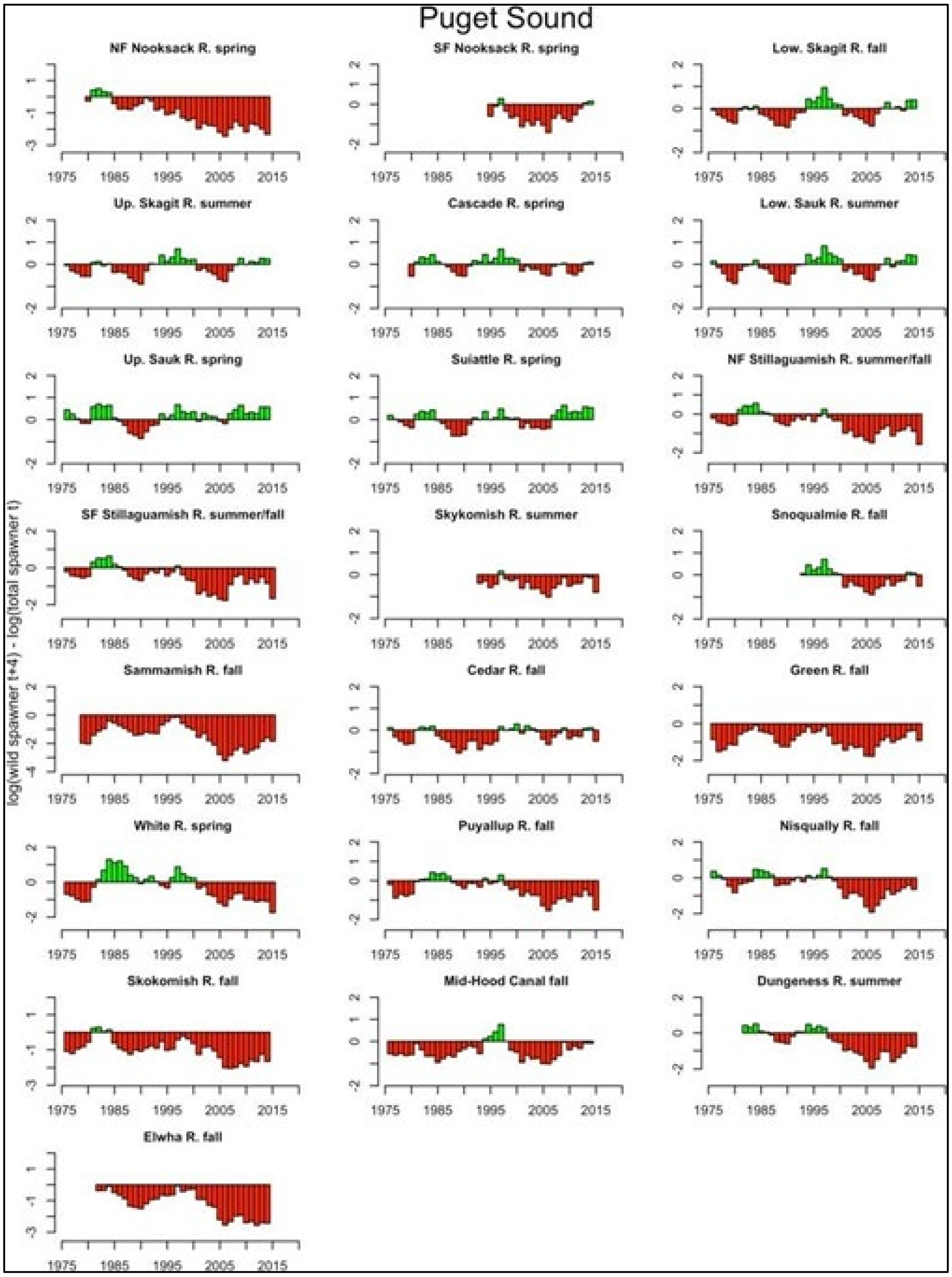

Figure 10. Trends in population productivity, estimated as the log of the smoothed natural-origin spawning abundance in year t – smoothed natural-origin spawning abundance in year (t – 4) (Ford in press).

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

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

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

- Increase the function and capacity of nearshore and marine habitats to support key needs of salmon;
- Protect and restore shallow, low velocity, fine substrate habitats along marine shorelines, including eelgrass beds and pocket estuaries, especially adjacent to major river deltas;
- Protect and restore riparian areas;
- Protect and restore estuarine habitats of major river mouths;
- Protect and restore spawning areas and critical rearing and migration habitats for forage fish;
- Protect and restore drift cell processes (including sediment supply, e.g., from feeder bluffs, transport, and deposition) that create and maintain nearshore habitat features such as spits, lagoons, bays, beaches.

Development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of marine habitat for PS Chinook salmon. Projected changes in nearshore and estuary development based on documented rates of developed land cover change in Bartz et al. (2015) show that between 2008 and 2060, an additional 14.7 hectares of development of shoreline areas and 204 hectares of estuary development can be expected.

Based on the current conditions described in the BAR and our current understanding of the nearshore environment throughout the Puget Sound, improved habitat conditions in the action areas would benefit PS Chinook salmon and help move the species towards recovery as described in the recovery plan documents.

Status of Puget Sound Steelhead

The PS steelhead DPS was listed as a threatened species under the ESA on May 11, 2007 (72 FR 26722) (Table 6). Subsequent status assessments of the DPS after the ESA-listing decision have found that the status of PS steelhead regarding risk of extinction has not changed substantially (Ford et al. 2011; NMFS 2016a) (81 FR 33468, May 26, 2016) (Ford, in press). As mentioned above in the PS Chinook status review section, on October 4, 2019 NMFS published a Federal Register notice (84 FR 53117), announcing NMFS' intent to initiate a new 5-year status review for 28 listed species of Pacific salmon and steelhead and requesting updated information from the public to inform the most recent five-year status review. On March 24, 2020, NMFS extended the public comment period, from the original March 27, 2020, through May 26, 2020 (85 FR 16619). The NWFSC and the NMFS' WCR are currently preparing the final five-year status review documents, with anticipated completion in 2022.

At the time of listing the Puget Sound steelhead Biological Review Team (BRT) considered the major risk factors associated with spatial structure and diversity of PS steelhead to be: (1) the low abundance of several summer run populations; (2) the sharply diminishing abundance of some winter steelhead populations, especially in south Puget Sound, Hood Canal, and the Strait of Juan de Fuca; and (3) continued releases of out-of-ESU hatchery fish from Skamania-derived summer run and Chambers Creek-derived winter run stocks (Hard et al. 2007; Hard et al. 2015). Loss of diversity and spatial structure were judged to be "moderate" risk factors (Hard et al. 2007). In 2011 the BRT identified degradation and fragmentation of freshwater habitat, with consequential effects on connectivity, as the primary limiting factors and threats facing the PS steelhead DPS (Ford et al. 2011). The BRT also determined that most of the steelhead populations within the DPS continued to show downward trends in estimated abundance, with a few sharp declines (Ford et al. 2011). The 2015 status review concurred that harvest and hatchery production of steelhead in Puget Sound were at low levels and not likely to increase substantially in the foreseeable future, thus these risks have been reduced since the time of listing. However, unfavorable environmental trends previously identified (Ford et al. 2011) were expected to continue (Hard et al. 2015).

In this Opinion, where possible, the 2015 status review information is supplemented with information and other population specific data available considered during the drafting of the 2020 five year status review for PS steelhead.

Spatial Structure and Diversity.
The PS steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations originating below natural and manmade impassable barriers from rivers flowing into Puget Sound from the Elwha River (inclusive) eastward, including rivers in Hood Canal, South Sound, North Sound and the Strait of Georgia. Non-anadromous ‘‘resident’’ *O. mykiss* occur within the range of PS steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (Hard et al. 2007). In October of 2016, NMFS proposed revisions to the hatchery programs included as part of Pacific salmon ESUs and steelhead DPSs listed under the ESA (81 FR 72759). NMFS issued its final rule in December of 2020 (85 FR 81822). This final rule includes steelhead from five artificial propagation programs in the PS steelhead DPS: the Green River Natural Program; White River Winter Steelhead Supplementation Program; Hood Canal Steelhead Supplementation Program; the Lower Elwha Fish Hatchery Wild Steelhead Recovery Program; and the Fish Restoration Facility Program. (85 FR 81822, December 17, 2020).

In 2013, the PSSTRT completed its evaluation of factors that influence the diversity and spatial structure VSP criteria for steelhead in the DPS. For spatial structure, this included the fraction of available intrinsic potential rearing and spawning habitat that is occupied compared to what is needed for viability[6]. For diversity, these factors included hatchery fish production, contribution of resident fish to anadromous fish production, and run timing of adult steelhead. Quantitative information on spatial structure and connectivity was not available for most PS steelhead populations, so a Bayesian Network framework was used to assess the influence of these factors on steelhead viability at the population, MPG, and DPS scales (Hard et al. 2015). The PSSTRT concluded that low population viability was widespread throughout the DPS and populations showed evidence of diminished spatial structure and diversity. Specifically, population viability associated with spatial structure and diversity was highest in the Northern Cascades MPG and lowest in the Central and South Puget Sound MPG (PSSTRT 2013). Diversity was generally

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

higher for populations within the Northern Cascades MPG, where more variability in viability was expressed and diversity generally higher, compared to populations in both the Central and South Puget Sound and Hood Canal and Strait of Juan de Fuca MPG, where diversity was depressed and viabilities were generally lower (NWFSC 2015). Most PS steelhead populations were given intermediate scores for spatial structure and low scores for diversity because of extensive hatchery influence, low breeding population sizes, and freshwater habitat fragmentation or loss (NWFSC 2015). The PSSTRT concluded that the Puget Sound DPS was at very low viability, considering the status of all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). For spatial structure there were a number of events that occurred in Puget Sound during the last review period (2015-2019) that are anticipated to improve status populations within several of the MPGs within the DPS (Ford, in press).

Since the PSSTRT completed its 2013 review, the only additional spatial structure and diversity data that have become available have been estimates of the fraction of hatchery fish on the spawning grounds (NWFSC 2015). Since publication of the NWFSC report in 2015, and drafting of the 2020 NWFSC biological viability risk assessment (Ford, in press), reductions in hatchery programs founded from non-listed and out of DPS stocks (i.e., Skamania) have occurred. In addition, the fraction of out of DPS hatchery steelhead spawning naturally are low for many rivers (NWFSC 2015; NMFS 2016d; 2016e). The fraction of natural-origin steelhead spawners was 0.9 or greater for the 2005-2009 and 2010-2014 time periods for all populations where data was available, but the Snoqualmie and Stillaguamish Rivers. For 17 of 22 DIPs across the DPS, the five-year average for the fraction of natural-origin steelhead spawners exceeded 0.75 from 2005 to 2009; this average was near 1.0 for 8 populations, where data were available, from 2010 to 2014 (NWFSC 2015). However, the fraction of natural-origin steelhead spawners could not be estimated for a substantial number of DIPs during the 2010 to 2014 period, or for the most recent 2015 – 2019 timeframe (NWFSC 2015; Ford, in press). In some river systems, such as the Green River, Snohomish/Skykomish Rivers, and the Stillaguamish Rivers these estimates were higher than some guidelines recommend (e.g., no more than 5 percent hatchery-origin spawners on spawning grounds for isolated hatchery programs (HSRG 2009) over the 2005-2009 and 2010-2014 timeframes. The draft 2020 NWFSC biological viability risk assessment (Ford, in press) states that a third of the 32 PS steelhead populations continue to lack monitoring and abundance data, and in most cases it is likely that abundances are very low.

Early winter-run fish produced in isolated hatchery programs are derived from Chambers Creek stock in southern Puget Sound, which has been selected for early spawn timing, a trait known to be inheritable in salmonids.[7] Summer-run fish produced in isolated hatchery programs were historically derived from the Skamania River summer stock in the lower Columbia River Basin (i.e., from outside the DPS). The production and release of hatchery fish of both run types (winter and summer) may continue to pose risk to diversity in natural-origin steelhead in the DPS, as described in Hard et al. (2007) and Hard et al. (2015). However, the draft 2020 NWFSC biological viability risk assessment (Ford, in press) states that risks to natural-origin PS steelhead

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

that may be attributable to hatchery-related effects has decreased since the 2015 status review due to reductions in production of non-listed stocks, and the replacement with localized stocks. The three summer steelhead programs continuing to propagate Skamania derived stocks from outside of Puget Sound should be phased out completely by 2031 (NMFS 2019c; Ford, in press).

Abundance and Productivity.
The viability of the PS steelhead DPS has improved somewhat since the PSSTRT concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). Increases in spawner abundance have been observed in a number of populations over the last five years; however, these improvements were disproportionately found within the South and Central Puget Sound and Strait of Juan de Fuca and Hood Canal MPGs, and primarily among smaller populations. The recent positive trends among winter-run populations in the White, Nisqually, and Skokomish rivers improve the demographic risks facing those populations. The abundance, productivity, spatial structure, and diversity of Elwha River steelhead winter and summer-runs has dramatically improved following the removal of the Elwha River dams. Improvements in abundance have not been as widely observed in the Northern Puget Sound MPG. The declines of summer and winter-run populations in the Snohomish Basin are especially concerning. These populations figure prominently as sources of abundance for the MPG and DPS (NMFS 2019d). Additionally, the decline in the Tolt River summer-run steelhead population was especially alarming given that it is the only summer-run population for which we have abundance estimates. The demographic and diversity risks to the Tolt River summer-run DIP are very high. In fact, all summer-run steelhead populations in the North Cascades MPG are likely at a very high demographic risk. In spite of improvements in some areas, most populations are still at relatively low abundance levels, with about a third of the DIPs unmonitored and presumably at very low levels (Ford in press).

The PSSTRT was reconvened by NOAA Fisheries and convened in March 2014 to develop a Recovery Plan for the PS steelhead DPS. This Recovery Plan was finalized in December 2019 (NMFS 2019d). Recovery targets were calculated using a two-tiered approach adjusting for years of low and high productivity. Abundance information is unavailable for approximately one-third of the DIPs, disproportionately so for summer-run populations. In most cases where no information is available it is assumed that abundances are very low. Some population abundance estimates are only representative of part of the population (index reaches, etc.). Where recent five-year abundance information is available, 30 percent (6 of 20 populations) are less than 10 percent of their high productivity recovery targets (lower abundance target), 65 percent (13 of 20) are between 10 and 50 percent, and 5 percent (1 of 20) are greater than 50 percent of their low abundance targets (Table 8). A key element to achieving recovery is recovering a representative number of both winter- and summer-run steelhead populations, and the restoration of viable summer-run DIPs is a long-term endeavor (NMFS 2019d). Fortunately, the relatively rapid reestablishment of summer-run steelhead in the Elwha River does provide a model for potentially re-anadromizing summer-run steelhead sequestered behind impassable dams.

Table 8. Recent (2015-2019) 5-year geometric mean of raw wild spawner counts for Puget Sound steelhead populations and population groups compared with Puget Sound Steelhead Recovery Plan high and low productivity recovery targets (NMFS 2019). (SR) – Summer-run. Abundance is compared to the high productivity individual DIP targets. Colors indicate the relative proportion of the recovery target currently obtained: red (<10%), orange (10%>x<50%), yellow (50%>x<100%), green (>100%). "*" denotes an interim recovery target.

Major Population Group	Demographically Independent Population	Recent Abundance (2015-2019)	Recovery Target	
			High Productivity	Low Productivity
Northern Cascades	Drayton Harbor Tributaries	N/A	1,100	3,700
	Nooksack River	1,906	6,500	21,700
	South Fork Nooksack River (SR)	N/A	400	1,300
	Samish River & Independent Tributaries	1,305	1,800	6,100
	Skagit River	7,181	15,000 *	
	Sauk River	N/A		
	Nookachamps River	N/A		
	Baker River	N/A		
	Stillaguamish River	487	7,000	23,400
	Canyon Creek (SR)	N/A	100	400
	Deer Creek (SR)	N/A	700	2,300
	Snohomish/Skykomish River	690	6,100	20,600
	Pilchuck River	638	2,500	8,200
	Snoqualmie River	500	3,400	11,400
	Tolt River (SR)	40	300	1,200
	North Fork Skykomish River (SR)	N/A	200	500
Central and South Sound	Cedar River	N/A	1,200	4,000
	North Lake Washington Tributaries	N/A	4,800	16,000
	Green River	1,282	5,600	18,700
	Puyallup/Carbon River	136	4,500	15,100
	White River	130	3,600	12,000
	Nisqually River	1,368	6,100	20,500
	East Kitsap Tributaries	N/A	2,600	8,700
	South Sound Tributaries	N/A	6,300	21,200
Strait of Juan de Fuca	Elwha River	1,241	2,619	
	Dungeness River	408	1,200	4,100
	Strait of Juan de Fuca Independent Tributaries	95	1,000	3,300
	Sequim and Discovery Bay Tributaries	N/A	500	1,700
	Skokomish River	958	2,200	7,300

Major Population Group	Demographically Independent Population	Recent Abundance (2015-2019)	Recovery Target	
			High Productivity	Low Productivity
	West Hood Canal Tributaries	150	2,500	8,400
	East Hood Canal Tributaries	93	1,800	6,200
	South Hook Canal Tributaries	91	2,100	7,100

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

Improvements in spatial structure can only be effective if done in concert with necessary improvements in habitat. Habitat restoration efforts are ongoing, but land development and habitat degradation concurrent with increasing human population in the Puget Sound corridor results in a continuing net loss of habitat. Recovery efforts in conjunction with improved ocean and climatic conditions have resulted in improved viability status for the majority of populations in this DPS; however, absolute abundances are still low, especially summer-run populations, and the DPS remains at high to moderate risk of extinction. However, since 2015, fifteen of the 21 populations indicate small to substantive increases in abundance. However, most steelhead populations remain small. From 2015 to 2019, nine of the 21 steelhead populations had fewer than 250 natural spawners annually, and 12 of the 21 steelhead populations had 500 or fewer natural spawners (Table 9).

Table 9. Five-year geometric mean of raw natural spawner counts for PS steelhead. In parentheses, 5-year geometric mean of raw total spawner counts is shown. Percent change between the most recent two 5-year periods is shown on the far right column (Ford, in press).

Biogeographic Region	Population	2010-2014	2015-2019	Population trend (% Change)
North Cascades	Samish R./ Bellingham Bay Tribs. (W)	748	1305	**Positive (74)**
	Nooksack R. (W)	1745	1906	**Positive (9)**
	Skagit R. (S and W)	6391	7181	**Positive (12)**
	Stillaguamish R. (W)	386	487	**Positive (26)**
	Snohomish/ Skykomish R. (W)	975	690	**Negative (-29)**
	Pilchuck R. (W)	626	638	**Positive (2)**
	Snoqualmie R. (W)	706	500	**Negative (-29)**
	Tolt R. (S)	108	40	**Negative (-63)**
Central/South Puget Sound Basin	N. Lake WA Tribs. (W)	-	-	-
	Cedar R. (W)	4	6	**Positive (50)**
	Green R. (W)	662	1289	**Positive (95)**
	White R. (W)	514	451	**Negative (-12)**
	Puyallup R. (W)	85	201	**Positive (136)**
	Carbon R. (W)	(290)	(735)	**Positive (153)**
	Nisqually R. (W)	477	1368	**Positive (187)**
Hood Canal/Strait of Juan de Fuca	S. Hood Canal (W)	69	91	**Positive (32)**
	Eastside Hood Canal Tribs (W)	60	93	**Positive (55)**
	Skokomish R. (W)	533	958	**Positive (80)**
	Westside Hood Canal Tribs (W)	138	150	**Positive (9)**
	Dungeness R. (S and W)	517	448	**Negative (-13)**
	Strait of Juan de Fuca Independents (W)	151	95	**Negative (-37)**
	Elwha R. (W)	680	1241	**Positive (82)**

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

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

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

Juvenile PS steelhead are less dependent on nearshore habitats for early marine rearing than Chinook or Chum Salmon; nevertheless, nearshore, estuarine, and shoreline habitats provide important features necessary for the recovery of steelhead. PS steelhead spend only a few days to a few weeks migrating through the large fjord, but mortality rates during this life stage are critically high (Moore et al. 2010; Moore and Berejikian 2017). Early marine mortality of PS steelhead is recognized as a primary limitation to the species' survival and recovery (NMFS 2019d). 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).

In the recovery plan, NMFS and the PSSTRT modified the 2013 and 2015 PSSTRT viability criteria to produce the viability criteria for PS steelhead, as described below:

- All three MPGs (North Cascade, Central-South Puget Sound, and Hood Canal-Strait of Juan de Fuca) (Figure 5) must be viable (Hard et al. 2015). The three MPGs differ substantially in key biological and habitat characteristics that contribute in distinct ways to the overall viability, diversity, and spatial structure of the DPS.
- There must be sufficient data available for NMFS to determine that each MPG is viable.

The recovery plan also established MPG-level viability criteria. The following are specific criteria are required for MPG viability:

- At least 50 percent of steelhead populations in the MPG achieve viability.
- Natural production of steelhead from tributaries to Puget Sound that are not identified in any of the 32 identified populations provides sufficient ecological diversity and productivity to support DPS-wide recovery.
- In addition to the minimum number of viable DIPs (50 percent) required above, all DIPs in the MPG must achieve an average MPG-level viability that is equivalent to or greater than the geometric mean (averaged over all the DIPs in the MPG) viability score of at least 2.2 using the 1–3 scale for individual DIPs described under the DIP viability discussion in the PSSTRT Viability Criteria document (Hard et al. 2015). This criterion is intended to ensure that MPG viability is not measured (and achieved) solely by the strongest DIPs, but also by other populations that are sufficiently healthy to achieve MPG-wide resilience. The Plan allows for an alternative evaluation method to that in Hard et al. (2015) may be developed and used to assess MPG viability.
- The plan also identified specific DIPs in each of the three MPGs which must attain viability NMFS 2019d).

Based on the current conditions described in the BAR and our current understanding of the nearshore environment throughout the Puget Sound, improved habitat conditions in the action areas would benefit PS steelhead and help move the species towards recovery as described in the 2019 recovery plan document.

Status of Puget Sound/Georgia Basin Bocaccio

NMFS adopted a recovery plan for PS/GB bocaccio rockfish in 2017. Extinction risk factors identified in the plan include loss of nearshore habitat (NMFS, 2017). Larval and newly settled bocaccio commonly rely on nearshore habitat. The nearshore is generally defined as habitats contiguous with the shoreline from extreme high water out to a depth no greater than 98 feet (30 m) relative to mean lower low water. This area generally coincides with the maximum depth of the photic zone of West Coast waters and contains physical or biological features essential to the conservation of many fish and invertebrate species, including PS/GB bocaccio. Approximately 27 percent of Puget Sound’s shoreline has been modified by armoring, altering sediment budget, wrack accumulation, and other biophysical processes, and in south-central Puget Sound over 60 percent of the shoreline is armored (Simenstad et al. 2011; Whitman 2011; Dethier et al. 2016).

Nearshore habitats throughout the greater Puget Sound region have been affected by a variety of human activities, including agriculture, heavy industry, timber harvest, and the development of sea ports and residential property (Drake et al. 2010).

There are no published estimates of historic or present-day abundance of bocaccio across the full DPSs area. Though PS/GB bocaccio were never a predominant segment of the multi-species rockfish population within the PS/GB, their present-day abundance is likely a fraction of their pre-contemporary fishery abundance (Tonnes et al. 2016). 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 2017). 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 (Pacunski et al.2013). The apparent reduction of populations of PS/GB bocaccio in the Main Basin and South Sound represents a further reduction in the historically spatially limited distribution of bocaccio, and adds significant risk to the viability of the DPS.

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

The 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.

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

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

Spatial Structure and Diversity.

The PS/GB bocaccio DPS includes all bocaccio from inland marine waters east of the central Strait of Juan de Fuca and south of the northern Strait of Georgia, collectively known as the Salish Sea. The waters of Puget Sound and Straits of Georgia can be divided into five interconnected basins that are largely hydrologically isolated from each other by relatively shallow sills (Burns 1985; Drake et al. 2010). The basins within US waters are: (1) San Juan, (2) Main, (3) South Sound, and (4) Hood Canal. The fifth basin consists of Canadian waters east and north of the San Juan Basin into the Straits of Georgia (Tonnes et al. 2016). Although most individuals of the PS/GB bocaccio DPS are believed to remain within the basin of their origin, including larvae and pelagic juveniles, some movement between basins occurs, and the DPS is currently considered a single population. Research intended to assess this assumption using genetic techniques was unable to collect sufficient samples for analysis (Andrews et al. 2018), but is ongoing.

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

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

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

Based on the current conditions described in the BAR and our current understanding of the nearshore environment throughout the Puget Sound, improvement of habitat in the action areas would benefit PS/GB bocaccio and may help move the species towards recovery as described in the 2017 recovery plan (NMFS 2017).

Southern Resident Killer Whale
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). The most recent 5-year review was completed in 2021 and also concluded that SRKW should remain listed as endangered and the DPS is currently experiencing a downward trend and has not met many of the recovery criteria outlined in the Final Recovery Plan (NMFS 2021).

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

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

reproduction unlike other resident killer whale populations that have generally been increasing since the 1970s (Carretta et al. 2021).

Abundance and Productivity.

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

Since the early 1970s, annual summer censuses in the Salish Sea using photo-identification techniques have occurred (Bigg et al. 1990; Center for Whale Research 2021). The population of SRKW was at its lowest known abundance in the early 1970s following live-captures for aquaria display (n = 68). The highest recorded abundance since the 1970s was in 1995 (98 animals), though the population declined from 1995-2001 (from 98 whales in 1995 to 81 whales in 2001). The population experienced a growth between 2001 and 2006 and has been generally declining since then. However, in 2014 and 2015, the SRKW population increased from 78 to 81 as a result of multiple successful pregnancies (n = 9) that occurred in 2013 and 2014. At present, the SRKW population has declined to near historically low levels. As of September 2021, the population is 74 whales, including 24 whales in J pod, 17 whales in K pod, and 33 whales in L pod, including two calves born to J pod in September 2020 and one new calf to the L pod in February 2021 (Center for Whale Research 2021).. The previously published historical estimated abundance of SRKW is 140 animals (NMFS 2008). 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.

Based on an updated pedigree from new genetic data, many of the offspring in recent years were sired by two fathers, meaning that less than 30 individuals make up the effective reproducing portion of the population. Because a small number of males were identified as the fathers of many offspring, a smaller number may be sufficient to support population growth than was previously thought (Ford et al. 2011; Ford et al. 2018). However, the consequence of this means inbreeding may be common amongst this small population, with a recent study by Ford et al. (2018) finding several offspring resulting from matings between parents and their own offspring. The fitness effects of this inbreeding remain unclear and are an effort of ongoing research (Ford et al. 2018).

Seasonal mortality rates among Southern and Northern Resident whales may be highest during the winter and early spring, based on the numbers of animals missing from pods returning to inland waters each spring and standings data. Olesiuk et al. (2005) identified high neonatal mortality that occurred outside of the summer season, and multiple new calves have been documented in winter months that have not survived the following summer season (Center for Whale Research, unpublished data). Stranding rates are higher in winter and spring for all killer whale forms in Washington and Oregon (Norman et al. 2004) and a recent review of killer whale strandings in the northeast Pacific provided insight into health, nutritional status and causes of mortality for all killer whale ecotypes (Raverty et al. 2020).

The Northwest Fisheries Science Center (NWFSC) continues to evaluate changes in fecundity and mortality rates, and has updated the population viability analyses conducted for the 2004 Status Review for SRKWs and the 2011 science panel review of the effects of salmon fisheries (Krahn et al. 2004; Hilborn et al. 2012; Ward et al. 2013) and the most recent 5-year review (NMFS 2021). The updated analysis[9] described the recent changes in population size and age structure, change in demographic rates over time, and updated projections of population viability (Ward 2019). According to Ward (2019), the model results indicate that fecundity rates have declined and have changed more than male or female survival since 2010. Ward (2019) performed a series of projections: (1) projections using fecundity and survival rates estimated over the long term data series (1985 to 2019); (2) projections using fecundity and survival rates from the most recent 5 year period (2014 to 2019); and (3) projections using the highest fecundity and survival rates estimated (in the period 1985 to 1989). The most optimistic scenario, using demographic rates calculated from the 1985 to1989 period, has a trajectory that increases and eventually declines after 2030, while the scenario with long-term demographic data, or the scenario only including the most recent years' demographic data, project declines. Additional runs for this scenario (1985 to1989 data) indicated a similar trajectory with a 50:50 sex ratio. Thus, the downward trends are likely driven by the current age and sex structure of young animals in the population (from 2011-2016 new births were skewed slightly toward males with 64 percent male), as well as the number of older animals (Ward 2019). As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates. The downward trend is in part due to the changing age and sex structure of the population. If the population of SRKW experiences demographic rates (e.g. fecundity and mortality) that are more similar to 2016 than the 5-year average from 2011 to 2016, the population will decline faster as shown in Figure 11 (NMFS 2016b). There are several demographic factors of the SRKW population that are cause for concern, namely (1) reduced fecundity; (2) a skewed sex ratio toward male births in recent years; (3) a lack of calf production from certain components of the population (e.g. K pod); (4) a small number of adult males acting as sires (Ford et al. 2018); and (5) an overall small number of individuals in the population (NMFS 2016b).

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

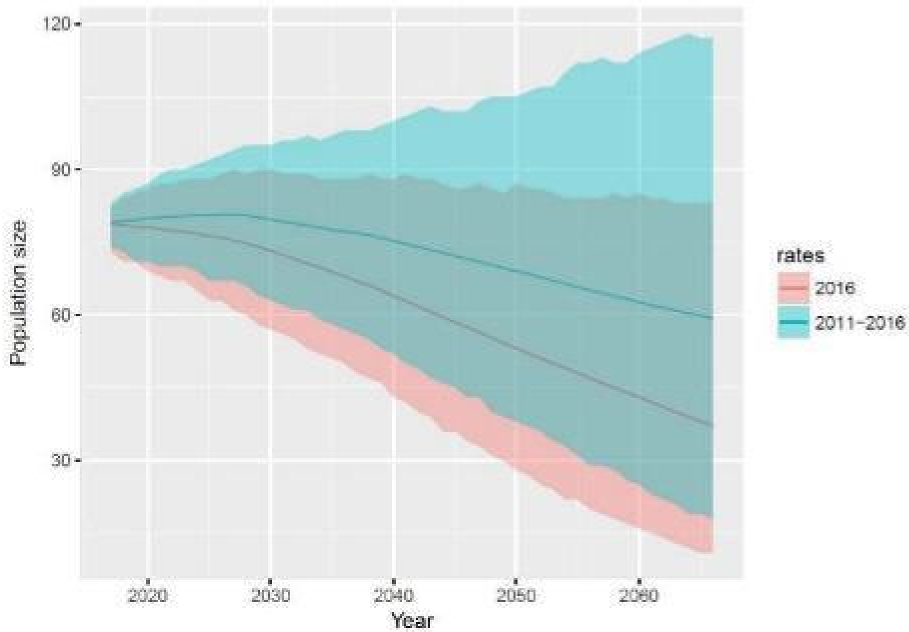

Figure 11. SRKW population size projections from 2016 to 2066 using two scenarios: (1) projections using demographic rates held at 2016 levels, and (2) projections using demographic rates from 2011 to 2016. The pink line represents the projection assuming future rates are similar to those in 2016, whereas the blue represents the scenario with future rates being similar to 2011 to 2016 (NMFS (2016b).

Because of the whales' small population size, the population is also susceptible to increased risks of demographic stochasticity—randomness in the pattern of births and deaths among individuals in a population. Several sources of demographic variance (e.g. differences between individuals or within individuals) can affect small populations and contribute to variance in a population's growth and increased extinction risk. Sources of demographic variance can include environmental stochasticity, or fluctuations in the environment that drive changes in birth and death rates, and demographic heterogeneity, or variation in birth or death rates of individuals because of differences in their individual fitness (including sexual determinations). In combination, these and other sources of random variation combine to amplify the probability of extinction, known as the extinction vortex (Gilpin and Soulé 1986; Fagan and Holmes 2006; Melbourne and Hastings 2008). The larger the population size, the greater the buffer against stochastic events and genetic risks.

Population-wide distribution of lifetime reproductive success of SRKWs can be highly variable, such that some individuals produce more offspring than others to subsequent generations, and male variance in reproductive success can be greater than that of females (e.g. Clutton-Brock 1998; Hochachka 2006). For long-lived vertebrates such as killer whales, some females in the population might contribute less than the number of offspring required to maintain a constant population size (n = 2), while others might produce more offspring. The smaller the population, the more weight an individual's reproductive success has on the population's growth or decline

(Coulson et al. 2006). For example, the overall number of reproductive females has been fluctuating between 25 and 35 for most of the last 40 years, and there have been contrasting changes by pod, with declines in L pod females and increases in J pod (Ward 2019). At the start of the survey in 1976, the distribution of females was skewed toward younger ages with few older, post-reproductive females. The distribution in recent years is more uniform across female ages (in other words, more females in their 30s, (Ward 2019)). However, from 2014 through July 2019, only 7 calves were born and survived (3 in J pod and 4 in L pod) (Ward 2019). In a novel study, researchers collected SRKW feces to measure pregnancy hormones (progesterone and testosterone) (Wasser et al. 2017). The fecal hormone data showed that up to 69 percent of the detected pregnancies do not produce a documented calf, and an unprecedented half of those losses occurred relatively later in the pregnancy when energetic costs and physiological risk to the mother are higher (Wasser et al. 2017). Recent aerial imagery corroborates this high rate of loss (Fearnbach and Durban unpubl. data). The congruence between the rate of loss estimates from fecal hormones and aerial photogrammetry suggests the majority of the loss is in the latter half of pregnancy when photogrammetry can detect anomalous shape after several months of gestation (Durban et al. 2016). Although the rates of successful pregnancies in wild killer whale populations is generally unknown, a relatively high level of reproductive failure late in pregnancy is uncommon in mammalian species and suggests there may be cause for concern.

Geographic Range and Distribution. SRKWs occur throughout the coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (NMFS 2008; Carretta et al. 2021; Ford et al. 2017) (Figure 12). 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).

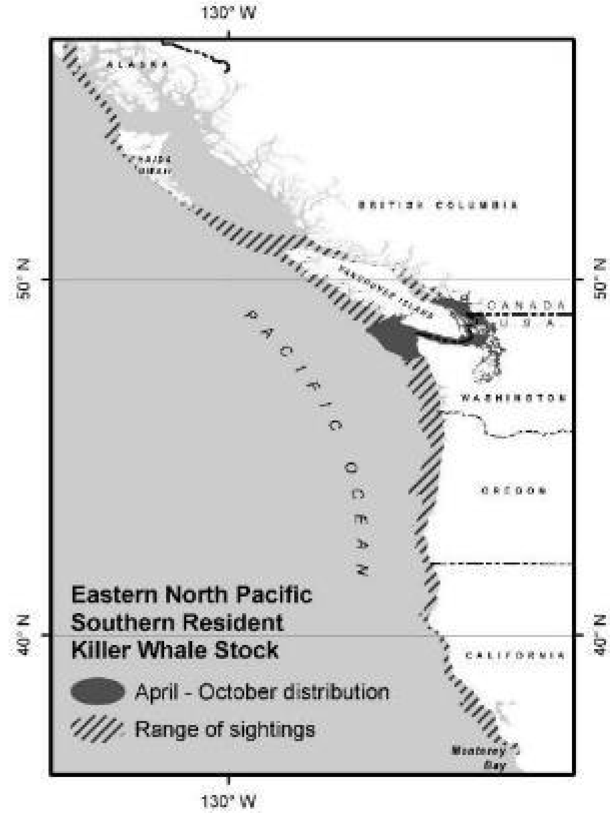

Figure 12. Approximate April–October distribution of SRKW (shaded area) and range of sightings (diagonal lines) (reprinted from Carretta et al. 2021).

Land- and vessel-based opportunistic and survey-based visual sightings, satellite tracking, and passive acoustic research conducted have provided an updated estimate of the whales' coastal range that extends from the Monterey Bay area in California, north to Chatham Strait in southeast Alaska. Since 1975, confirmed and unconfirmed opportunistic SRKW sightings from the general public or researchers have been collected off British Columbia, Washington, Oregon, and California. Because of the limitations of not having controlled and dedicated sampling efforts, these confirmed opportunistic sightings have provided only general information on the whales' potential geographic range during this period of time (*i.e.,* there are no data to describe the whales' general geographic range prior to 1975). Together, these SRKW sightings have confirmed their presence as far north as Chatham Strait, southeast Alaska and as far south as Monterey Bay, California (NMFS 2019b).

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

Over the course of the study, the eight satellite tags deployed were monitored for a range of signal contact durations from 3 days to 96 days depending on the tag, with deployment from late December to mid-May (Table 10). The winter locations of the tagged whales included inland and coastal waters. The inland waters range occurs across the entire Salish Sea, from the northern end of the Strait of Georgia and Puget Sound, and coastal waters from central west coast of Vancouver Island, British Columbia to northern California (Hanson et al. 2017). The tagging data from 2012 to 2016 provided general information on the home range and overlap of each pod, and areas that are used more frequently than others by each pod. Specifically, J pod had high use areas (defined as 1 to 3 standard deviations) in the northern Strait of Georgia and the west entrance to the Strait of Juan de Fuca where they spent approximately 30 percent of their time there (Figure 13), but they spent relatively little time in other coastal areas. K/L pods occurred almost exclusively on the continental shelf during December to mid-May, primarily on the Washington coast, with a continuous high use area between Grays Harbor and the Columbia River and off Westport and spending approximately 53 percent of their time there (Figure 14) (Hanson et al. 2017, 2018). These differences resulted in generally minimal overlap between J pod and K/L pods, with overlap in high use areas near the Strait of Juan de Fuca western entrance for only a total area of approximately 200 km2, which comprised only 0.5 percent of the three pods' ranges.

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

Table 10. Satellite-linked tags deployed on SRKW 2012-2016. (Hanson et al. 2018). This was part of a collaborative effort between NWFSC, Cascadia Research Collective, and the University of Alaska.

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

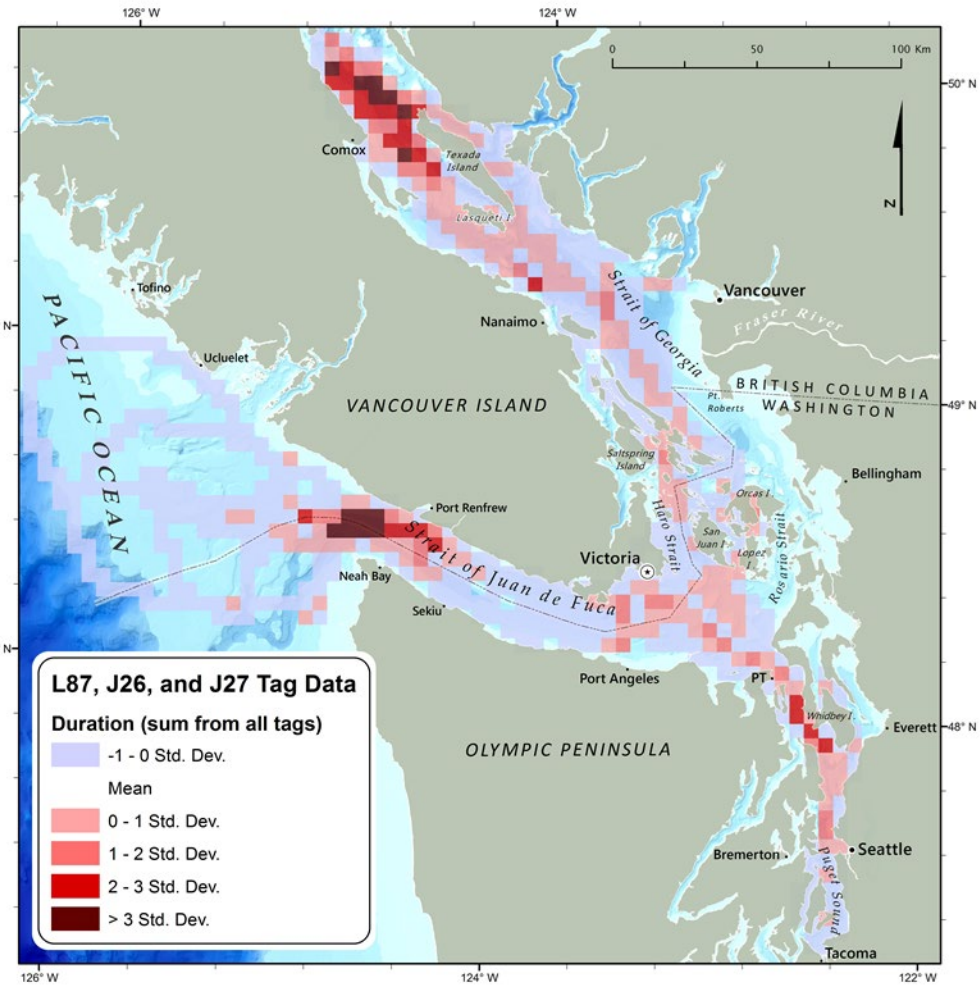

Figure 13. Duration of occurrence model output for J pod tag deployments (Hanson et al. 2017). "High use areas" are illustrated by the 0 to > 3 standard deviation pixel**.** Duration of occurrence model for all unique K and L pod tag deployments (Hanson et al. 2017). "High use areas" are illustrated by the 0 to > 3 standard deviation pixels.

Passive acoustic recorders were deployed off the coasts of California, Oregon and Washington in most years since 2006 to assess their seasonal uses of these areas via the recording of stereotypic calls of the SRKW (Hanson et al. 2013; Emmons et al. 2019). Passive aquatic listeners (PALs) were originally deployed from 2006–2008. Since 2008, four to seventeen Ecological Acoustic Recorders have been deployed. From 2006–2011, passive acoustic listeners and recorders were deployed in areas thought to be of frequent use by SRKWs based on previous sightings, where enhanced productivity was expected to be concentrated, and in areas with a reduced likelihood of fisheries interactions (Hanson et al. 2013). The number of recorder sites off the Washington coast increased from 7 to 17 in the fall of 2014 and locations were selected based on "high use areas" identified in the duration of an occurrence model (Figure 15), 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 16), 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).

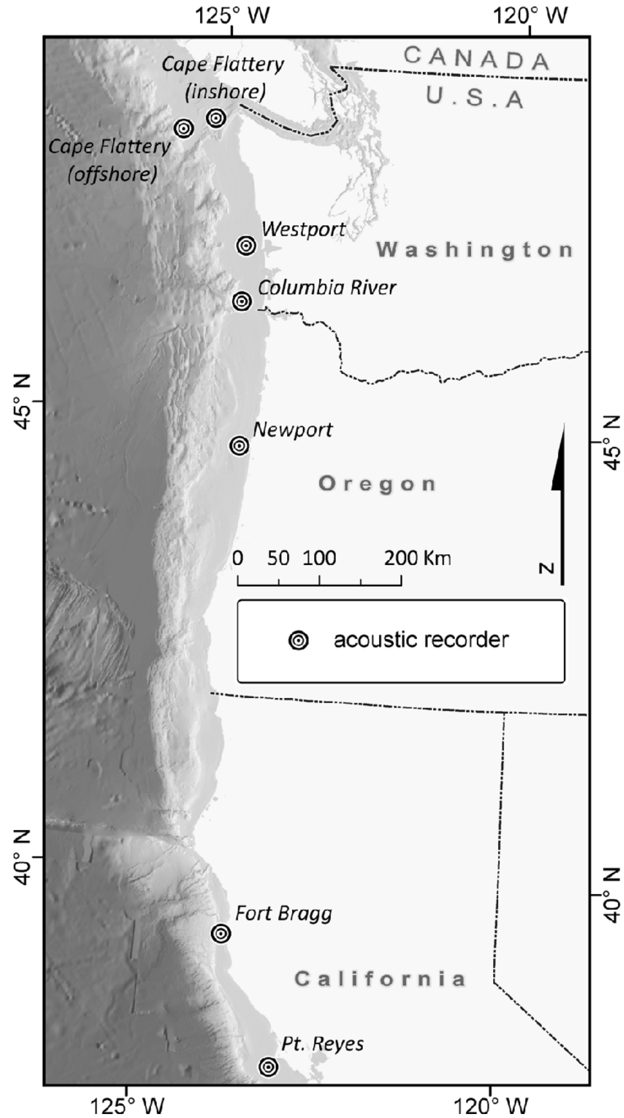

Figure 14. Deployment locations of acoustic recorders on the U.S. west coast from 2006 to 2011 (Hanson et al. 2013).

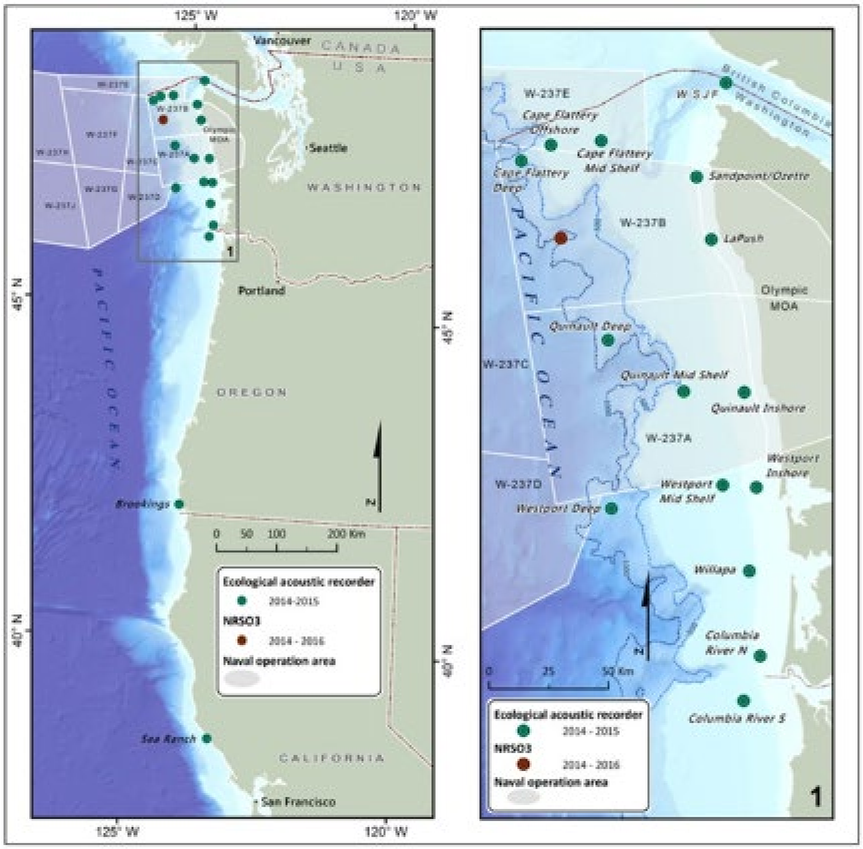

Figure 15. Locations of passive acoustic recorders deployed beginning in the fall of 2014 (Hanson et al. 2017).

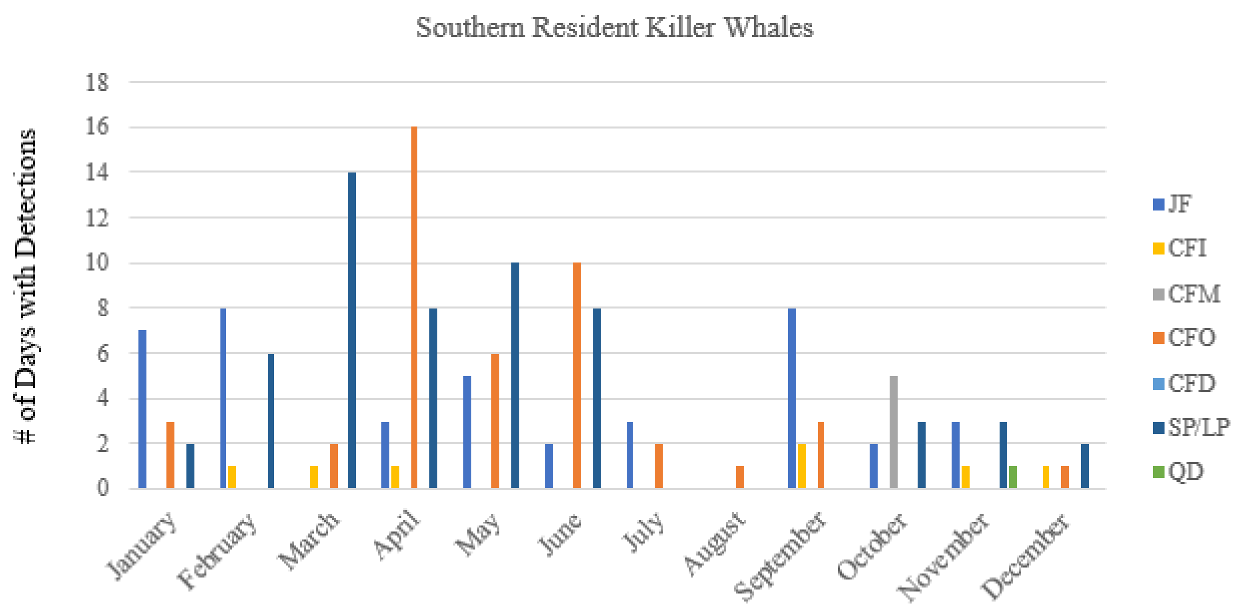

Figure 16. Counts of detections at each northern recorder site by month from 2014-2017 (Emmons et al. 2019). Areas include Juan de Fuca (JF); Cape Flattery Inshore (CFI); Cape Flattery Mid Shelf (CFM); Cape Flattery Offshelf (CFO); Cape Flattery Deep (CFD); Sand Point and La Push (SP/LP); and Quinault Deep (QD).

Additionally, researchers collected data using an autonomous acoustic recorder deployed at Swiftsure Bank from August 2009 to July 2011 to assess how this area is used by Northern Resident and Southern Residents as shown in Figure 13 (Riera et al. 2019). SRKW were detected on 163 days with 175 encounters (see Figure 18 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).

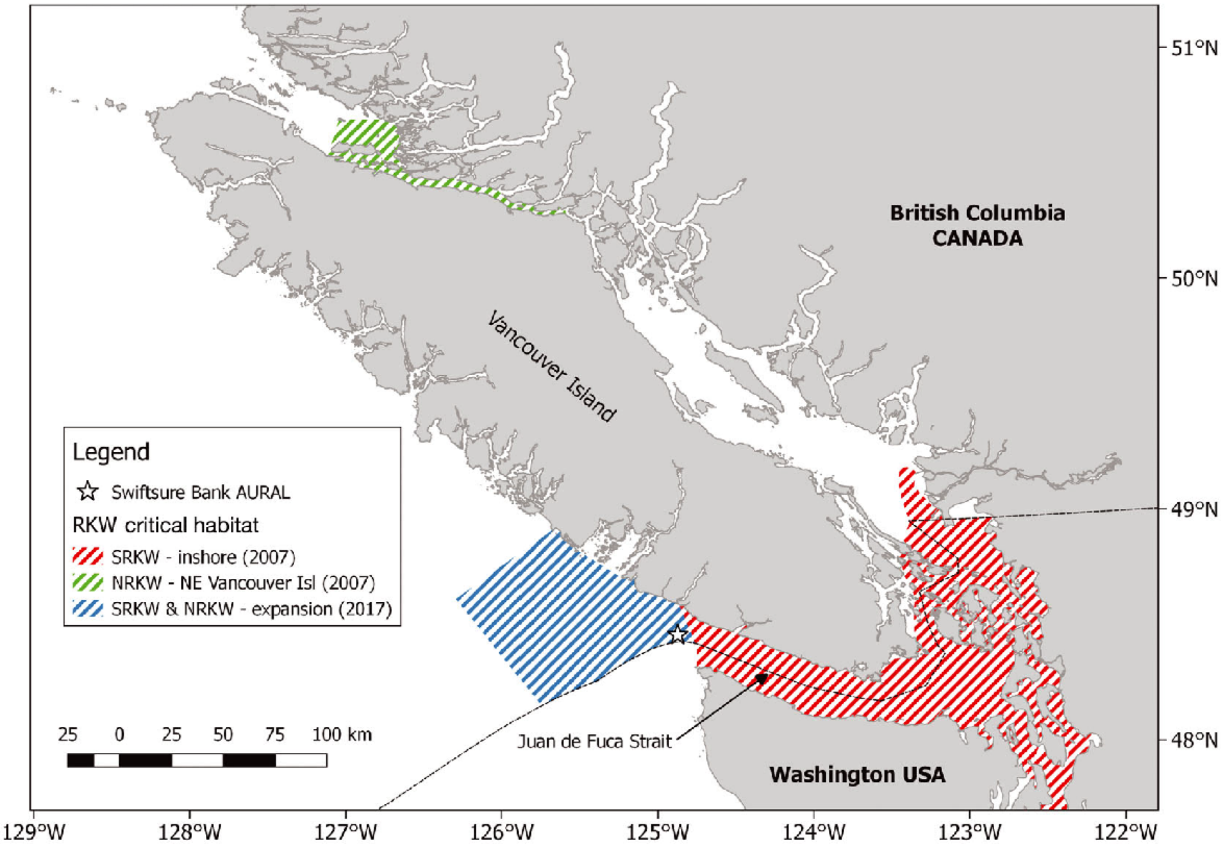

Figure 17. Swiftsure Bank study site off the coast of British Columbia, Canada in relation to the 2007 Northern Resident critical habitat (NE Vancouver Island) and 2007 SRKW critical habitat (inshore waters) and the 2017 Northern Resident and Southern Resident expansion of critical habitat (Riera et al. 2019).

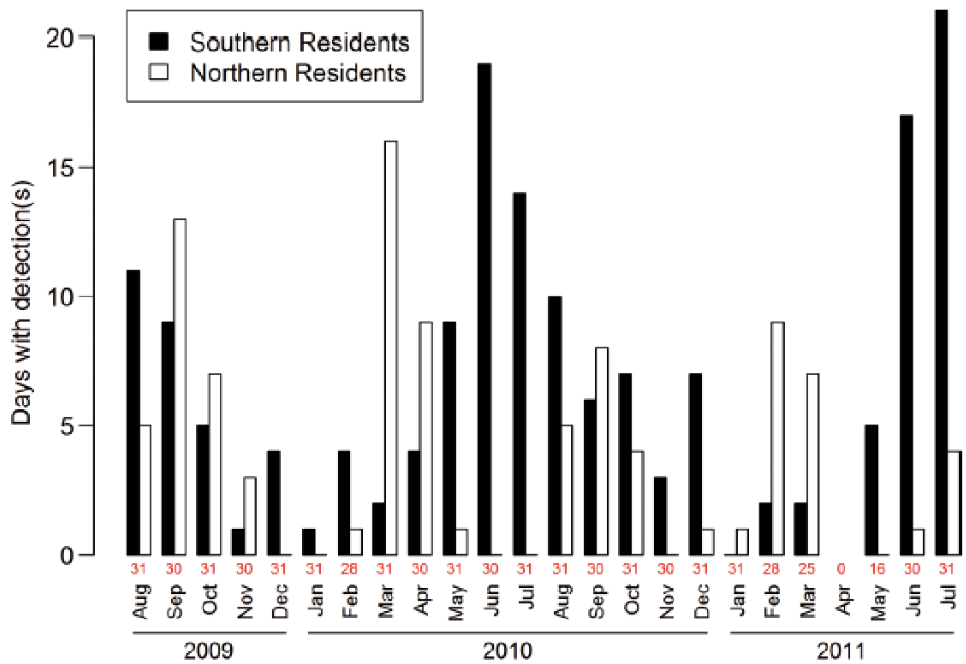

Figure 18. Number of days with acoustic detections of SRKWs at Swiftsure Bank from August 2009–July 2011. Red numbers indicate days of effort. (Riera et al. 2019).

A recent study found SRKWs and NRKWs competition for prey resources among ecologically similar populations that occur in sympatry can be reduced by spatiotemporal resource partitioning and SRKWs were found to prefer the nearshore areas (Emmons et al. 2021). Understanding patterns of habitat use of cetaceans can be difficult since they are highly mobile and can have large home ranges. Passive acoustic monitoring was used at 15 sites along the coast of Washington, to assess habitat use patterns of two sympatric populations, the NRKW and the SRKW. This area is part of the ocean distributions of a number of important runs of Chinook salmon, the preferred prey of both populations, and critical habitat for SRKW. Monthly occurrences were compared for both populations at recorder locations grouped by their proximity to the Strait of Juan de Fuca to the north and the Columbia River to the south in one analysis and by their distance from shore in a second analysis. NRKW and SRKW were detected throughout the year with spring and fall peaks in occurrence. The northernmost sites accounted for 93 percent of NRKW detections, while less than half of SRKW detections were at these sites. SRKW were most frequently detected at nearshore sites (83 percent of detections), while the majority of NRKW detections were at mid-shelf and deep sites (94 percent of detections) (figure 19). This study provides further information about the habitat use of these resident killer whale populations with implications for their management and conservation.

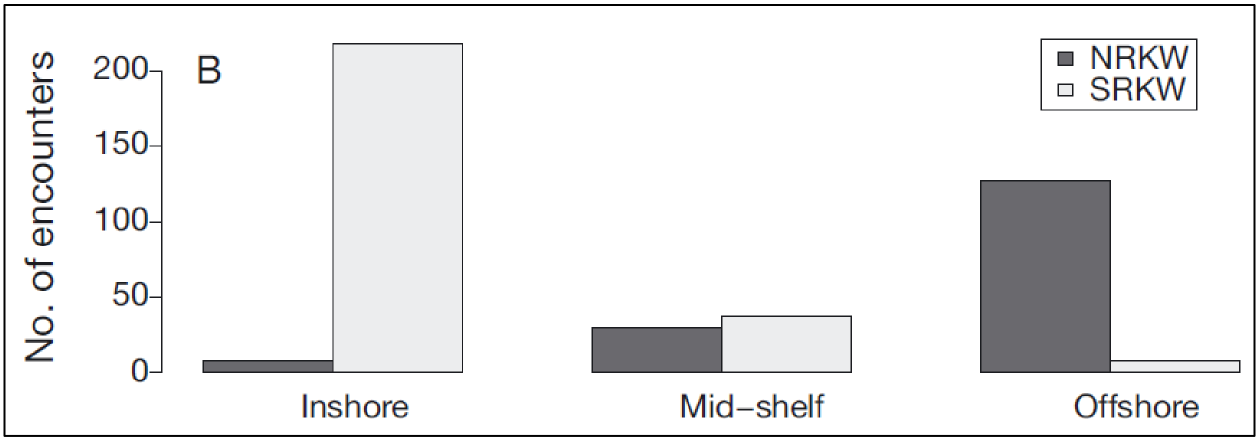

Figure 19. Total number of encounters at inshore, mid-shelf, and offshore sites (Emmons et al. 2021)

Limiting Factors.
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 2008).

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 primary prey for SRKWs. The best available information suggests an overall preference for Chinook salmon (during the summer and fall. Chum salmon, coho salmon, and steelhead) may also be important in the SRKW diet at particular times and in specific locations.

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

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

Over the last forty years, predation on Chinook salmon off the West Coast of North America by marine mammals has been estimated to have more than doubled (Chasco et al. 2017). In particular, southern Chinook salmon stocks ranging south from the Columbia River have been subject to the largest increases in predation, and Chasco et al. (2017) suggested that SRKWs may be the most disadvantaged compared to other NRKW populations given the northern migrations of Chinook salmon stocks in the ocean and this competition may be limiting the growth of the SRKW population.

May–September

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

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

October–December

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

January–April

Observations of SRKWs overlapping with salmon runs (Wiles 2004; Zamon et al. 2007) and collection of prey and fecal samples have also occurred in coastal waters in the winter and spring months. Although fewer predation events have been observed and fewer fecal samples collected in coastal waters, recent data indicate that salmon, and Chinook salmon in particular, remains an important dietary component when the SRKWs occur in outer coastal waters during these timeframes. Prior to 2013, only three prey samples for SRKW on the U.S. outer coast had been collected (Hanson 2021). From 2013 to 2016, satellite tags were used to locate and follow the whales to obtain predation and fecal samples. A total of 57 samples were collected from northern California to northern Washington (Figure 20). Results of the 57 available prey samples indicate that, as is the case in inland waters, Chinook salmon are the primary species detected in diet samples on the outer coast, although steelhead, chum salmon, lingcod, and halibut were also detected in samples. Despite J pod utilizing much of the Salish Sea—including the Strait of Georgia—in winter months (Hanson et al. 2018), few diet samples have been collected in this region in winter.

The occurrence of K and L pods off the Columbia River in March suggests the importance of Columbia River spring runs of Chinook salmon in their diet (Hanson et al. 2013). Chinook genetic stock identification from samples collected in winter and spring in coastal waters from California through Washington included 12 U.S. west coast stocks, and showed that over half the Chinook salmon consumed originated in the Columbia River (Hanson 2021). Columbia River, Central Valley, Puget Sound, and Fraser River Chinook salmon collectively comprised over 90 percent of the 33 Chinook salmon prey samples collected (for which genetic stock origin was determined, of a total 44 prey samples collected) for SRKWs in coastal areas.

As noted, most of the Chinook salmon prey samples opportunistically collected in coastal waters were determined to have originated from the Columbia River basin, including Lower Columbia Spring, Middle Columbia Tule, and Upper Columbia Summer/Fall. In general, we would expect to find these stocks given the diet sample locations (Figure 20). However, the Chinook salmon stocks included fish from as far north as the Taku River (Alaska and British Columbia stocks) and as far south as the Central Valley California (Hanson et al. 2021).

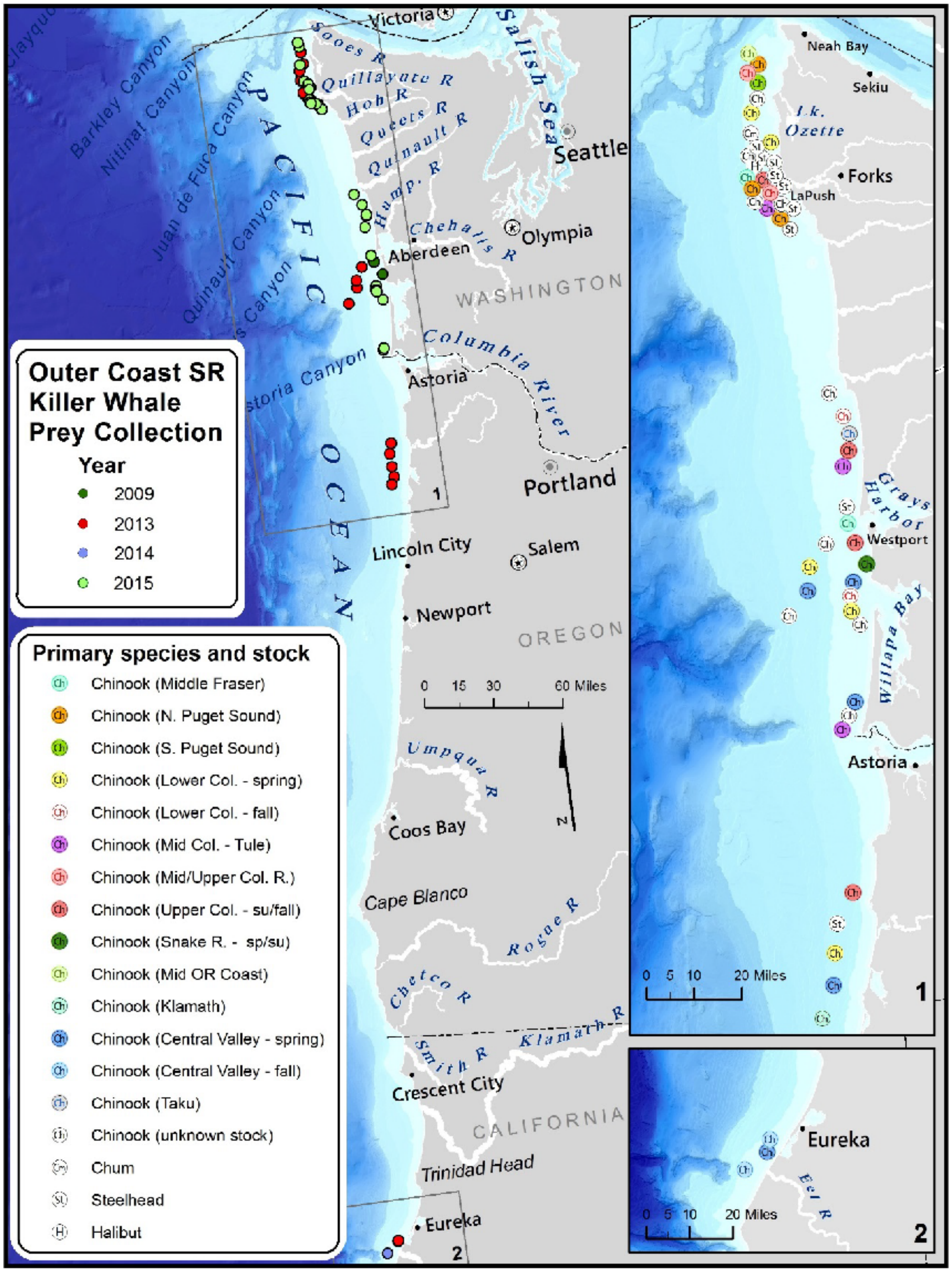

Figure 20. Location and species for scale/tissue samples collected from SRKW predation events in outer coastal waters (NMFS 2019b).

In an effort to prioritize recovery efforts such as habitat restoration and help inform efforts to use fish hatcheries to increase the whales' prey base, NMFS and WDFW developed a report identifying Chinook salmon stocks thought to be of high importance to SRKW along the West Coast (NOAA and WDFW 2018).[10] Scientists and managers from the U.S. and Canada reviewed the model at a workshop sponsored by the National Fish and Wildlife Foundation (NFWF), where the focus was on assisting NFWF in prioritizing funding for salmon related projects. The priority stock report was created using observations of Chinook salmon stocks found in scat and prey scale/tissue samples, and by estimating the spatial and temporal overlap with Chinook salmon stocks ranging from SEAK to California (CA). Puget Sound Chinook salmon are considered a top priority prey stock. Extra weight was given to the salmon runs that support the Southern Residents during times of the year when the whales' body condition is more likely reduced and when Chinook salmon may be less available, such as in winter months. However, it important to note, this priority stock report will continue to get updated over time as new data become available. Given this was designed to prioritize recovery actions and there are no abundance estimates for each stock that are factored in, it is currently not designed to assess fisheries actions or prey availability by area.

Hatchery production is a significant component of the salmon prey base returning to watersheds within the range of SRKWs (Barnett-Johnson et al. 2007; NMFS 2008). The release of hatchery fish has not been identified as a threat to the survival or persistence of SRKWs and there is no evidence to suggest the whales prefer wild salmon over hatchery salmon. Increased Chinook salmon abundance, including hatchery fish, benefit this endangered population of whales by enhancing prey availability to SRKWs and hatchery fish often contribute significantly to the salmon stocks consumed (Hanson et al. 2010, Hanson 2021). Currently, hatchery fish play a mitigation role of helping sustain Chinook salmon numbers while other, longer term, recovery actions for natural fish are underway. Although hatchery production has contributed some offset of the historical declines in the abundance of natural-origin salmon within the range of the whales, hatcheries also pose risks to natural-origin salmon populations (Nickelson et al. 1986; 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

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

reproductive or survival rates in a population (Trites and Donnelly 2003). During periods of nutritional stress and poor body condition, cetaceans lose adipose tissue behind the cranium, displaying a condition known as "peanut-head" in extreme cases (Pettis et al. 2004; Bradford et al. 2012; Joblon et al. 2014). Between 1994 and 2008, 13 SRKWs were observed from boats to have a pronounced "peanut-head"; and all but two subsequently died (Durban et al. 2009; Center for Whale Research unpublished data). None of the whales that died were subsequently recovered, and therefore definitive cause of death could not be identified. Both females and males across a range of ages were found in poor body condition.

Since 2008, NOAA's Southwest Fisheries Science Center (SWFSC) has used aerial photogrammetry to assess the body condition and health of SRKWs, initially in collaboration with the Center for Whale Research and the Vancouver Aquarium. Aerial photogrammetry studies have provided finer resolution for detecting poor condition, even before it manifests in "peanut-head" that is observable from boats. Annual aerial surveys of the population from 2013-2017 (with exception of 2014) have detected declines in condition before the death of seven SRKWs (L52 and J8 as reported in Fearnbach et al. (2018); J14, J2, J28, J54, and J52 as reported in Durban et al. (2017)), including five of the six most recent mortalities (Trites and Rosen 2018). These data have provided evidence of a general decline in SRKW body condition since 2008, and documented members of J pod being in poorer body condition in May compared to September of the previous year (at least in 2016 and 2017) (Trites and Rosen 2018). Other pods could not be reliably photographed in both seasonal periods.

Data collected from three SRKW strandings in recent years have also contributed to our knowledge of the health of the population and the impact of the threats to which they are exposed. Transboundary partnerships have supported thorough necropsies of L112 in 2012, J32 in 2014, and L95 in 2016, which included testing for contaminant load, disease and pathogens, organ condition, and diet composition.[11] In fall 2016 another young adult male, J34, was found dead in the northern Georgia Strait (Carretta et al. 2021). The necropsy indicated that the whale died of blunt force trauma consistent with vessel strike.

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

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

It is possible that poor nutrition could contribute to mortality through a variety of mechanisms. To exhibit how this is possible, we reference studies that have demonstrated the effects of energetic stress (caused by incremental increases in energy expenditures or incremental reductions in available energy) on adult females and juveniles, which have been studied extensively (e.g., adult females: Gamel et al. 2005), Schaefer 1996, Daan et al. 1996, juveniles: Trites and Donnelly 2003). Small, incremental increases in energy demands should have the same effect on an animal's energy budget as small, incremental reductions in available energy, such as one would expect from reductions in prey. Malnutrition and persistent or chronic stress can induce changes in immune function in mammals and may be associated with increased bacterial and viral infections, and lymphoid depletion (Mongillo et al. 2016; Neale et al. 2005; Maggini et al. 2018). Ford and Ellis (2006) report that SRKWs engage in prey sharing about 76 percent of the time. Prey sharing presumably would distribute more evenly the effects of prey limitation across individuals of the population than would otherwise be the case (i.e., if the most successful foragers did not share with other individuals).

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

What appears to be constrained growth in both resident killer whale populations occurred in the 1990s during a time when range-wide abundance of Chinook salmon in multiple subsequent years fell below the 1979–2003 average (Ford et al. 2010). The low Chinook salmon abundance and smaller growth in body size in whales coincided with an almost 20 percent decline from 1995 to 2001 (from 98 whales to 81 whales) in the SRKW population (NMFS 2008). During this period of decline, multiple deaths occurred in all three pods of the SRKW population and relatively poor survival occurred in nearly all age classes and in both males and females. The NRKWs also experienced population declines during the late 1990s and early 2000s. Hilborn et al. (2012) stated that periods of decline across killer whale populations "suggest a likely common causal factor influencing their population demographics" (Hilborn et al. 2012).

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

Although both intrinsic and extrinsic factors can affect social cohesion, it has been generally recognized the most important extrinsic factors for medium and larger terrestrial carnivores are the distribution and abundance of prey (refer to Parsons et al. 2009). In social animals, once optimal group size occurs (that is based on intrinsic and extrinsic factors), the response to reduced prey abundance for example could include “group fissioning”. However, this may not always be the case, especially if the benefit of “cooperative care” or food sharing outweighs the cost of the large group size. Parsons et al. (2009) note that smaller divisions within the pod’s matrilines may temporarily occur in SRKWs as opposed to true fission but this warrants further investigation. Good fitness and body condition coupled with stable group cohesion and reproductive opportunities are important for reproductive success.

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

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

In April 2015, NMFS hosted a 2-day SRKW health workshop to assess the causes of decreased survival and reproduction in the killer whales. Following the workshop, a list of potential action items to better understand what is causing decreased reproduction and increased mortality in this population was generated and then reviewed and prioritized to produce the Priorities Report (NMFS 2015c). The report also provides prioritized opportunities to establish important baseline information on Southern Resident and reference populations to better assess negative impacts of future health risks, as well as positive impacts of mitigation strategies on SRKW health.

Disturbance from Vessels and Sound. Killer whales rely on their highly developed acoustic sensory system for navigating, locating prey, and communicating with other individuals. While in inland waters of Washington and British Columbia, SRKWs are the principal target species for the commercial whale watch industry (Hoyt 2001; O'Connor et al. 2009) and encounter a variety of other vessels in their urban environment (e.g., recreational, fishing, ferries, military, shipping). Several main threats from vessels include direct vessel strikes (which can result in injury or mortality (Gaydos and Raverty 2007)), the masking of echolocation and communication signals by anthropogenic sound, and behavioral changes (NMFS 2008). There is a growing body of evidence documenting effects from vessels on small cetaceans and other marine mammals. Research has shown that SRKWs spend more time traveling and performing surface active behaviors and less time foraging in the presence of all vessel types, including kayaks, and that noise from motoring vessels up to 400 meters away has the potential to affect the echolocation abilities of foraging whales (Holt 2008; Lusseau et al. 2009; Noren et al. 2009; Williams et al. 2010). Individual energy balance may be impacted when vessels are present because of the combined increase in energetic costs resulting from changes in whale activity with the decrease in prey consumption resulting from reduced foraging opportunities (Williams et al. 2006; Lusseau et al. 2009; Noren et al. 2009; Noren et al. 2012). Ayres et al. (2012) examined glucocorticoid and thyroid hormone levels in fecal samples collected from SRKWs in inland waters and their results suggest that the impacts from vessel traffic on hormone levels are lower than the impacts from reduced prey availability. In another study, suction-cup sound and movement tags were attached to SRKWs in their summer habitat while collecting geo-referenced proximate vessel data. Holt et al. (2021a) identified prey capture dives by using whale kinematic signatures and it found that the probability of capturing prey increased as salmon abundance increased but decreased as vessel speed increased. When vessels emitted navigational sonar, whales made longer dives to capture prey and descended more slowly when they initiated these dives. Finally, whales descended more quickly when noise levels were higher and vessel approaches were closer.

At the time of the SRKWs' listing under the ESA, NMFS reviewed existing protections for the whales and developed recovery actions, including vessel regulations, to address the threat of vessels to SRKWs. NMFS concluded it was necessary and advisable to adopt regulations to protect SRKWs from disturbance and sound associated with vessels, to support recovery of SRKWs. Federal vessel regulations were established in 2011 to prohibit vessels from approaching SRKWs within 200 yards (182.9m) and from parking in the path of SRKWs within 400 yards (365.8m). These regulations apply to all vessels in inland waters of Washington State with exemptions to maintain safe navigation and for government vessels in the course of official duties, ships in the shipping lanes, research vessels under permit, and vessels lawfully engaged in commercial or treaty Indian fishing that are actively setting, retrieving, or closely tending fishing gear (76 FR 20870, April, 14, 2011).

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

In 2019, the Washington Legislature passed Senate Bill 5577: a bill concerning the protection of SRKWs from vessels, which developed a license for commercial whale watching and directed the WDFW to administer the licensing program and develop rules for commercial viewing of SRKW. *See* RCW 77.65.615 and RCW 77.65.620. In 2021 the rule went into effect. The rules do not restrict the viewing of other whales or marine mammals, but set a three-month July-September season for viewing of SRKW by motorized commercial whale watching vessels at closer than one-half nautical mile. From July-September, motorized commercial whale watching of SRKWs is permitted daily during two, two-hour periods (10 a.m-12 p.m. and 3-5 p.m.). During these times, there is a limit of three motorized commercial whale watching vessels per group of SRKWs. The rules formally establish the 'no-go' zone on the west side of San Juan Island for motorized commercial whale watching vessels, allowing a 100-yard corridor along the shore for commercial kayak tours. The no-go zone applies year-round regardless of SRKW presence. The no-go zone remains voluntary for vessels not engaging in commercial whale watching operations. The rules establish training, reporting, and compliance monitoring procedures, including real-time reporting of SRKW sightings to the Whale Report Alert System.

In 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 pod size, late reproductive maturity, low reproductive rate, and specialized diet, among other attributes (Jarvela-Rosenberger et al. 2017). Oil spills have occurred in the range of SRKWs in the past, and there is potential for spills in the future. Oil can be discharged into the marine environment in any number of ways, including shipping accidents, refineries and associated production facilities, and pipelines. Despite many improvements in spill prevention since the late 1980s, much of the region inhabited by SRKWs remains at risk from serious spills because of the heavy volume of shipping traffic and proximity to petroleum refining centers.

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

Climate Change and Other Ecosystem Effects. In Section 2.2, above, we briefly discussed climate change and the stress it can bring to the ESA-listed species and habitats considered in this Opinion. In a broader view, overwhelming data indicate the planet is warming (IPCC 2014), which poses a threat to many species. Climate change has the potential to impact species abundance, geographic distribution, migration patterns, timing of seasonal activities (IPCC 2014), and species viability into the future. Changes in climate and ocean conditions happen on several different time scales and have had a profound influence on distributions and abundances of marine and anadromous fishes.

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

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

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

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

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

Although few predictions of impacts on the Southern Residents have been made, it seems likely that any changes in weather and oceanographic conditions resulting in effects on salmon populations would have consequences for the whales. SRKWs might shift their distribution in response to climate-related changes in their salmon prey. Persistent pollutant bioaccumulation may also change because of changes in the food web.

Recent analysis ranked the vulnerability of West Coast salmon stocks to climate change and, of the top priority stocks for Southern Residents (NMFS and WDFW 2018), California Central Valley Chinook salmon stocks, Snake river fall and spring/summer Chinook salmon, Puget Sound Chinook salmon, and spring-run Chinook salmon stocks in the interior Columbia and Willamette River basins were ranked as “high” or “very high” vulnerability to climate change (Crozier et al. 2019). In general, Chinook, coho, and sockeye salmon runs were more vulnerable and this stemmed from exposure to higher ocean and river temperatures as well as exposure to changes in flow regimes (including in relation to snowpack, upwelling, sea level rise, and flooding). However, certain Chinook salmon runs do have higher ability to adapt and/or cope with climate change due to high life history diversity in juveniles and adults (including both subyearling and yearling smolts, multiple migration timings), but diversity may be lost with future climate change. Overall, chum and pink salmon were less vulnerable to climate change because they spend less time in fresh water than other salmonids, and certain steelhead runs had more moderate vulnerability than many Chinook and coho salmon runs because of higher resilience (Crozier et al. 2019).

Improving habitat conditions for PS Chinook salmon benefits the SRKW and helps move the species toward recovery as described in the 2008 recovery plan and subsequent status reviews. Table 11 provides a summary of listing and recovery plan information, status summaries and limiting factors for the species addressed in this opinion. More information can be found in recovery plans and status reviews for these species.

Table 11. Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for each species considered in this opinion.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent (2021) Status Review	Status Summary	Limiting Factors
Puget Sound Chinook salmon	Threatened 6/28/05 (70 FR 37159)	Shared Strategy for Puget Sound 2007 NMFS 2006	NWFSC 2015	This ESU comprises 22 populations distributed over five geographic areas. Most populations within the ESU have declined in abundance over the past 7 to 10 years, with widespread negative trends in natural-origin spawner abundance, and hatchery-origin spawners present in high fractions in most populations outside of the Skagit watershed. 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.	• Degraded floodplain and in-river channel structure • Degraded estuarine conditions and loss of estuarine habitat • Degraded riparian areas 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 • Severely altered flow regime
Puget Sound steelhead	Threatened 5/11/07	NMFS 2019d	NWFSC 2015	This DPS comprises 32 populations. The DPS is currently at very low viability, with most of the 32 populations and all three population groups at low viability. Information considered during the most recent status review indicates that the biological risks faced by the Puget Sound Steelhead DPS have not substantively changed since the listing in 2007, or since the 2011 status review. Furthermore, the Puget Sound Steelhead TRT recently concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 populations. In the near term, the outlook for environmental conditions affecting Puget Sound 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 Puget Sound steelhead survival and production are expected to continue.	• Continued destruction and modification of habitat • Widespread declines in adult abundance despite significant reductions in harvest • Threats to diversity posed by use of two hatchery steelhead stocks • Declining diversity in the DPS, including the uncertain but weak status of summer-run fish • A reduction in spatial structure • Reduced habitat quality • Urbanization • Dikes, hardening of banks with riprap, and channelization

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent (2021) Status Review	Status Summary	Limiting Factors
Puget Sound/ Georgia Basin DPS of bocaccio	Endangered 04/28/10	NMFS 2017	NMFS 2016c	Though 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 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 bocaccio in the Main Basin and South Sound represents a further reduction in the historically spatially limited distribution of bocaccio, and adds significant risk to the viability of the DPS.	• Over harvest • Water pollution • Climate-induced changes to rockfish habitat • Small population dynamics
Southern resident killer whale	Endangered 11/18/05	NMFS 2008	NMFS 2021	The Southern Resident killer whale DPS is composed of a single population that ranges as far south as central California and as far north as southeast Alaska. The estimated effective size of the population (based on the number of breeding individuals under ideal genetic conditions) is very small — <30 whales, or about 1/3 of the current population size. The small effective population size, the absence of gene flow from other populations, and documented breeding within pods may elevate the risk from inbreeding and other issues associated with genetic deterioration As of September 2021, the population is 74 whales, including 24 whales in J pod, 17 whales in K pod, and 33 whales in L pod,. Estimates for the historical abundance of Southern Resident killer whales range from 140 whales (based on public display removals to 400 whales, as used in population viability analysis scenarios.	• Quantity and quality of prey • Exposure to toxic chemicals • Disturbance from sound and vessels • Risk from oil spills

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area for each project (Eagle Harbor Maintenance Facility Slip F Drive-on Improvement Project, Edmonds Ferry Terminal Trestle Repair Project, Edmonds Ferry Terminal Trestle Emergency Repair, and Point Defiance, Tahlequah, Vashon Ferry Terminals Trestle Repairs Project), includes effects associated with the repairs and replacement of structures at each of the facilities. These effects are all encompassed within the South Central Puget Sound Service Area[12].

The BAR provides a detailed description of current conditions at each facility relative to listed species and critical habitats. For each proposed action, there are short-term construction-related effects and long-term structure-related effects. Increased noise levels from construction, especially pile driving, will extend into the aquatic and terrestrial environments. However, terrestrial noise levels which are based on increased in-air sound levels from impact pile driving are not significant to the listed species in this consultation.

The area of effect within the aquatic portion of the Eagle Harbor Slip F Drive-on Improvements Project's action area is based on the geographic extent of the temporary increase in sound pressure levels from impact pile driving 36-inch diameter piles at Eagle Harbor maintenance facility. The area of effect within the aquatic portion of the Edmonds Trestle Repair Project is based on the geographic extent of the temporary increase in sound pressure levels from vibratory pile driving a steel H-pile at the Edmonds terminal. The current background noise levels at both terminals, near developed shorelines, is 120dB_{RMS}[13] (also the marine mammal continuous noise disturbance threshold). Using the practical spreading loss model for underwater sound we calculated the range at which sound pressure generated by the impact and vibratory pile driving would attenuate to below current background levels and be indistinguishable.

Impact pile driving noise (195 dB_{RMS}) at the Eagle Harbor facility is estimated to attenuate to below the background levels at an underwater distance of 621 miles from the source, or the nearest land mass which will block sound upon reaching a topographic barrier. Underwater noise could cause potential effects and will extend from Eagle Harbor to the Seattle waterfront. Vibratory pile driving noise (153 dB_{RMS}) at the Edmonds Terminal is estimated to attenuate to below the background levels at an underwater distance of 1 mile from the source or the nearest land mass which will block sound upon reaching a topographic barrier.

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[12] Service areas have been established for the Puget Sound Partnership Nearshore Credits Program (PNCP). Although the PNCP is not being used due to credits accrued by WSF, the service area boundaries are applied to credits accrued. See https://www.psp.wa.gov/pspnc.php

[13] The RMS level is the square root of the energy divided by the impulse duration. This level is the mean square pressure level of the pulse. NMFS uses RMS to describe disturbance-related effects (harassment) to marine mammals and behavioral effects to fish. Thresholds for disturbance to marine mammals is 120 dB_{RMS} for vibratory pile driving and 160 dB_{RMS} for impact pile driving, and for behavioral effects to fish is 150 dB_{RMS}.

Project footprints and project-generated turbidity in tidal environments are expected to return to background conditions within a 150-foot radius of seabed disturbance, which is the extent of the action area for the projects without impact or vibratory pile driving (Edmonds Emergency Repair and Point Defiance, Tahlequah, and Vashon Trestle Repairs Project). The extent of potential contaminant release from creosote-treated pile removal during construction are captured within this distance.

The extent of physical, chemical or biological effects post-construction is associated with likely impacts of permanent water quality effects due to the continuing discharge of stormwater and the persistence of structures in and over the nearshore environment. Because no method of treatment other than full infiltration will fully remove all contaminants, stormwater discharges will continue to be a chronic source of episodic chemical load into Puget Sound. Existing creosote treated piles are likely to leach PAHs into the water column, degrading water quality in their vicinity. The structures themselves create potential long-term obstructions of the migratory corridor, create shading, and diminish aquatic food supply in their vicinity.

The action areas for the Eagle Harbor and Edmonds projects contain critical habitat designations for PS Chinook salmon, PS/GB bocaccio, PS/GB yelloweye rockfish, and SRKW as well as EFH designations for Pacific salmon, Pacific coast groundfish, and coastal pelagic species. The action areas for the Edmonds Emergency Repair Project and Point Defiance, Tahlequah, and Vashon Trestle Repairs Project contain the same critical habitat and EFH designations as in the Eagle Harbor and Edmonds action areas with the exception of PS/GB yelloweye rockfish critical habitat. PS steelhead and humpback whale critical habitat is not designated within any of the action areas. The effects to EFH are analyzed in the MSA portion of the document.

2.4 Environmental Baseline

The “environmental baseline” refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The 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).

Many of the factors affecting listed species and critical habitat generally are also present as degrading habitat factors in the baseline of the action areas (See section 2.3). For example, water quality is affected by stormwater runoff and existing and legacy creosote treated timber. Baseline conditions that are specific to the action areas include background levels of noise from significant commercial and recreational vessel traffic, as well as degraded nearshore habitat due to bank armoring, development from residential properties, marinas, and large in-water WSF terminal structures.

The COE and WSF have provided NMFS with the BAR, which provides terminal specific information[14], in addition to the construction information described previously. The BAR includes detailed descriptions of the environmental baseline followed by the distribution of ESA-listed species and designated critical habitats at each terminal. The baseline and species information at each of the proposed action WSF facilities can be found in the BAR (WSF 2019, Chapter 4), and is incorporated here by reference.

The project action occurs in the Puget Sound nearshore which can be generally described as the zone where marine water, fresh water, and terrestrial landscapes interact in a complex mosaic of habitats and processes. The nearshore environment typically provides important ecological functions for salmonids and rockfish including foraging, growth, and refuge from predation.

Each of the project facilities is located in developed nearshore environments of South Central Puget Sound, consisting of marinas, shoreline armoring (bulkheads and jetties), and significant commercial and private vessel traffic. Daytime underwater noise levels near developed shorelines are approximately 120 dB_{RMS} and can increase by 3dB in the summer due to recreational boat traffic (WSDOT, 2020).

Water quality in Puget Sound, in general, is highly degraded as described in the Puget Sound Partnership 2018-2022 Action Agenda and Comprehensive Plan (Puget Sound Partnership 2018). As described in section 2.3 (Action Area), ambient conditions in the nearshore environment at the project locations present a persistence of pollutants that consist of stormwater discharges and contaminants such as creosote that result in ongoing adverse effects. There are also good and meaningful BMP’s built into the WSF stormwater and contaminant management program as required by the Stormwater Management Manual for Western Washington (Ecology 2019).

The Eagle Harbor maintenance facility is in Eagle Harbor, on the southeastern portion of Bainbridge Island, which is approximately 2.2 miles long and 0.35 mile wide. Three year-round streams and six seasonal streams discharge into Eagle Harbor, none of which support ESA-listed salmonid species. Eagle Harbor has significant vessel traffic, which includes the Bainbridge Island Ferry, public moorage and three commercial marinas. In addition to the Category 5 water quality listings (impaired) for PAHs and polychlorinated biphenyls (PCBs) (Ecology, 2021), a seafood consumption advisory has been in place at Eagle Harbor since the early 1980s. Recreational shellfish harvesting is not advised and commercial

[14] The BAR is authored by WSF staff biologists and was updated in August 2019. The document is available online here: https://wsdot.wa.gov/engineering-standards/environmental-guidance/endangered-species-act-essential-fish-habitat

harvest of shellfish is prohibited—partly because of chemical contamination concerns from the Wyckoff Co./Eagle Harbor Superfund site[15] where cleanup is ongoing, and also because of a nearby municipal sewage outfall operated by the City of Bainbridge Island (DOH, 2009).

The Pt. Defiance terminal is located on the southern side of Dalco Passage, within the Commencement Bay Nearshore-Tideflats Superfund site that is located in the cities of Tacoma and Ruston at the southern end of Puget Sound. The former Asarco smelter operated here for nearly 100 years, venting heavy metals and arsenic over land from Seattle to Olympia. While contaminated soils have been capped at the Pt. Defiance peninsula and includes the development of Point Ruston and the Dune Peninsula at Point Defiance Park, Ecology is still removing contaminated soils in the area of the smelter plume[16]. These upland sites have the potential to leach contaminants into the marine waters. Widespread contamination of water and sediments have also required remediation including dredging and capping with clean sediments[17], and are ongoing. These actions are part of past consultations, are therefore part of the environmental baseline, and are not considered further in this Opinion.

The Tahlequah terminal is located at the south end of Vashon Island, and is on the north side of Dalco Passage opposite from Pt. Defiance. Conditions are similar to Pt. Defiance, including impaired water quality listings in the terminal area. The COE and WSF recently completed (NWS-2020-699) a soft shore armoring project at this location, replacing a deteriorating timber and concrete bulkhead with streambed gravel and cobbles to restore a more natural beach slope. Still, there is extensive hardening of the shoreline to protect single family homes.

The Vashon terminal is located on the northern end of Vashon Island. There are no data on impaired waters or sediments in the terminal area. The shoreline vegetation is most prominent at this terminal where hardwood and deciduous forested species occur east and west of the ferry terminal, including Douglas fir, western red cedar, big leaf maple and red alder.

The Edmonds Ferry Terminal is located between Seattle and Everett. The marine waters around the Edmonds terminal have Category 5 water quality listings for PAHs and PCBs

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[15] About 100 acres of sediment on the bottom of Eagle Harbor became contaminated with creosote and other wood preserving chemicals released from the former Wyckoff wood treating facility. At West Harbor, the site of a former shipyard, the soil and sediment became contaminated with mercury and other metals. See https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=1000612
[16] The plume is a 1,000 square mile area of arsenic and lead soil contamination. See Tacoma Smelter Plume Project https://ecology.wa.gov/Spills-Cleanup/Contamination-cleanup/Cleanup-sites/Tacoma-smelter
[17] Commencement Bay Nearshore-Tideflats Superfund site, Cleanup Activities: https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.cleanup&id=1000981

(Ecology, 2021). With the exceptions of Lund's Creek estuary, Edmonds Underwater Park, Brackett's Landing, and part of Marina Beach Park, the entire Edmonds shoreline (more than 90 percent) is armored by the BNSF railroad bed and bulkheads (City of Edmonds, 2007). The BNSF railroad right-of-way limits further shoreline development near the terminal.

The Washington State Ferries System has developed a Long Range Plan[18] which provides a blueprint of short-, medium-, and long-term actions recommended for their assets for the next 20 years and is updated once each decade. The current version describes the future of the ferry system through 2040 and was submitted to the Washington State Legislature in January 2019. The current Edmonds Ferry terminal trestle was built in 1952, then modified and expanded in 1989 and 1995. These modifications are part of the environmental baseline.

Complete replacement of the trestle is tentatively scheduled for the 2027-2029 timeframe. Preservation projects are planned for the terminal buildings at Vashon (2025-2027 timeframe), and at Tahlequah and Pt. Defiance in the medium to long-term (in place by 2039). Additionally, some smaller preservation elements are planned at Tahlequah and Eagle Harbor Maintenance Facility (in addition to the Slip F improvements). The timeframes for these smaller preservation projects are based on the condition of terminal assets. Ongoing maintenance is expected to occur to serve the needs of the system through 2040 and beyond, until their useful service life has ended, in order to support reliable terminal infrastructure and efficient service at each of WSFs' assets. Future actions, as described here, are not part of the environmental baseline and are not considered in this consultation, but would be subject to future consultations.

Estuaries and submerged aquatic vegetation (SAV), including canopy kelps and eelgrass beds, provide habitats that are biologically productive and provide a significant contribution to the marine and estuarine food webs. In general, there is a steady decline of kelp forests in Puget Sound, which are impacted by sediment, toxic pollution and shoreline alterations (Berry et al. 2021). Due to its resilience, eelgrass in Puget Sound is more stable overall, but has a patchy distribution along the subtidal and intertidal areas of the project sites and is negatively impacted by warmer waters and over water shading.

The BAR identifies no kelp or eelgrass near the Eagle Harbor maintenance facility, but both are present at the mouth of the harbor approximately 1 mile away. At the Edmonds Ferry terminal, kelp is nearly continuous between -5 and -60 feet MLLW, and approximately 4 acres of eelgrass occurs at depths from -2 to -20 feet MLLW to the north and south of the terminal. Kelp and eelgrass are prevalent east and west of the Vashon terminal. At the Point Defiance terminal no eelgrass or kelp is identified near the terminal. At the Tahlequah

[18] WSF Long Range Plan: See https://wsdot.wa.gov/travel/washington-state-ferries/about-us/washington-state-ferries-planning/washington-state-ferries-long-range-plan

terminal eelgrass is present east of the terminal between -2 feet MLLW to -6 feet MLLW. Two small patches (less than 3 square ft.) occur on the west side of the terminal. The areas directly underneath the ferry terminals and maintenance facility are generally devoid of eelgrass, mostly likely a result of shade. The areas directly offshore of and including the docking areas of the ferry terminals and maintenance facility are generally devoid of macroalgae, mostly likely a result of propeller-induced turbulence. Forage fish spawning (surf smelt) occurs year-round in Eagle Harbor and is documented near the Vashon and Edmonds terminals.

2.5 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action (see 50 CFR 402.02). 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 the factors set forth in 50 CFR 402.17(a) and (b).

The proposed actions will have multiple types of effects, ranging from temporary to enduring. The temporary effects associated with construction include water quality impairment, noise in the aquatic habitat, and benthic communities and forage species reductions. The enduring effects associated with structures in the aquatic habitat include alteration of predator/prey dynamics, water quality impairment, migration impediment, and disruption of shore processes. Also included in this section, are any positive effects of project design features, designed to reduce the impact of a structure, and conservation measures (as described in Section 1.3). We analyzed these effects on features of habitat first, including critical habitat, and then we identify the listed species that will encounter these effects.

2.5.1 Temporary Effects During Construction

Construction in and near the water, despite the use of BMPs to reduce suspended sediments/contaminants and underwater noise levels, will have temporary consequences to listed species and their habitats. The action will include (a) water quality reductions; (b) increased noise in the aquatic environment; and (c) reduction of prey/forage (benthic prey, forage fishes).

Water Quality

Turbidity: Water quality effects during replacement of the trestle and transfer span at Eagle Harbor and other terminal trestle repairs are likely to include turbid conditions and contaminant release. These effects can occur during pile installation/removal and excavation to install jackets around existing piles. In the short term, removal of creosote piles can release creosote into the surrounding water, resulting in a temporary degradation of water quality (Weston Solutions 2006). In estuaries, aquatic life use criteria (WAC 173-201A-210) establish a point of compliance for a temporary area of mixing shall be at a radius of 150 feet from the activity causing the turbidity exceedance. A violation of the criteria would be a reportable violation and is not analyzed in this document. It is expected that during the days that construction activities occur in the water, elevated suspended sediment levels, including resuspension of PAHs from creosote, could occur within this area.

Construction related discharge: BMPs and minimization measures, discussed in Section 1.3 above, will be employed to prevent accidental losses or spills of construction debris or hazardous materials into the waters. As a result, construction-related stormwater, including epoxy grout wastewater for encapsulations, are unlikely to violate applicable state or federal water quality standards. Therefore, the proposed action is expected to result in only localized, temporary degradation of the existing water quality.

Underwater Noise

Elevated underwater noise is expected as a short-term consequence from construction activities, specifically during pile driving, which will occur at the Edmonds Ferry Terminal and Eagle Harbor Facility. Only vibratory driving is proposed to remove one creosote pile and install one H-pile at the Edmonds Ferry Terminal. Vibratory and impact pile driving will occur at the Eagle Harbor Facility. Impact driving will only be used to determine the load bearing capacity of the steel piles at the Eagle Harbor facility after they have been installed with a vibratory pile driver.

Impact pile driving can cause high levels of underwater sound in the aquatic habitat. The use of a confined or unconfined bubble curtain has resulted in significant noise reduction (mean attenuation up to 36 dB), but is dependent on the project location and can be inconsistent and unpredictable (WSDOT 2020, Chapter 7).

No instances of fishes killed or injured have been associated with vibratory pile driving. However, high levels of noise, including noise from impact and vibratory pile driving, can result in temporary shifts in hearing sensitivity, masking, and behavioral effects in fish. Because of the paucity of data on the response of salmon to pile driving sounds, NMFS is currently using a conservative level of 150 dB RMS as a trigger for analysis of potential adverse behavioral effects from all types of sounds, including those from impact and vibratory hammers. NMFS' overall synthesis of the best available science leads us to our findings. Studies in which these effects have been studied for salmonids and rockfish include, Grette 1985 (on Chinook salmon and sockeye), Feist et al. 1996 (on chum salmon), Ruggerone et al. 2008 (on Coho salmon), Popper 2003 (on behavioral responses of fishes), and Pearson et al.1992, and Skalski et al. 1992 (on rockfish).

In this Opinion, the potential for adverse behavioral effects will be most important to juvenile Chinook that are outmigrating and overlap with pile driving, because they face a greater risk of predation than subadult or adult fish in marine waters. Behavioral effects to juvenile bocaccio could also put them at a greater risk of predation.

The noise from pile driving and extraction will radiate outward until the sound level attenuates with distance to background levels. Cumulative sound exposure level (cSEL) is a measure of the sound energy integrated across all of the pile strikes. The Equal Energy Hypothesis, described by NMFS (2007), is used as a basis for calculating 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.

Benthic Communities and Forage Species

Areas where sediment is disturbed by pile driving and in- or near- water work (excavation) to facilitate construction will disturb and diminish benthic prey communities. When juvenile salmonids are entering the nearshore or marine environment, they must have abundant prey to allow their growth, development, maturation, and overall fitness. As bottom sediments are dislodged, benthic communities are disrupted, taking time to fully re-establish their former abundance and diversity. When benthic prey is less available, the growth and fitness of juveniles, can be incrementally diminished as migrants may experience reduced food or increased competition to a degree that impairs their growth, fitness, or survival.

The speed of recovery by benthic communities is affected by several factors, including the intensity and duration 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. Due to the longer project duration for trestle replacement and minimal duration for trestle repairs, we expect recovery to range from several weeks to many months.

2.5.2 Enduring Effects of In-water and Overwater Nearshore Structures

In- and overwater structures in the nearshore influence habitat functions and processes for the duration of the time they are present within the habitat. The effects include: (a) altered predator/prey dynamics, (b) disrupted migration, and (c) degraded water quality. These effects are chronic, persistent, and co-extensive with the useful life of the replaced and repaired structures.

To assess the enduring effects of all the proposed projects, NMFS used the NHVM, as described in Section 2.1, which as currently proposed resulted in a credit, based on positive environmental results to nearshore habitat quality, quantity, or function, of +221 (see Table 4 above). The Eagle Harbor Slip F project will result in an overall reduction of over-water coverage, increase grating, and remove approximately 150 tons of creosote. In the long term, the proposed removal of creosote will reduce water quality degradation overall and improve the water quality for critical habitat. The replacement and repair of in-water and over-water structures will result in the persistence effects in the nearshore environment below HAT.

The *enduring effects on water quality* include the chronic and system-wide introduction and extended existence of pollutants from ferry vessel use associated with trestles and upland overwater stormwater Increased levels of PAHs, oils, 6-PPD/quinone, and other contaminants will be widely dispersed, and can have detrimental effects 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, episodic, and enduring effects on water quality will create an incremental but chronic diminishment of the water quality PBF for all of the listed species with designated critical habitat in the action area, throughout the new useful life period (40 to 50 years, depending on the structure).

Predator/Prey Dynamics

Eelgrass is an important habitat for juvenile salmonids (Williams and Thom 2001), and is also an important spawning substrate for Pacific herring, which is a forage species of Chinook salmon. Macroalgaes such as kelp and sea lettuce, as well as epibenthos and macrofauna contribute to the productivity and diversity of nearshore habitats. Invertebrates are an important food source for juvenile PS/GB bocaccio and PS Chinook salmon and for forage fish prey species of salmonids.

Over water structures adversely affect SAV, if present, and inhibit the establishment of SAV where absent, by creating enduringly shaded areas (Kelty and Bliven 2003). There are ways to reduce the impacts of OWS, including increasing deck height off the water, pier orientation relative to incidental sunlight, compensatory lighting, etc., but they do not fully offset the impacts. Decreased ambient light typically results in lower overall productivity, which is ultimately reflected in lower shoot density and biomass, and any overwater structure, however small, is likely to alter the marine environment (Shafer 1999; 2002). Studies examining the effect of OWS on SAV are limited to 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 will continue to adversely affect all macroalgae and eelgrass production and retention in the vicinity of the project structures. Juvenile chinook and larval bocaccio are affected by the loss of 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 (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). Though herring spawning has not been recorded near the project structures, the lack of eelgrass has an impact on Chinook salmon forage species. The likely ongoing suppression in epibenthic species and forage fish associated with shading SAV will reduce prey communities for juvenile Chinook salmon and juvenile bocaccio.

Obstructions in Migration Areas

Outmigrating juvenile PS Chinook in the earliest periods of their marine residency prefer the protection of shallow nearshore water. PS steelhead smolts and adults, adults and subadults of PS Chinook and all life stages of bocaccio are not expected to be affected by these stressors because they do not migrate along the nearshore.

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). 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). 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). 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 2001). Swimming around structures lengthens the migration distance and is correlated with increased mortality. 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 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). In summary, NMFS anticipates that the increase in migratory path length from swimming around the replaced and existing OWS, as well as the increased exposure to piscivorous predators in deeper water, likely will result in proportionally increased juvenile PS Chinook salmon mortality. Steelhead are not nearshore dependent and thus the presence of the structures is unlikely to affect their behavior.

2.5.3 Effects of Habitat Conservation Offsets

To address enduring impacts to aquatic habitats from replacement and repair projects that perpetuate the persistence of over water structures, the COE will meet and exceed habitat conservation offset requirements for the proposed action. The conservation credits will offset the loss of ecosystem functions due to the modification of the seabed for benthic communities, water column, and shoreline.

Conservation credits are expected to achieve a no-net-loss of habitat function as a result of these proposed projects, which is needed to help ensure that PS Chinook salmon 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. Juvenile PS Chinook salmon survival is directly linked to the quality and quantity of nearshore habitat. Campbell et al. (2017) 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 Central Puget Sound, there appear to be higher rates of mortality in the fry life stage in the more urbanized watersheds. By contrast, in watersheds where the estuaries are at least 50 percent functioning, fry out-migrants made up at least 30 percent of the returning adults, compared to the 3 percent in watersheds like the Puyallup and the Green rivers, where 95 percent of the estuary has been lost (Campbell et al. 2017).

This also means that for projects that occur in less developed areas and within stretches of functioning habitats, no net loss is even more crucial. It has been long understood that protection and conservation of existing unimpaired systems is more effective and efficient than full restoration of impaired systems (Goetz et al. 2004). The conservation offsets will not result in adding to the needed nearshore restoration in Puget Sound, but they will ensure that the proposed action does not cause nearshore habitat conditions to get worse.

2.5.4 Effects on Critical Habitat

Nearshore or marine critical habitat for PS Steelhead, PS/GB yelloweye rockfish, and humpback whales are not designated in the action areas.

As mentioned in Section 2.2.1, nearshore marine critical habitat for PS chinook and PS/GB bocaccio occurs within the action areas along portions of the shoreline in South Central Puget Sound. The SRKW critical habitat PBF 2 is affected anywhere their prey species (Chinook salmon) are affected. For these proposed actions, the only project impact that deepwater critical habitat for PS/GB bocaccio [and PS/GB yelloweye (see section 2.12)] will be exposed to is temporary non-injurious noise levels from pile driving. While the sound will travel outside of the nearshore area, the level of harm to fish is within nearshore areas.

Effects to habitat features include temporary and permanent diminishment of benthic communities and forage fish (i.e., prey abundance and diversity), migratory obstruction and required energy expenditure, and potential temporary and permanent increases in predators and predator success upon juvenile salmonids. Timing, duration, and intensity of the effects on critical habitat are taken into account in the adverse modification analysis, and we also consider them as the pathways of exposure creating effects to the species, as discussed below.

Whether or not habitat is designated as critical, the full range of the action areas provides accessible habitat to the various listed fishes considered in this opinion, and it is certain that the features of the habitat, will be altered either temporarily, or for the foreseeable future. Given the mixture of critical and non-critical habitat within the action areas, in the following section, we will review effects to all habitat features, whether or not the habitat is designated as critical, as this analysis is foundational to our review of the effects of the proposed action on the listed species themselves.

The temporary effects on features of habitat associated with construction are:

1) Underwater noise, which can cause
    a. Direct mortality or injury,
    b. Migratory pathways obstruction, and
    c. Forage fish impacts,
2) Disturbance of bottom sediments which can cause
    a. Water quality impacts, and
    b. Disturbance of benthic communities (forage).

The enduring effects on features of habitat associated with in water structures are:

1. Over water coverage/Shade which can cause
    a. Migratory pathways obstruction
    b. Reductions in aquatic vegetation/cover
    c. Diminished benthic communities/forage; and,
2. Habitat Conservation Offsets

NMFS reviews the effects on critical habitat affected by the proposed action by examining changes to the condition and trends of PBFs identified as essential to the conservation of the listed species.

The action areas contain the estuarine and nearshore marine PBFs (PBFs 4 and 5) of Puget Sound Chinook salmon critical habitat. Specifically, PBFs of nearshore habitat for PS Chinook salmon include complexity, absence of artificial obstructions, natural cover, adequate water, and high water-quality. The nearshore environment supports various life stages of PS Chinook salmon including growing and sexually maturing adults, migrating spawners, and rearing and growing juveniles. The proposed projects will adversely affect water quality, including forage and aquatic vegetation.

The action areas for the proposed actions contain nearshore critical habitat for PS/GB bocaccio. Critical habitat features for PS/GB bocaccio differ between adults and juveniles, as each life history stage has different location and habitat needs. The proposed action will adversely affect nearshore bocaccio critical habitat but is unlikely to adversely affect deepwater critical habitat.

Based on the natural history of SRKWs and their habitat needs, NMFS identified the following PBFs essential to conservation: (1) Water quality to support growth and development; (2) Prey species of sufficient quantity, quality and availability to support individual and population growth as well as reproduction and development; and (3) Passage conditions to allow for migration, resting, and foraging. Water quality and prey species PBFs occur in the action areas and will be adversely affected.

As described in Section 2.4 (Environmental Baseline), water quality in Puget Sound, in general, is degraded. Reduced prey abundance, particularly Chinook salmon, is a primary concern for critical habitat. In a recent study, Chinook salmon were observed to be the most common prey species when averaged across SRKW fecal samples collected (51.0%, 67.3%), Puget Sound and outer coast waters, respectively. Chum salmon was the next most common species consumed in two areas of three areas surveyed (Puget Sound, 31.2%, Juan de Fuca/San Juan Islands 31.5%) but virtually nonexistent in outer coast waters (1.2%) (Hanson et al. 2021).

2.5.4.1 Temporary effects on features of habitat associated with construction:

Underwater noise - During construction of the trestle and transfer span at Eagle Harbor maintenance facility, 38 steel piles ranging in diameter from 18- to 36-inch diameter will be installed to provide support for the trestle and transfer, to support the relocated float, and for dolphins and wingwalls. The 11 steel piles for the trestle and transfer span are load bearing and will require proofing with an impact hammer. The remaining piles at the Eagle Harbor facility will be installed using vibratory methodology. The one H-pile installed at the Edmonds terminal will also be installed using vibratory driving. Timber and steel piles to be discarded will also be removed using vibratory methods.

Vibratory pile driving is estimated to take approximately 60 minutes per pile for installation and 15 to 60 minutes for removal, depending on the size and pile type. Impact proofing of 11 steel piles is anticipated to take approximately 30 minutes per pile, requiring approximately 450 strikes each. No more than three piles will be impact driven each day, for a maximum of 1,350 strikes per day over 4 days. Estimated pile driving at Eagle Harbor will require a maximum, of 107 hours over 34 days, and is primarily vibratory. None of the other trestle repairs require impact driving. One timber pile will be replaced with a steel pile using vibratory methods only at the Edmonds terminal, which will be conducted in one day and is estimated to take approximately 10 minutes.

Both vibratory noise with high frequency and impact noise with high amplitude can create sufficient disturbance that the action areas are impaired as migratory areas, but this persists only for the duration of the pile driving. Because work ceases each day, migration values are re-established during the evening, night, and early morning hours. The current background noise level near both the Eagle Harbor Facility and the Edmonds Ferry Terminal construction sites is 120 dB RMS. The distance that vibratory and impact pile driving noise will extend throughout the habitat is described in section (2.3 Action Area).

Noise caused by the proposed action may affect PS/GB bocaccio and PS Chinook salmon nearshore habitat. Habitat may be affected by noise levels detectable to fish, beyond background noise levels, and above the dual injury thresholds (see below for effects on species). Because the impact pile driving of steel piles will be conducted during the timeframe when juvenile salmon are least likely to be present and will also be conducted utilizing a noise attenuation device (bubble curtain or other device), migration value impairment will be minimized, and is of short duration. The remainder of the pile driving will be with a vibratory driver, which also creates sound throughout the action areas, but does not create underwater noise levels that would diminish the area for migration values.

Forage fish include: Pacific herring, surf smelt, and Pacific sand lance (Penttila 2007). Adult forage fish 2 grams or larger, and juveniles and larval forage fish smaller than 2 grams, may be exposed to injurious levels of underwater noise (as described below). However, Halvorsen et al. (2012) determined that fish like sand lance that do not have swim bladders, may be less susceptible to injury from simulated impact pile driving. The majority of potential impacts to sand lance are expected to be limited to minor behavioral disturbance. Pacific herring and surf smelt have a swim bladder, but impacts to all forage fish species will be limited in extent and duration. Therefore, these responses will not reduce the forage base for ESA-listed species.

Disturbance of Bottom Sediments -
Pile driving, pile removal, and excavation causes short-term and localized increases in turbidity and total suspended solids (TSS) as the bottom materials are displaced during the intrusion of the pile structures, and from the percussive effect of the driving. Removal of creosote piles can also release contaminants into the surrounding water. This affects water quality and benthic prey communities as described above in section 2.5.1 (Temporary Effects during Construction).

We anticipate multiple episodes of suspended sediment daily for the piling work with each pile installation, removal, or encapsulation creating a small, temporary, turbidity plume at each site. Temporary localized effect on marine vegetation, benthos, and forage fish, with indirect effects on prey availability for listed species is expected to occur. The benthic communities in the footprints of the piles will be disturbed when the piles are removed and installed. Intertidal habitats, including clam and oyster beds, will be outside the limited construction zone and will not be impacted by construction.

Construction activities will result in the temporary increase in suspended sediments and contaminants and disturbance of benthic habitat. For estuarine waters, the point of compliance for a temporary area of mixing must not exceed a radius of 150 feet from the activity causing the disturbance of bottom sediments.

Forage fish that occur in the immediate project vicinity during in-water construction will be exposed to increased levels of turbidity and contaminant exposure. It is reasonable to assume that forage fish utilize the shorelines at the project terminal locations. Therefore, forage fish could be present and potentially affected by bottom disturbing construction activities.

2.5.4.2 Enduring Effects on Habitat

Migration Obstruction - Migration habitat values are not expected to be impaired for PS/GB bocaccio and SRKW, as these species do not rely on the nearshore area for migration.

Salmon habitat will experience enduring incremental diminishment of safe migration for Chinook salmon as described above in Section 2.5.2. 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. Shadows from large overwater structures built within nearshore environments can disrupt nearshore migratory behavior. A study conducted at ferry terminals found that juvenile salmon (predominantly pink salmon [*O. gorbuscha*]) will avoid swimming under docks and shaded areas, causing delay in migration by several hours during the daytime at high tide periods and on sunny days (Ono et al., 2010). These findings show that overwater-structures can disrupt juvenile migration in the Puget Sound nearshore, reducing the value of the habitat for its designated purpose of juvenile salmonid migration in estuarine and nearshore ocean environments.

Cover and Prey species - The portions of the structures that occur overwater in the nearshore environment will reduce vegetation and as a result refugia, potentially altering the existing species composition inhabiting the area to more shade-preferring species, as well as potentially affecting the nearshore migratory behavior of juvenile salmonids. It is reasonable to assume that shading from OWS adversely affects (by inhibiting and stunting growth) any SAV within the shadow of the structures.

The intertidal shallows and eelgrass beds provide important habitat for a variety of marine invertebrates and fishes, including rockfish, salmonids and their prey species. Surf smelt, a prey species, are believed to spawn throughout the year in portions of the action areas, with the heaviest spawn occurring from mid-October through December. It is important to avoid, minimize, and offset all impacts of the proposed action on the SAV in order to support cover and prey for listed species.

For SRKW, actions in Chinook salmon critical habitat have the potential to reduce quality and quantity of prey. 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 contaminants.

Given that 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 PS Chinook salmon from temporary effects would have little effect on Southern Resident killer whales. However, declines of SRKW's prey as a result of the enduring effects of overwater structures repaired or replaced in the proposed projects 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.

Habitat Conservation Offsets - The analysis offered in this biological opinion utilizes the Conservation Calculator with a target goal of no-net-loss of critical habitat functions. NMFS has determined that this proposed action would result in positive environmental results to nearshore habitat quality, quantity, or function equivalent to +221 credits (Table 4).

The proposed conservation offsets will address the loss of ecosystem functions due to the modification to the nearshore environment from the primary element of the proposed action. The conservation offsets included as part of the proposed action are intended to provide a small benefit to nearshore habitat conditions for salmon and rockfish by replacing solid decking on an overwater structure, which may in turn improve production of benthic prey communities that support the fitness growth and maturation of salmonids and juvenile rockfish. While there will be a brief in-water disturbance of habitat values (sound, visual disturbance, suspended sediment, water quality reduction) the removal of creosote-treated piles will result in an increase in benthic substrate to support the recruitment and establishment of submerged aquatic vegetation, which in turn creates additional refuge and forage habitat for juvenile rockfish and PS Chinook salmon. Additionally, removal of creosote timber piles will likely reduce accumulation of chemical compounds in nearshore marine sediments and the tissue of fish over the long-term (DNR 2014) by removing an in-water source. Each of these positive environmental results will benefit PS Chinook salmon, and thereby benefit SRKW critical habitat.

Summary of Effects on Critical Habitat

To summarize the effects on critical habitat, PBFs will be temporarily impaired during construction at each project location with a corresponding reduction in habitat/resource availability while the work occurs. Removal of creosote piles is likely to have detrimental water quality effects for up to three years. However, activities covered by this Opinion also improve habitat over existing conditions by permanently removing creosote piles and increasing light-penetration at the Eagle Harbor Facility.

Although, chronic and enduring diminishments of habitat created by nearshore in-water and overwater structures to water quality, migration areas, shallow water habitat, forage base, and SAV have and will continue to incrementally degrade the function of habitat, for PS Chinook salmon and PS/GB bocaccio considered in this analysis, the NHVM is being used to ensure no net loss of habitat function, as described in Section 2.1. Therefore, the enduring effects of the repaired or replaced structures will not result in measurable enduring effects to the juvenile PS Chinook salmon at the population level and the prey base PBF of SRKW critical habitat will not be impaired.

2.5.5 Effects on Listed Species

Effects on listed species are 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 life stage at exposure. This section presents an analysis of exposure and response.

The temporary effects on species associated with construction are:

1) Underwater noise, which can cause
    a. Impact driving – fish and SRKW response,
    b. Vibratory driving – fish and SRKW response,
    c. Disrupted migration.
2) Disturbance of bottom sediments which cause
    a. Water quality impacts, and
    b. Disturbance of benthic communities (forage).

The enduring effects on species associated with in water structures are:

1) Shade from the overwater structure which can cause
    a. Migratory pathways obstruction,
    b. Reductions in aquatic vegetation/cover,
    c. Reduced benthic communities/forage; and,
    d. Increased predator risk
2) Habitat conservation offsets

As noted above in the effects to habitat and 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 areas, 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.

Species Presence and Exposure

As described in Section 1.3, all work would occur from August 1 through February 15, within one in-water work window at each of the facilities. The work window is designed to minimize juvenile salmonid exposure to construction effects. Also, where required by the WDFW, forage fish surveys will occur prior to the start of repairs, and will only proceed when forage fish eggs are no longer present. However, these measures will not completely avoid exposure to listed species and their prey from temporary construction effects and long-term effects from the persistence of the structures.

Each of the following species uses the action areas, but is present at differing life history stages, and with variable presence. In order to determine effects on species, we must evaluate when species will be present and the nature (duration and intensity) of their exposure to those effects of the action in their habitat, which were described above. It should be noted; an effect exists even if only one individual may be affected (Fish and Wildlife Service and the National Marine Fisheries Service 1998).

Puget Sound Chinook Salmon and Steelhead
Generally, PS Chinook salmon juveniles emigrate from freshwater natal areas to estuarine and nearshore habitats from January through April as fry, and from April through early July as larger subyearlings. As juvenile Chinook salmon increase in size they occupy deeper, offshore waters in search of larger prey. By July juvenile PS Chinook salmon are sufficiently large to no longer orient to the shoreline and thus would be less likely to be caught during beach seine surveys. Juvenile PS Chinook salmon are likely present in the action areas during the in-water work window, but in the deeper, offshore waters.

In contrast to other juvenile salmonids, juvenile steelhead outmigrate as age-2 or 3- year old fish and are larger in size. They typically move offshore shortly after entering the marine waters of Puget Sound (Goetz et al., 2015) and do not favor nearshore habitats for outmigration (Moore et al., 2010). Typically, PS steelhead juveniles emigrate from natal rivers as 2- or 3-year old smolts from March through June, peaking in April and May.

Beach-seining surveys conducted in the shore zones of Bainbridge Island, where impact pile driving will occur for the Eagle Harbor action, indicate that juvenile Chinook salmon are most numerous from May through August, but may be present in the action areas from March through December (Dorn and Best 2005; Shared Strategy for Puget Sound 2007). Steelhead are less common in the shallow nearshore, and beach seining sampling around Puget Sound has found few (Rice, 2011).

PS/GB Bocaccio
Adult bocaccio typically occupy waters deeper than 120 feet and are very unlikely to occur within the Eagle Harbor action area because of its mostly shallower depth. It is possible that juvenile bocaccio occur in any of the action areas. At 3 to 6 months, juvenile bocaccio settle onto rocky or cobble substrates in the shallow nearshore in areas that support kelp, and sandy zones with eelgrass or drift algae (Love et al. 2002). They move to progressively deeper waters as they grow (Love et al., 2002, Palsson et al. 2009.

Bocaccio larvae are typically found in the pelagic zone, often occupying the upper layers of open waters, under floating algae, detached seagrass, and kelp. Larval rockfish likely remain within the basin where they are released (Drake et al. 2010) but may be broadly dispersed from the place of their birth (NMFS 2003). Larvae are thought to be mostly distributed passively by currents (Love et al. 2002). Larval rockfish appear in the greatest numbers during the spring months (Moser and Boehlert 1991; Palsson et al. 2009). However, PS rockfish have been reported to extrude larvae as late as September (Beckmann et al. 1998). Larval rockfish were present in an early spring and a late summer peak that both coincide with the primary production peaks. Rockfish larvae essentially disappeared from surface waters by the beginning of

November (Greene and Godersky, 2012). Therefore, rockfish larvae presence can overlap with the work window so their exposure to construction effects is likely.

SRKW

Olson et al. (2018) systematically reviewed observations of SRKW from 1976 to 2014, which generally showed that all three pods had consistent presence in the Central Salish Sea (e.g. eastern Strait of Juan de Fuca and Southern Strait of Georgia including the San Juan Islands) during summer months (June - August) and a presence in Puget Sound proper during the fall and early winter months (September-January). 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.

In Puget Sound proper, there was limited SRKW occurrence in the spring and summer with an increased occurrence during the fall and early winter months between the months of October and January (Olson et al. 2018). All of the action areas for the projects in this Opinion occur in Puget Sound proper and SRKWs could be present during the in-water work window (August 1 – February 15 for all project sites) when project work will occur, especially from October through January.

2.5.5.1 Temporary effects on species associated with construction

Underwater noise – Impact pile driving can cause levels of underwater sound high enough to injure or kill fish and alter behavior (Turnpenny and Nedwell 1994; Turnpenny *et al*. 1994; Popper 2003; Hastings and Popper 2005). Death from barotrauma can be instantaneous or delayed up to several days after exposure. High sound levels can also 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 cSEL as low as 183 dB (re: 1µPa2-sec) was sufficient to injure the non-auditory tissues of juvenile spot and pinfish with an estimated mass of 0.5 gram.

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.

Cumulative SEL is a measure of the sound energy integrated across all of the pile strikes. The Equal Energy Hypothesis, described by NMFS (2007), is used as a basis for calculating 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. NMFS, USFWS, and WSDOT agreed to interim criteria to minimize potential impacts on 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.

For the Eagle Harbor project, WSF will impact drive 11 steel piles [(9) 24-inch diameter, (2) 36-inch diameter]. All 11 piles will be installed first with a vibratory hammer, which does not produce sound levels high enough to directly injure fish, then proofed with an impact hammer to verify their load-bearing capacity. To reduce sound levels, WSF will use a bubble curtain on all impact-proofed piles in water depths of 3-feet or greater. None of the other projects will conduct impact pile driving.

Underwater SPLs from impact pile-driving will be temporary and intermittent, lasting up to 6 hours per work day when installing the steel piles and removing timber piles with a vibratory driver. Proofing steel piles with an impact hammer will last approximately 90 minutes per work day. Removal of the timber piles and installation of the steel piles with a vibratory driver will take up to 29 days, and proofing piles with an impact hammer will take up to 5 days. All in-water work will occur between August 1 and February 15. Puget Sound Chinook salmon, and steelhead are unlikely to be less than 2 grams during this window (Rice, 2011), so the cSEL injury threshold for salmonids is 187 dB. Forage fish may be less than 2 grams or 2 grams and larger. Little information is available on the effects of underwater sound on rockfish (Hastings and Popper, 2005). However, all fish with swim bladders are likely affected by underwater sound, and we expect impacts for listed larval and juvenile listed rockfish similar to what we established for salmonids.

The pile work includes both impact driving, and vibratory driving, and the characteristics of sound from each of these methods are unique; each produces a different response in exposed species. The sound characteristics are also different between the sizes of piles in the aquatic environment. Finally, the response between species to each type of sound also varies based on their hearing acuity, their size, and their body composition. Based on the best scientific information available, we used the following assumptions for estimating the effects of the pile driving component of the proposed action on juvenile and adult PS chinook, steelhead, and bocaccio:

- PS Chinook salmon juveniles in the vicinity of pile driving activity during the work window will weigh more than 2 grams.
- Densities of PS Chinook juveniles in the PS nearshore 14 fish per hectare in August (Rice 2011).
- The density of steelhead smolts in the vicinity of pile driving is extremely low and all steelhead smolts in PS are larger than 2 grams.

- Larval and juvenile listed bocaccio may be present in the nearshore during impact pile driving. Exposure of adult rockfish to construction effects is considered very unlikely since they do not occupy the nearshore.
- The COE and WSF will be working August 1through February 15.
- Adult Chinook and steelhead may be present during piling installation.

NMFS presumes that underwater noise in excess of 150 dB_{RMS} (re: 1μPa) has the potential to elicit temporary behavioral changes, including a startle response or other behaviors, which may alter fish behavior in such a way as to delay migration, increase risk of predation, reduce foraging success, or reduce spawning success, indicative of stress. While SPLs of this magnitude are unlikely to lead to permanent injury, depending on a variety of factors (e.g., duration of exposure) they can still indirectly result in potentially lethal effects. NMFS' overall synthesis of the best available science leads us to our findings. Studies in which these effects have been studied for salmonids and rockfish include, Grette 1985 (on Chinook salmon and sockeye), Feist et al. 1996 (on chum salmon), Ruggerone et al. 2008 (on Coho salmon), Popper 2003 (on behavioral responses of fishes), and Pearson et al.1992, and Skalski et al. 1992 (on rockfish).

Although numerous studies have attempted to discern behavior effects to different fish species from elevated sound levels that are below harm levels but above ambient levels, relatively few papers have linked this exposure to effects on fish (Popper et al. 2014). Under some conditions, with some species, elevated sound may cause an effect but it is not possible to extrapolate to other conditions and other species (Popper and Hastings 2009). Davidson et al. (2009) indicated that studies have shown that salmonids do not have a wide hearing bandwidth or hearing sensitivity to SPL and are therefore not as likely to be impacted by increased ambient sound.

The WSDOT and WSF have compiled acoustic monitoring data for various pile driving projects throughout the state. Data can vary substantially between locations due to site-specific conditions (e.g. water depth, soft mud, sand, cobble, depth to bedrock, etc.). As a result, the use of site-specific data is critically important. In this opinion NMFS used local data provided by WSF to do this analysis. The observed increased sound pressures at 10 m for impact driving 36-inch steel piles in a marine environment are; 210 dB peak, 193 dB RMS, 183 dB SEL(single strike). The observed increased sound pressures at 10 m for impact driving 24-inch steel piles in a marine environment are; 212 dB peak, 189 dB RMS, 181 dB SEL(single strike).. Therefore, this analysis uses a conservative assumption of unattenuated impact-pile noise for noise impact analysis.

NMFS uses a Sound Pressure Exposure spreadsheet or calculator to estimate the area around each pile where fish would be considered at risk of injury or behavioral disruption during pile driving. Table 12 lists the expected sound levels that could be generated by driving the largest proposed steel pile associated with the project.

Table 12. Chinook salmon, steelhead, listed rockfish, and forage fish thresholds distances for impact pile driving (without attenuation reduction).

Pile Size/Estimated Number of Strikes	Distance (feet) to threshold			
	Onset of Physical Injury			Behavior
		cSEL dB		
	dB_{PEAK}	Fish ≥ 2 grams	Fish < 2 grams	dB_{RMS}
24-inch-diameter/450	82	1,595	2,950	13,061
36-inch-diameter/450	59	2,169	4,006	24,134

We expect that some death or injury of ESA-listed salmonids and rockfish is likely to occur from impact pile driving. Although the proposed steel pile driving is scheduled to occur at a time when most salmonid species are not actively migrating through the action areas, we expect some salmon and steelhead to be present during this time period and these are reasonably certain to be injured or killed within the threshold distances above.

The above discussed criteria specifically address fish exposure to impulsive sound. No consideration of non-impulsive sounds is given, and the discussion in Stadler and Woodbury (2009) makes it clear that the thresholds likely overestimate the potential for impacts on fish. Further, 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.

Vibratory hammers have not been observed to cause injury or death to fishes or other aquatic organisms. This may be due to the lack of sharp rise times (the time taken for the impulse to reach its peak over-pressure or under-pressure) and the fact that the energy produced is spread out over the time it takes to drive the pile. At the Eagle Harbor Facility, we anticipate that vibratory pile driving to install 38 piles and remove 194 piles (186 creosote and 8 steel) will cause only minor behavioral effects to adults but may cause behavioral changes in juveniles that can lead to predation or to changes in feeding behavior. We expect varying levels of behavioral responses, from no change, to mild awareness, or a startle response (Hastings and Popper, 2005), but we do not believe that this response will alter the fitness of any adults. However, a small number of juvenile salmonids and rockfish may exhibit a behavioral response that may kill or injure a listed juvenile. At the Edmonds terminal only 1 H-pile will be installed and 1 timber pile removed resulting in brief durations of vibratory pile driving of approximately 10 minutes. This short duration of exposure is unlikely to produce a significant response to the noise exposure.

While the timing of the work occurs over a work window designed to reduce the numbers of juvenile salmonids that would be migrating through in-water construction work, it is reasonable to assume that not all fish will be fully avoided, and that the few salmonids present will respond to noise in their migratory corridor. The range of responses are described above as direct effects to fish, and while we expect few fish from the various listed species or component populations will be present, the full range of effects will be experienced, making the migration area less suitable for these fishes by increasing the likelihood that they will be injured or killed during their migratory behavior. This will create a small detrimental effect on the survival rate, in both the work seasons, but this reduction will likely be indiscernible in the cohort adult returners, so productivity should remain at current levels.

We have no data to indicate that juvenile bocaccio migration to deeper water areas of habitat as they mature will be affected by underwater noise caused by the proposed action.

Disturbance of Bottom Sediments – Disturbance of bottom sediments affects water quality and benthic prey communities as described above in section 2.5.1 (Temporary Effects during Construction).

Listed fish near the creosote-treated timber structures in the action areas are likely exposed to PAHs. PAHs associated with creosote-treated wood can contaminate surrounding sediment up to 6.5 feet from the pile (Evans et al. 2009). Removal of the creosote-treated piles can mobilize PAHs into the surrounding water and sediments (Smith 2008; Parametrix 2011). The project will also release PAHs directly from creosote-treated timber during the demolition of the deck and if any of the piles break during removal (Parametrix 2011). The concentration of PAHs released into surface water rapidly dilutes. Smith (2008) reported concentrations of total PAHs of 101.8 micrograms per liter (µg/L) 30 seconds after creosote-pile removal and 22.7 µg/L 60 seconds after removal. While Weston Solutions 2006 found PAH concentrations of over 134 µg/L were observed 5 minutes following pile removal and concentrations in samples did not always go down at 5 minutes after removal. Contaminants in the water column generally settle out soon after pile removal; however, PAH levels in the sediment can remain high for 6 months or more (Smith 2008). These contaminants have been documented to cause massive cardiac effects in very low concentrations, especially at early life stages and in fish with developing hearts (West et.al, 2019). Larval and juvenile PS/GB bocaccio, PS Chinook, and PS steelhead are likely to be exposed. Because they are shoreline-oriented and spend a greater amount of time within Puget Sound, juveniles of Chinook salmon and PS/GB bocaccio will have the highest probability of exposure to PAHs; however, NMFS cannot discount the probability of juvenile steelhead being exposed to PAHs.

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. Turbidity plumes from disturbed sediments may exceed baseline water quality conditions up to 150 feet in any direction from the source. However, the impacts of pile installation and removal, and excavation are very minor and unlikely to significantly affect listed fish because they are: (1) one-time; (2) small-scale, and (3) very temporary, the sediment will settle within several minutes and will be easily avoided by listed fish species. Additionally, variations in turbidity occur normally within the environmental baseline of the marine nearshore—which is regularly subject to strong winds and currents that generate suspended sediments. Thus, the juvenile salmonids and rockfish likely will have encountered similar turbidity before. In general, low level increases expected to suspended sediment, within small affected areas, renders the effects of the increased turbidity on juvenile salmonids and bocaccio not meaningful.

As was discussed above, benthic communities will be impacted and it can take weeks to many months to re-establish their former abundance and diversity. During the in-water work, we can expect that benthic prey is less available to juveniles, incrementally diminishing the growth and fitness of individual outmigrants that pass through the action areas.

The reduction in total quantity of prey (PS Chinook salmon) available to SRKWs throughout their range from the temporary construction effects of the proposed action is extremely small 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.

2.5.5.2 Enduring Effects on Species

Shading – As discussed in Section 2.5.2 (Enduring Effects of in-water and Overwater Nearshore Structures), and 2.5.4 (Effects on Critical Habitat), shade from these structures will produce a direct effect on salmonids and rockfish that causes delays in migration that can be detrimental to the species from an increased risk of predation. In addition, increased energy expenditure caused by delay during migration can impair growth and fitness at a time when juveniles are maturing for their ocean life history phase.

The reduced light regime under the OWS is also likely to result in temporarily decreased visual ability and decreased feeding success for those juveniles that do swim under structures in PS. The adverse effects of temporarily decreased visual ability and resulting decreased feeding success are considered reasonably likely to occur from the long-term existence of the structures. While the short-term decreased feeding success will likely result in a minor sub-lethal response of incrementally reduced growth in individuals, the decreased visual ability can lead to increased susceptibility among juvenile salmonids to predation, as mentioned above.

As discussed previously, shade from overwater and in-water structures is likely to cause a reduction to the primary production of SAV beds, which is likely to incrementally reduce the cover for individual juvenile PS Chinook salmon and bocaccio. The additional shade in the nearshore will likely prevent any disturbed eelgrass and macroalgae from reestablishing in the shaded area. This reduction will be an additional loss of prey, including epibenthos (Haas et al., 2002), which will primarily affect juvenile salmonids that migrate through and bocaccio that rear in the action areas at a time when their growth, development, maturation, fitness, and energy expenditure require plentiful prey.

Overwater structures in areas with forage fish spawning are likely to result in reduced numbers of forage fish (Penttila 2007). Salmonids exposed to these changed conditions are likely to experience a reduction in their individual growth, fitness, survival, and abundance. In general, early marine juvenile growth is dependent on ample food supply and has been shown to be linked to overall salmonid survival and production (Beamish et al. 2004) (Tomaro et al. 2012). Rapid growth of PS Chinook salmon during the early marine period is critical for improved marine survival (Duffy and Beauchamp, 2011). As generalist predators, bocaccio eat a diversity of other animals, from crabs, to worms, to fish and the loss of prey will affect them as well.

In summary, NMFS anticipates that PS Chinook juveniles will be vulnerable to piscivorous predators from aggregating at the replaced and repaired structures and forced into deeper water in order to go around the structures for the duration of each replaced structure's lifespan. Therefore, the enduring presence of the structures is considered to adversely affect individual juvenile PS Chinook salmon. Because the NHVM is being used to ensure no net loss of habitat function, as described in Section 2.1, the enduring effects of the repaired and replaced structures will not result in measurable enduring effects to the juvenile PS Chinook salmon at the population level.

No direct effect to SRKW is expected from the presence of increased overwater cover at the WSF' terminals because nearshore overwater structures are not considered to be a significant obstruction to their movements. No measurable effects to the forage base of SRKW is expected because habitat offsets will be used to ensure no net loss of habitat function.

Habitat Conservation Offsets -

To address enduring impacts to aquatic habitats for this consultation, the COE and WSF used credits calculated with the NHVM, as described in Section 2.1. The credits will address the loss of ecosystem functions with the goal of achieving a no-net-loss of habitat function as a result of these proposed projects. A no-net-loss will help ensure that PS Chinook do not continue to drop below the existing 1-2% percent juvenile survival rates (Kilduff et al. 2014, Campbell et al. 2017) and in turn will not further reduce available SRKW prey. With implementation of the NHVM, we expect no net loss of shoreline habitat from repair and replacement of in-water and over-water structures covered by this Opinion.

Summary of Effects on Listed Species

In addition to the short-term construction-related effects that will affect only those cohorts of fish present during the work, the proposed action has long-term effects on the marine nearshore environment that multiple cohorts of fish will experience over the useful life of the structures. These long-term effects result in obstruction of fish movement, potential reduction in SAV density and food supply, and disturbance from boating activity and noise. The species most likely to be repeatedly/chronically exposed to these conditions are juvenile PS Chinook salmon which typically migrate or rear in the nearshore area. Steelhead are less affected by the habitat detriments associated with the action because by the time they reach the nearshore/marine environment, they are larger fish more adapted to deeper water, and so have lower demand for nearshore migration, predator refugia, and prey base. The reduction in food supply and SAV would adversely affect juvenile bocaccio present in the nearshore.

These long-term habitat changes, which will persist for the life of the structures, result in an incremental increase in stress, reduction in foraging success, alteration of migration patterns (forcing juveniles to leave the nearshore), and impairment of predator avoidance. Effects to individual fish will occur among an undetermined percentage of all future cohorts of all populations that use the nearshore areas in each project's action area. We anticipate that a small number of juveniles of each species will be injured or killed because of reduced habitat suitability for listed species and increased predation resulting from the action. We expect these decreases to be proportional to the relatively small amount of habitat adversely affected.

Further reductions in SRKW prey quantity, or spatial or temporal depletions would reduce the representation of diversity in prey 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.

We also expect that the conservation credits calculated will result in a net zero loss of habitat function. Although the proposed action results in suppression of habitat quality due the persistence of structures in the nearshore of Puget Sound, we anticipate that a small number of juvenile PS Chinook salmon, juvenile PS steelhead, and PS/GB bocaccio, would be injured or die as a result of the reduced habitat quality. These impacts will be offset with the resulting conservation credits. As such, we anticipate no population-scale effects to these species.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation [50 CFR 402.02 and 402.17(a)]. 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.

Non-federal cumulative effects reasonably certain to occur in the action areas include operation, maintenance, and use of the terminals as well as future upland activities including commercial and residential development resulting from population growth, over fishing, commercial and recreational use of Puget Sound, and global warming. Planned growth consistent with county land use and growth management plans, will, in the long-term, result in additional effects to ecological functions, surface water quality, and nearshore habitat.

The human population in the PS region increased from about 1.29 million people in 1950 to about 4.2 million in 2020, and is expected to reach nearly 5 million by 2040 (Puget Sound Regional Council 2020). Thus, future private and public development actions are very likely to continue in and around Puget Sound. 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, and additive degradation to occur. We consider human population growth to be the main driver for most of the future negative effects on salmon, steelhead, bocaccio, and their habitat.

Anticipated climate effects on abundance and distribution of PS Chinook salmon include a wide variety of climate impacts. The greatest risks will likely occur during incubation, when eggs are vulnerable to high mortality due to increased flooding and variability in seasonal flow (Ward et al. 2015). Crozier et al. (2019) identified early life stages such as incubating eggs as highly sensitive when exposed to more variable hydrologic regimes. Crozier et al (2019) also predicted that 8% of spawning habitat will change from snow-dominated to transitional, and 16% will change from transitional to rain-dominated. These projections suggest that winter flooding will become more common, directly affecting incubating eggs. Stream temperature ranks high in the extent of change expected, which could increase pre-spawn mortality in low-elevation tributaries (Bowerman et al. 2017). Rising temperatures during late spring and summer may also impact Chinook salmon juveniles in estuary and riverine habitats. Most Puget Sound estuaries already surpass optimal summer rearing temperatures, and the expectation of additional warming would further degrade already degraded habitat (Crozier et al 2019, Appendix S3).

In addition to these growth-related habitat changes, climate change has become an increasing driver for infrastructure development and changes to protect against sea level rise in coastal areas. These changes to nearshore habitat can include sea walls like the one currently being constructed in Venice, Italy and considered for many major US cities including New York (Marshall, May 2014). Regardless of the environmental effects, the cost of flooding has been predicted to be higher than the cost of building such sea walls (Lehmann, February, 2014) which increases the likelihood of more flood protection projects being implemented in the Puget Sound region in the future. These flood protection projects will likely include, filling, raising of habitat, dikes, dunes, revetments, flood gates, pump stations, and sea walls; all habitat modifications that will be detrimental to salmon. Over the useful life of the existing terminal structures covered in this Opinion, we expect the effects of climate change in the action areas will include decreasing salinity, modified temperature regime, increasing acidity, and sea-level rise.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

Salmonids – PS Chinook salmon and PS steelhead are threatened species, while bocaccio rockfish and SRKW are endangered. The status of these species is driven in part by habitat conditions that limit productivity in the action areas as a baseline condition, and habitat loss and degradation designation-wide. To this baseline, and cognizant of the status of species, we add the effects of the proposed action.

The anticipated effects during trestle replacement, float removal, and pile installation, removal, and encapsulations will occur among rearing PS Chinook salmon, and migrating PS steelhead. They will be exposed to elevated turbidity, reduced forage opportunities, and elevated underwater noise. The effects are expected to be behavioral responses that abate quickly and are unlikely to result in injury or death for more than a few individuals (fishes).

To the degree that juvenile PS Chinook salmon are exposed to water quality contamination from creosote, they could have a sublethal or delayed health responses. It is unlikely that the proposed action will reduce population viability because only one cohort of Chinook salmon juveniles would be negatively affected by the construction effects of the action. Additionally, the habitat conservation offsets ensure that habitat conditions and overall carrying capacity are not reduced below baseline conditions by the permanent in-water effects of structures. In fact, small long-term habitat benefits are associated with the conservation offsets and may slightly increase carrying capacity over time.

Critical Habitat PS Chinook – The critical habitat has high conservation value for PS Chinook salmon (NOAA Fisheries 2005) despite the current degraded conditions. Nearshore habitat modification has caused broad-scale ecological changes, reducing the ability of critical habitat to support PS Chinook salmon juvenile migration and rearing. Once developed, shoreline areas tend to remain developed due to the high residential, commercial, and industrial demand for use of these areas. New development continues and as infrastructure deteriorates, it is rebuilt. Shoreline bulkheads, marinas, residential structures, and port facilities are quickly replaced as they reach the end of their useful life. Although designs of replacement infrastructure are often more environmentally friendly, replacement of these structures ensures their physical presence will cause adverse effects on nearshore habitat into the future. This is evidenced by the continued requests for consultation on these types of actions. As a result, shoreline development causes a "press disturbance" in which habitat perturbations accumulate without periods of ecosystem recovery. This interrupts the natural cycles of habitat disturbance and recovery crucial for maintenance of 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 for PS Chinook salmon. 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, nearshore habitat is not able to support optimal juvenile survival of PS Chinook salmon such that populations of this ESU can become viable.

The proposed action would have minor, positive and negative localized habitat effects. Additionally, the temporary effects on critical habitat do not occur at an intensity that will further limit the action areas' role for growth, maturation, or movement of any of the fishes between important habitats. Cumulative effects – including increased recreational use of marine waters, upland sources of contamination associated with human population increases, and intensified climate change– are likely to outweigh the conservation gain in this habitat, but do make the need for conservation gains more acute. When long and short term effects are considered together and added to the baseline, the proposed action does not further reduce the conservation value of the action areas for PS Chinook salmon.

Puget Sound/Georgia Basin bocaccio and critical habitat - PS/GB bocaccio are endangered species. Abundance and productivity is a fraction of historic abundance. Bocaccio abundances continue to decline with little to no signs of any effects of recent protective measures. One of the main factors for their poor status and low abundance and productivity is past practices of overharvesting and a life history that does not allow for fast recovery. Rockfish are long-lived, mature late, and highest fecundity occurs in older and larger fish which largely have been harvested. Climate change is likely to exacerbate several of the ongoing issues for bocaccio critical habitat, mainly the reduction in available quality nearshore rearing habitat.

On top of the poor abundance, productivity, and nearshore habitat conditions, three effects resulting from the proposed action are likely to have measurable adverse effects on bocaccio critical habitat and listed species: (1) sound effects from impact driving steel piles, (2) increased contaminants from creosote-treated timber pile extraction, (3) reduced forage as a result of sediment disturbance piles and overwater coverage. The effects are of the same nature and magnitude as described above for salmonids.

Changes to nearshore areas in Puget Sound have reduced the ability of this habitat to support juvenile life stages of PS/GB bocaccio. Loss of submerged aquatic vegetation has reduced cover available for larval and juvenile rockfish. Changes in physical characteristics of nearshore areas and loss of water quality reduce the amount of prey available for juvenile rockfish. Even though aspects of the baseline are degraded, mainly through nearshore development, and cumulative effects likely will continue to adversely affect the nearshore portion of bocaccio critical habitat, the added adverse effects of the proposed action are too small on a DPS-level to substantially reduce the conditions of critical habitat or preclude re-establishing properly functioning conditions. Overall, when added to the baseline and cumulative effects, the effects of the action on bocaccio critical habitat do not significantly affect the conservation value of critical habitat at the designation scale. The long term effects on PBFs for bocaccio are neither positive nor negative because of the offsetting habitat measures.

For effects to species, we expect a very small number of larval and juvenile rockfish to experience measurable adverse effects as the result of the construction and existence of the structures. Bocaccio are not identified with component populations, so effects among individuals are considered at the species scale in this section. Even when we consider the current poor status of the populations and degraded environmental baseline within the action areas, when we evaluate the addition of effects of temporary turbidity, sound, reduced forage, and chemical exposure to the baseline condition, we do not expect reductions in abundance of larvae or juveniles from these construction effects to alter adult abundance or productivity, nor to further degrade baseline conditions or limiting factors.

Although loss of nearshore habitat quality is a threat to bocaccio, the recovery plan for this species list the severity of this threat as low (NMFS 2017). Other factors, such as overfishing, are more significant threats to PS/GB bocaccio. Moreover, due to the uncertainty associated with current population abundance estimates and the uncertainty of the total number of fish likely to be taken as a result of the action it is difficult to determine the impact on the population viability of Central and South basin bocaccio populations. However, because the adverse construction effects are short term only one cohort of juvenile bocaccio would be impacted and is unlikely to reduce the viability of the populations. The effects of the action will be too small in scale and too minor to have a measurable impact on the affected populations. Because the proposed action will not significantly reduce the productivity, spatial structure, or diversity of the affected populations, the action, when combined with a degraded environmental baseline and additional pressure from cumulative effects, will not appreciably affect the status of PS/GB bocaccio.

<u>Southern Resident Killer Whale and critical habitat</u> - Southern Resident killer whales are endangered species. 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. 2021). Reduced prey availability is a major limiting factor for this species. Most wild salmon stocks throughout the whales' geographic range are at fractions of their historic levels. Moreover, further reductions in prey salmon species, particularly Chinook salmon, will risk SRKW recovery and persistence.

As described in Section 2.5.5 (Effects to Listed Species), the anticipated short-term reduction of PS Chinook salmon 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.

Critical habitat for SRKWs is designated in Puget Sound and in certain areas outside Puget Sound. Within Puget Sound, the quality of critical habitat for SRKWs has been negatively affected by reduction of prey availability. Over the past several years, the reduced and declining SRKW status has become a serious concern. PS Chinook salmon, a key part of the prey PBF for SRKW critical habitat, is a concern for this consultation. Impacts on the survival of juvenile PS Chinook salmon translate to reduction of adult PS Chinook salmon, the prey PBF for SRKW critical habitat. As observed during recent years, the SRKW's population has declined. Toxins in Puget Sound persist and build up in marine organisms including SRKWs and their prey resources, despite bans in the 1970s of some harmful substances and continued cleanup efforts. Once in the environment these substances proceed up the food chain, accumulating in long-lived top predators like SRKWs. Under the current environmental baseline combined with the effects to prey resources from the proposed actions' enduring effects, critical habitat for SRKWs would reduce the ability for habitat to produce enough Chinook salmon to support the conservation of this species. As presented in Table 4 and discussed in Section 2.1, Analytical Approach, the output of the NHVM for the four batched projects resulted in a net positive balance of conservation offsets. With application of the offsets, we do not expect a long-term reduction of the prey PBF for SRKW.

2.8 Conclusion

Table 13 provides the effect determinations that the NMFS concluded in this opinion.

Table 13. Effect determinations concluded by NMFS

Species	Listed Species Determination	Critical Habitat Determination
PS Chinook	LAA	LAA
PS Steelhead	LAA	N/A
PS/GB Bocaccio	LAA	LAA
PS/GB Yelloweye Rockfish	NLAA	NLAA
SRKW	LAA	LAA
Humpback Whales	NLAA	N/A

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action areas, the effects of the proposed actions, the effects of other activities caused by the proposed actions, habitat conservation offsets, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon, PS steelhead, PS/GB bocaccio, and SRKW or destroy or adversely modify PS Chinook salmon, PS/GB bocaccio, or SRKW designated critical habitat.

2.9 Incidental Take Statement

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

No recommendations were provided to the COE by NMFS in response to the notification of an emergency action at the Edmonds Ferry terminal.

2.9.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

NMFS expects harm of PS Chinook salmon (juvenile and adult), PS steelhead (juvenile and adult), and PS/GB bocaccio (egg, larvae, and juvenile), SRKW from temporary construction related actions[19]. Additionally, we expect harm of individual PS Chinook salmon (juvenile and adult), PS steelhead (juvenile and adult), PS/GB bocaccio (egg, larvae, juvenile, and adult) and SRKW from enduring impacts resulting from the persistence of the existing terminal structures that were replaced or repaired.

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 areas 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 areas 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 are exceeded, they are considered meaningful reinitiation triggers and exceeding any of the surrogates would suggest a greater level of effect than was considered by NMFS in its analysis.

Construction Timing and Duration Surrogates

The timing (in-water work window) and duration (days) of in-water work are applicable to construction related stressors described below because the in-water work windows for specific geographic regions are designed to avoid the expected peak presence of listed species in the

[19] The temporary nature of the construction related effect on SRKW and their 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.

action areas. Construction outside of the in-water work window could increase the number of fish that would be exposed to construction related stressors, as would working for longer than planned. Therefore, for all stressors below that identify a timing and duration take surrogate, they will be synonymous with the defined in-water work window and number of in-water workdays.

Harm from Impact Pile Driving Activities - Noise

PS Chinook salmon (juvenile and adult), PS steelhead (juvenile and adult), and PS/GB bocaccio (egg, larvae, juvenile) will be exposed to construction-related noise resulting from impact pile installation activities. Disruption of normal feeding and migration, and injury and death can occur from this exposure. The maximum number of individual pile strikes per day (1,350), and time of impact pile driving per day (90 minutes) are the best available surrogates for the extent of take from exposure to pile installation. Impact pile driving that increases the daily number of strikes or duration increases the numbers of fish exposed to harmful conditions, and would be an measurable exceedance of take.

Harm from Suspended Sediments, Contaminants, and Benthic Disturbance

PS Chinook salmon (juvenile and adult), PS steelhead (juvenile and adult), PS/GB bocaccio (egg, larvae, and juvenile), will be exposed to suspended sediments and contaminants during removal of debris (timber treated piles) in the nearshore, and nearshore construction activities (excavation and pile installation). Impairment of normal patterns of behavior including rearing, migrating, and foraging effects, as well as potential injury such as gill abrasion, cough, cardiac impacts.

The extent of harm to Chinook salmon, steelhead and bocaccio from suspended sediments, turbidity, elevated PAHs and reduced prey can be measured by the area where suspended sediments exceed background levels. The maximum extent of take from elevated suspended sediment is defined as within the 150-foot buffer around the outer boundaries of each of the project footprints. If suspended sediments are visible in an area beyond the 150-foot buffer, the number of fish exposed to harmful conditions would increase, and that would indicate exceedance of take.

Harm due to habitat-related effects

PS Chinook salmon (juvenile and adult), PS steelhead (juvenile and adult), PS/GB bocaccio (egg, larvae, juvenile) and SRKW will be exposed to reduction in the quantity and quality of nearshore habitat resulting from the persistence of nearshore overwater 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.

The proposed action does not result in an increase in over water structures, but an overall reduction. Therefore, there is no incidental take due to increased shading from structures. Although the persistence of the structures represent harm to listed species, there is no increase from the proposed action to the number of individuals affected. Additionally, the habitat conservation offsets are anticipated to minimize and avoid any incidental take associated with the persistence of nearshore overwater structures. If the size of overwater structures is increased, then the amount of displacement from preferred migration areas, the amount of shade, and the amount of predator habitat will all increase, affecting a greater number of listed fish than was considered in this analysis and the take surrogate will be exceeded. 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. Therefore, if any surrogate is exceeded, reinitiation of consultation will be required.

2.9.2 Effect of the Take

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

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1. Minimize the incidental take of listed salmonid and rockfish species from the effects of pile driving.

2. Minimize incidental take of listed species resulting from suspended sediment, contaminants, and benthic disturbance during construction.

3. Prepare and provide NMFS with plans and reports describing how impacts of the incidental take on listed species will be monitored and documented.

4. Ensure a no-net-loss of habitat function via equivalent credit allocation or debit offset via confirmation of creosote tonnage removed and the use of the Conservation Calculator.

2.9.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The COE or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:
    a. During impact pile driving, a soft-start approach will be used. This soft-start approach requires contractors to initiate noise from hammers at reduced energy, followed by a waiting period.
2. The following terms and conditions implement reasonable and prudent measure 2:
    a. Conduct water quality monitoring during construction activities to ensure compliance with State Water Quality Standards at each project site.
    b. If turbidity plume exceedances beyond the State compliance level and distance occurs, place and maintain additional turbidity management BMPs, such as a silt curtain.
3. The following terms and conditions implement reasonable and prudent measure 3:
    a. Monitor to ensure:
        i. Impact driving will last no more than 90 minutes in total time each day.
        ii. Steel piles receive no more than 1,350 pile strikes per day total.
        iii. Suspended sediments, turbidity, and elevated PAHs and reduced prey (benthic disturbance) do not exceed the 150-foot buffer around the outer boundaries of each of the piles.
        iv. Amount of over water coverage (shade) at project completion does not exceed existing over water cover.
    b. Provide Monitoring Report(s) that include:
        i. Description of pile driving activities such as:
            a. Dates and daily duration of pile related in-water work.
            b. Number of piles installed with an impact pile driver.
            c. Number and method of piles removed.
        ii. The final size/amount of overwater coverage:
        iii. Water quality monitoring results.
        iv. The report(s) shall be submitted to NMFS within 6 months of completion of construction. 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.

4. The following terms and conditions implement reasonable and prudent measure 4:
   a. Confirmation of creosote tonnage is required to confirm conservation credits associated with this action as conservation offsets are realized. Following the submission of creosote tonnage documentation, a final balance, not to exceed +221 conservation offsets will be confirmed by NMFS.
      i. The applicant is responsible for tracking and accounting of conservation offsets.
   b. Confirm the tonnage of creosote removed resulting from the proposed action by submitting dump receipts verifying the total creosote tonnage removed *and* submitting photos of vessels/vehicles with creosote timber on them at the disposal felicity.
      i. Tonnage less than the estimated 149-tons shall result in a re-calculation of conservation offsets in the Conservation Calculator.
      ii. Tonnage in excess of the estimated 149-tons will *not* result in a recalculation.
   c. If this project results in a negative value in the Conservation Calculator (due to fewer tons of creosote than projected), the applicant must offset those remaining debits within one year, within the South-Central Puget Sound Partnership service area.
      i. Offsets may be achieved by on-site conservation or off-site conservation actions within the same Puget Sound Basin. These will be evaluated with the Conservation Calculator.
      ii. Offsets may also be purchased through a conservation bank.

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).

The COE and the WSF should identify and implement nearshore habitat enhancement or restoration activities in South Central Puget Sound, including the action areas, that:

1. Improve the quality of riparian habitat and submerged aquatic vegetation to increase cover and forage for juvenile migration and rearing; and
2. Remove existing in-water structures such as docks, floats, piles, bulkheads, or armoring that are no longer in use.

Please notify NMFS if the COE or WSF carries out these recommendations so that we will be kept informed of actions that are intended to improve the conservation of listed species or their designated critical habitats.

2.11 Reinitiation of Consultation

This concludes formal consultation for the U.S. Army Corps of Engineers Eagle Harbor Maintenance Facility Slip F Drive-on Improvement Project, the Point Defiance, Tahlequah, Vashon Ferry Terminals Trestle Repairs Project, the Edmonds Ferry Terminal Trestle Repair Project, and the Edmonds Ferry Terminal Trestle Emergency Repair Project in Kitsap, Pierce, King and Snohomish Counties, Washington (COE Nos. NWS-2016-545, NWS-2021-162, and NWS-2010-38).

Under 50 CFR 402.16(a): "Reinitiation 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: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered;, (3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence: or (4) If a new species is listed or critical habitat designated that may be affected by the identified action."

2.12 "Not Likely to Adversely Affect" Determinations

The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur.

Humpback Whales

Humpback whales are baleen whales, filtering their food through the baleen from the water. They feed on tiny crustaceans (mostly krill), plankton, and small fish and can consume up to 3,000 pounds (1,360 kg) of food per day. Factors which may be limiting humpback whale recovery include entanglement in fishing gear, collisions with ships, whale watching harassment, subsistence hunting, and anthropogenic sound (NMFS 1991). On September 8, 2016, NMFS published a final rule to divide the globally listed endangered humpback whale into 14 DPSs and place four DPSs as endangered and one as threatened (81 FR 62259). There are two separate ESA-listed DPSs of humpback whales that may occur in the action areas, the Central American DPS and Mexico DPS. Since 2000, humpback whales have been sighted with increasing frequency in the inside waters of Washington (Falcone et. al. 2005).

While humpback sightings in PS do occur during the proposed work window, the likelihood for exposure to construction-related impacts (increased sound pressure levels) is discountable. This is because the COE and WSF will be implementing a marine mammal monitoring program that will include monitoring to identify humpback whales and shut down any pile driving activities before an animal could be exposed. Our understanding is that visual marine mammal monitoring will be conducted before, during, and after pile driving by experienced Marine Mammal Observers, within zones that are estimated to encompass acoustic levels that could exceed injury or behavioral disturbance thresholds. In order to protect listed marine mammals, pile driving will not start, or will cease if underway, if marine mammals enter the Level A injury zone. In addition to the Level A shutdown protocol, if humpback whales are seen in the Level B monitoring zone, pile driving shall cease.

Furthermore, anticipated long-term impacts to primary productivity, invertebrates and forage fish, all of which are potential prey of humpbacks, are localized to the intertidal and nearshore areas adjacent to the terminal facilities where humpbacks are unlikely to occur.

Yelloweye Rockfish and its Designated Critical Habitat

Critical habitat for adult and juvenile yelloweye rockfish includes 414.1 square miles of deepwater marine habitat in Puget Sound, all of which overlaps with areas designated for adult bocaccio. No nearshore component was included in the critical habitat listing for juvenile yelloweye rockfish as they, different from bocaccio, typically are not found in intertidal waters (Love et al., 1991). Yelloweye rockfish are most frequently observed in waters deeper than 30 meters (98 ft) near the upper depth range of adults (Yamanaka et al., 2006). Project effects that may extend into these deepwater habitats include noise from pile driving at the Eagle Harbor Facility and Edmonds Terminal. Temporary noise, primarily continuous noise from vibratory pile driving, that extends into deepwater habitat will not measurably alter the PCEs of this habitat, including prey species, water quality and structure and is considered insignificant.

Unlike PS/GB bocaccio, larval and juvenile PS/GB yelloweye rockfish do not typically utilize the nearshore environment and are more likely to be found in areas with greater depth. It is unlikely that juvenile yelloweye rockfish will occur within SAV habitats of the action area because they do not use the nearshore for rearing. Larval rockfish presence typically peaks twice, once in spring and once in late summer. Larval rockfish likely remain within the basin they are released (Drake et al. 2010) but may be broadly dispersed from the place of their birth (NMFS 2003). Still, we find the likelihood of larval or juvenile PS/GB yelloweye rockfish to be occupying the action areas to be low. Similarly, the presence of adult PS/GB yelloweye in the action area is extremely unlikely. Suitable habitat for the adult lifestage is extremely limited based on preferred habitat depths and features such as rugosity. Although, given the ability of this species to move throughout the marine environment, we cannot conclude that they would not ever occur within the action areas, either during construction action or over a proposed structure's useful life. However, we expect exposure of all life stages of PS/GB yelloweye rockfish to project effects to be extremely unlikely. We find the likelihood of PS/GB yelloweye rockfish experiencing adverse effects from the proposed action to be highly unlikely and therefore discountable.

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

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)].

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

3.1 Essential Fish Habitat Affected by the Project

The proposed action and action areas for this consultation are described above in Sections 1.3 (Proposed Federal Action) and 2.3 (Action Area). The action areas for the proposed projects include habitat which has been designated as EFH for various life stages of Pacific coast groundfish, coastal pelagic species, and Pacific salmon (Table 14).

Of the 83 managed groundfish species, less than half are likely to occur in the nearshore of Puget Sound. EFH for Pacific coast groundfish is defined as aquatic habitat necessary to allow for groundfish production to support long-term sustainable fisheries or groundfish and for groundfish contributions to a healthy ecosystem. This definition includes all waters from the MHHW line, and the upper extent of saltwater intrusion in river mouths along the coasts of Washington, Oregon, and California seaward to the boundary of the EEZ.

Three coastal pelagic species are known to occur in the greater Puget Sound: northern anchovy, Pacific mackerel, and market squid. The definition for coastal pelagic species EFH is based on the geographic range and in-water temperatures where these species are present during a particular life stage (67 Federal Register 2343-2383). EFH for these species includes all estuarine and marine waters above the thermocline where sea surface temperatures range from 50 to 68°F. Coastal pelagic species have value to commercial Pacific fisheries, and are also important as food for other fish, marine mammals, and birds (63 Federal Register 13833).

Three salmon species are known to occur in the greater Puget Sound: coho, Chinook, and pink. In estuarine and marine areas, salmon EFH extends from the extreme high tide line in nearshore and tidal submerged environments within state territorial waters out to the exclusive economic zone (200 nautical miles) offshore of Washington (PFMC 2014). Within these areas, EFH consists of four major components: (1) spawning and incubation; (2) juvenile rearing; (3) juvenile migration corridors; and (4) adult migration corridors and adult holding habitat.

Habitat areas of particular concern (HAPC) are specific habitat areas, a subset of the much larger area identified as EFH, that play an important ecological role in the fish life cycle or that are especially sensitive, rare, or vulnerable. Coastal pelagic species do not have designated HAPCs. The action areas include EFH which has been designated as HAPC for groundfish and salmon. As described in section 2.4 (Environmental Baseline), estuaries and submerged aquatic vegetation (SAV), including canopy kelps and eelgrass beds, provide habitats that are biologically productive and provide a significant contribution to the marine and estuarine food webs for these fisheries. In general, there is a steady decline of kelp forests in Puget Sound, which are impacted by sediment, toxic pollution and shoreline alterations. Due to its resilience, eelgrass in Puget Sound is more stable overall, but has a patchy distribution along the subtidal and intertidal areas of the project sites and is impacted by warmer waters and over water shading.

The BAR identifies no kelp or eelgrass near the Eagle Harbor maintenance facility, but both are present at the mouth of the harbor approximately 1 mile away. At the Edmonds Ferry terminal, kelp is nearly continuous between -5 and -60 feet MLLW, and approximately 4 acres of eelgrass occurs at depths from -2 to -20 feet MLLW to the north and south of the terminal. Kelp and eelgrass are prevalent east and west of the Vashon terminal. The areas directly underneath the ferry terminals and maintenance facility are generally devoid of eelgrass, mostly likely a result of shade. The areas directly offshore of and including the docking areas of the ferry terminals and maintenance facility are generally devoid of macroalgae, mostly likely a result of propeller-induced turbulence.

Table 14. EFH species and life history stage associated with shallow nearshore water in PS.

Scientific Name	Common Name	Adult	Juvenile	Larvae	Egg
Groundfish Species					
Anoplopoma fimbria	Sablefish	X	X	X	X
Citharichthys sordidus	Pacific sanddab	X			
Eopsetta jordani	Petrale sole	X			
Glyptocephalus zachirus	Rex sole	X			
Hexagrammos decagrammus	Kelp greenling	X		X	
Hippoglossoides elassodon	Flathead sole	X			
Hydrolagus colliei	Spotted ratfish	X	X		

Scientific Name	Common Name	Adult	Juvenile	Larvae	Egg
Isopsetta isolepis	Butter sole	X			
Lepidopsetta bilineata	Rock sole	X			
Merluccius productus	Pacific hake	X	X		
Ophiodon elongates	Lingcod			X	
Parophrys vetulus	English sole	X	X		
Platichthys stellatus	Starry flounder	X	X		
Psettichthys melanostictus	Sand sole	X	X		
Raja binoculata	Big skate	X			
Raja rhina	Longnose skate	X	X		X
Scorpaenichthys marmoratus	Cabezon	X	X	X	X
Sebastes auriculatus	Brown rockfish	X			
Sebastes caurinus	Copper rockfish	X	X		
Sebastes diploproa	Splitnose rockfish		X	X	
Sebastes entomelas	Widow rockfish		X		
Sebastes flavidus	Yellowtail rockfish	X			
Sebastes maliger	Quillback rockfish	X	X		
Sebastes melanops	Black rockfish	X	X		
Sebastes mystinus	Blue rockfish	X	X	X	
Sebastes nebulosus	China rockfish	X	X		
Sebastes nigrocinctus	Tiger rockfish	X			
Sebastes paucispinis	Bocaccio		X	X	
Sebastes pinniger	Canary Rockfish		X	X	
Squalus acanthias	Spiny dogfish	X			
Coastal Pelagic Species					
Engraulis mordax	Anchovy	X	X	X	X
Scomber japonicas	Pacific mackerel	X			
Loligo opalescens	Market squid	X	X	X	
Pacific Salmon					
Oncorhynchus tshawytscha	Chinook salmon	X	X		
Oncorhynchus kisutch	Coho salmon	X	X		
Oncorhynchus gorbuscha	Pink salmon	X	X		

3.2 Adverse Effects on Essential Fish Habitat

Migratory Pathway Obstruction

The proposed replacement of the Eagle Harbor trestle and transfer span and persistence of ferry terminals in aquatic habitat will continue to alter outmigration routes of juvenile salmonids due to physical characteristics of the structure. Juveniles will likely alter their migratory route to navigate around the proposed structures and move into even deeper water. When juveniles leave the shallow nearshore it increases their migration route and has the potential to increase their risk of predation. Although the total overwater cover of the proposed action will decrease slightly, and grated decking will be used, we expect this action to continue to impair the quality of the migratory corridor and hinder safe passage.

Effects on Forage, Cover, and Predation

SAV was documented in the project footprint near some of the terminals. There is a high likelihood that SAV patches will come and go within the action areas over the life of the structures. SAV is important in providing protective cover and a food base for juvenile fish, including salmon. Shading portions of the nearshore habitat for the life of the structures can adversely affect primary productivity and SAV if present in the structures shadow zone. Coastal pelagics, like northern anchovy, use estuarine habitats such as the intertidal zone, eelgrass, kelp, and other macroalgae and could therefore be affected by the impacts on their designated EFH. Any juvenile and sub-adult groundfish within the action areas would also be expected near the eelgrass and kelp habitats within the nearshore.

The continuing presence of structures in the water column also alter the suitability for EFH species, with different species preferring different types of substrate and minimal shading from over water cover.

Water Quality

Replacement of the Eagle Harbor slip will require removal and installation of 38 steel piles up to 36 inches in diameter and removal of 194 piles permanently (186 creosote and 8 steel). One timber pile will be removed at the Edmonds Ferry Terminal and one H-pile installed. Pile installation, removal, and pile repairs at the Vashon, Tahlequah, Point Defiance, and Edmonds ferry terminals will temporarily disturb bottom sediments within the immediate project construction area, resulting in localized increases in suspended sediment concentrations that, in turn, will cause increases in turbidity during the work window. Also, installation and operation of the sound attenuation measures (e.g., bubble curtain) will result in some local resuspension of bottom sediments into the water column.

Nearshore habitat disturbance and localized turbidity increases could affect the water column and substrate that is used as EFH by eggs and larvae of EFH species. Northern anchovy do not spawn on Puget Sound beaches but instead spawn year-round in the water column. Species that deposit eggs on, or in, the substrate have potential to be damaged directly by construction activities or smothered by sediments settling out of the water column. Should nearshore spawning habitats be disturbed during the eggs' presence, these eggs could be dispersed into the water column, increasing their risk of predation.

Elevated turbidity could alter normal dispersal patterns within the water column, potentially reducing survival. Sediments within the action areas are subject to leaching of PAHs from existing creosote treated piles in the environment and may be introduced to the water column when timber piles are removed. Larvae for a number of species for which EFH has been designated could also be affected by increased turbidity or contaminant exposure. Changes in water quality throughout in-water construction activities will be relatively small scale and localized and may affect EFH differently depending on varying life histories. Based on the analysis of water quality effects, along with the BMPs and minimization measures included, all effects to EFH from changes in water quality will be minor and localized, and short in duration.

The potential for accidental spills or releases of hazardous materials will be minimized through implementation of spill prevention and response plan to clean up fuel or fluid spills.

Benthic Communities

Temporary (pile removal) and enduring (piling placement, structure shading, etc.) impacts will disrupt benthic environments and larval/juvenile rearing habitats and food sources. Reduced diversity or density of epibenthic meiofauna reduces prey resources. Marine benthos will be removed where it is growing attached to existing piles. The cumulative impact of numerous and contiguous urban marine structures may be detrimental to the long-term success of numerous species, particularly recovery efforts for anadromous fish species that migrate along shorelines. There will be some loss of benthic habitat, some slow recovery, but other areas will rebound after the disturbance.

Hydroacoustic Obstruction of Habitat

Construction-generated noise has the potential to degrade groundfish, salmon, and coastal pelagic EFH by exposing the EFH to noise above behavioral and possibly injurious thresholds. The proposed action will increase cause sound waves that disrupt the aquatic habitat. The SPL from pile driving and extraction will occur contemporaneous with the work and radiate outward; the effect attenuates with distance. Both vibratory noise with high frequency and impact noise with high amplitude can create sufficient disturbance that the action areas are impaired as migratory areas, but this persists only for the duration of the pile driving or removal. Because work ceases each day, migration values are re-established during the evening, night, and early morning hours.

As stated in Section 2.5.1 in the opinion, the steel piles will be permanently installed to support the replacement of trestle and transfer span at Eagle Harbor. EFH will experience temporary increases in underwater sound levels during construction. It should be noted that 1) while impact piles driving will be used for proofing, the majority of pile driving will occur using a vibratory pile driver; 2) an attenuation device will be used during impact pile driving of steel piles; and 3) steel impact pile driving is anticipated to be required primarily for proofing piles. Coastal pelagic, Pacific coast groundfish, and Pacific coast salmon EFH present will be exposed to detectable noise in the water column. Pacific coast groundfish and salmon EFH will be exposed to noise above the injurious threshold as these distances would extend over existing eelgrass shoreward of the project area.

Conservation Actions

The proposed project will have temporary and enduring effects on EFH water bottoms and water columns. These effects culminate in short-term (construction-related) and long-term adverse effects on Pacific Coast groundfish, coastal pelagic species, and Pacific Coast salmon EFH. The proposed action incorporates a number of minimization measures to avoid, reduce, and minimize the adverse effects of the action on EFH. The overall proposed action results in a generation of conservation credits, to be used to offset negative habitat effects of the proposed action.

Conclusion

Pacific coast groundfish species are considered sensitive to overfishing, the loss of habitat, and reduction in water and sediment quality. Coastal pelagic species are considered sensitive to overfishing, loss of habitat, reduction in water and sediment quality, and changes in marine hydrology. Pacific salmon EFH is primarily affected by the loss of suitable spawning habitat, barriers to fish migration (habitat access), reduction in water quality and sediment quality, changes in estuarine hydrology, and decreases in prey food source

Based on information provided in the biological assessments, supplemental documentation, and the analysis of effects presented here and in the ESA portion of this document, NMFS determined that the proposed actions will have adverse effects on EFH designated for Pacific groundfish, coastal pelagic species, and Pacific Coast salmon. NMFS determined that the proposed action will adversely affect EFH by temporarily increasing noise and turbidity and contaminant levels, by the ongoing presence of overwater structures, and by altering benthic habitat.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS determined that the following conservation measures are necessary to avoid, minimize, mitigate, or otherwise offset the impact of the proposed action on EFH.

Therefore, NMFS recommends the following to ensure the conservation of EFH and associated marine fishery resources:

1. Preserve and enhance EFH by providing new gravel for spawning areas (beach nourishment).

2. Place a ring of clean sand around the base of each pile before removal. This ring will contain some of the sediment that would normally be suspended.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in Section 3.2 above, for Pacific coast groundfish, coastal pelagic species, and Pacific coast salmon.

3.4 Statutory Response Requirement

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

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The COE must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations [50 CFR 600.920(l)].

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the 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 U.S. Army Corps of Engineers. Other interested users could include, but are not limited to, the WSF, Washington State Department of Transportation and Ecology, tribal entities, counties, and Non-Governmental Organizations interested in conservation. Individual copies of this opinion were provided to the COE. 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 part 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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