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

Refer to NMFS No.:
WCRO-2019-01086

October 21, 2019

Michelle Walker
Corps of Engineers, Seattle District
Regulatory Branch CENWS-OD-RG
P.O. Box 3755
Seattle, Washington 98124-3755

Re: Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the BNSF North Fender Replacement Project at Railway Bridge 0050-37.0, Everett, Washington, COE Number: NWS-2019-65, Sixth Field HUC: 171100110202 – Snohomish River.

Dear Ms. Walker:

Thank you for your June 13, 2019 letter to request 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 U.S Army Corps of Engineers (COE) authorization of the BNSF Fender Replacement Project. 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 (MSA)(16 U.S.C. 1855(b)) for this action.

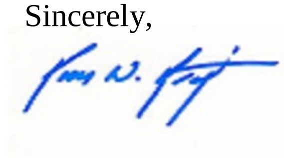
The enclosed document contains the biological opinion (Opinion) prepared by the NMFS pursuant to section 7(a)(2) of the ESA on the effects of the proposed action. In this Opinion, the NMFS concludes that the proposed action is not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon and PS steelhead, or to result in the destruction or adverse modification of designated critical habitat for those species. This document also serves to document our conclusion that the proposed action is not likely to adversely affect Puget Sound/Georgia Basin (PS/GB) bocaccio, PS/GB yelloweye rockfish, southern resident (SR) killer whales, and designated critical habitats for those three species.

As required by section 7 of the ESA, the NMFS has provided an incidental take statement with this Opinion. The incidental take statement describes reasonable and prudent measures the NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action, and sets forth nondiscretionary terms and conditions that the COE must comply with to meet those measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA’s prohibition against the take of listed species.

This document also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to Section 305(b) of the MSA. The NMFS reviewed the likely effects of the proposed action on EFH, and concluded that the action would adversely affect designated EFH for Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species. Therefore, we have included the results of that review in Section 3 of this document.

Please contact Donald Hubner in the North Puget Sound Branch of the Oregon/Washington Coastal Office at (206) 526-4359, or by electronic mail at Donald.Hubner@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,



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

cc: Ronald Wilcox, COE

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

for

BNSF North Fender Replacement at Railway Bridge 0050-37.0,
Everett, Snohomish County, Washington (6th Field HUC 171100110202 – Snohomish River)
(COE Number: NWS-2019-65)

NMFS Consultation Number: WCRO-2019-01086

Action Agency: U.S. Army Corps of Engineers

Affected Listed Species and Critical Habitats and NMFS's Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Chinook salmon (*Oncorhynchus tshawytscha*) Puget Sound (PS)	Threatened	Yes	No	Yes	No
Steelhead (*O. mykiss*) PS	Threatened	Yes	No	Yes	No
Bocaccio (*Sebastes paucispinis*) Puget Sound /Georgia Basin (PS/GB)	Endangered	No	No	No	No
Yelloweye rockfish (*S. ruberrimus*) PS/GB	Threatened	No	No	No	No
Killer whales (*Orcinus orca*) Southern resident (SR)	Endangered	No	No	No	No

N/A = not applicable. The action area is outside designated critical habitat, or critical habitat has not been designated.

Affected Essential Fish Habitat (EFH) and NMFS' Determinations:

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

Consultation Conducted By: National Marine Fisheries Service
West Coast Region

Issued By:

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

Date: October 21, 2019

TABLE OF CONTENTS

LIST OF ACRONYMS

BE – Biological Evaluation
BMP – Best Management Practices
CFR – Code of Federal Regulations
COE – Corps of Engineers, U.S. Army
DIP – Demographically Independent Population
DO – Dissolved Oxygen
DPS – Distinct Population Segment
DQA – Data Quality Act
EF – Essential Feature
EFH – Essential Fish Habitat
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FR – Federal Register
FMP – Fishery Management Plan
HAPC – Habitat Area of Particular Concern
HUC – Hydrologic Unit Code
ITS – Incidental Take Statement
LW – Large Wood
mg/L – Milligrams per Liter
MPG – Major Population Group
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NTU – Nephlometric Turbidity Units
PAH – Polycyclic Aromatic Hydrocarbons
PBF – Physical or Biological Feature
PCB – Polychlorinated Biphenyl
PCE – Primary Constituent Element
PFMC – Pacific Fishery Management Council
PS – Puget Sound
PSTRT – Puget Sound Technical Recovery Team
PSSTRT – Puget Sound Steelhead Technical Recovery Team
RL – Received Level
RMS – Root Mean Square
RPA – Reasonable and Prudent Alternative
RPM – Reasonable and Prudent Measure
SAV – Submerged Aquatic Vegetation
SEL – Sound Exposure Level
SL – Source Level
SR – Southern Resident (Killer Whales)
SR – State Route
TTS – Total Suspended Solids
VSP – Viable Salmonid Population
WCR – Westcoast Region (NMFS)

WDFW – Washington State Department of Fish and Wildlife
WDNR – Washington State Department of Natural Resources
WDOE – Washington State Department of Ecology

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 USC 1531 *et seq*).

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

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 (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file at the Oregon Washington Coastal Office.

1.2 Consultation History

The NMFS received a letter from the US Army Corps of Engineers (COE) on June 13, 2019 requesting informal consultation for the proposed action (COE 2019a). The COE's letter expressed their determination that the proposed action would be "not likely to adversely affect" (NLAA) Puget Sound (PS) Chinook salmon, PS steelhead, and critical habitat for both of those species, and that it would have "no effect" on Puget Sound/Georgia Basin (PS/GB) bocaccio, PS/GB yelloweye rockfish, Southern Resident (SR) killer whales, and the designated critical habitats for those 3 species. The consultation request also included an enclosed biological evaluation (BE) for the proposed action (Jacobs 2019a).

On July 10, 2019, the NMFS responded to the COE's letter with an e-mail that stated that the NMFS could not concur with the COE's NLAA determination for PS Chinook salmon, PS steelhead, and critical habitat for both of those species. The e-mail requested the COE to withdraw the request for informal consultation, and to request formal consultation for those species and critical habitats. The e-mail also stated that the NMFS disagreed with the COE's "no-effect" determination for SR killer whales and their designated critical habitat, and suggested that the COE revise their effect determination to NLAA for SR killer whales and their designated critical habitat. The NMFS also informed the COE that the information they had provided with their original consultation request was adequate to initiate formal consultation should they choose to do so. On July 11, 2019, the NMFS received an e-mail from COE requesting formal consultation for the proposed action. However, the e-mail did not address the COE's original no effect determinations for SR killer whales and their critical habitat. The NMFS initiated formal consultation with the COE for the proposed action on July 11, 2019.

On August 27, 2019, the regulations governing interagency consultation (50 CFR part 402) were updated (84 FR 44976), and will become effective on October 28, 2019. Because this consultation was pending and will be completed prior to that time, we are applying the previous regulations to this consultation. However, as the preamble to the final rule adopting the new regulations noted, "[t]his final rule does not lower or raise the bar on section 7 consultations, and it does not alter what is required or analyzed during a consultation. Instead, it improves clarity and consistency, streamlines consultations, and codifies existing practices." Therefore, the updated regulations would not be expected to alter our analysis in this consultation.

This Opinion is based on the information identified above; the recovery plans, status reviews, and critical habitat designations for ESA-listed PS Chinook salmon and PS steelhead; published and unpublished scientific information on the biology and ecology of those species; and relevant scientific and gray literature (see Literature Cited).

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). "Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). The COE identified, and the NMFS anticipates, no actions that would be considered interrelated with or interdependent upon the action considered in this consultation.

The COE proposes to authorize BNSF Railway (BNSF) to replace the north fender under Railway Bridge 0050-0037.0 (Bridge 37.0), near the north bank of the main stem Snohomish River, north of Everett, Washington (Figure 1). BNSF would also remove about 200 additional derelict timber piles from the river between the fender and the north bank of the river. The NMFS knows of no actions that would interrelated and/or interdependent to the proposed action.

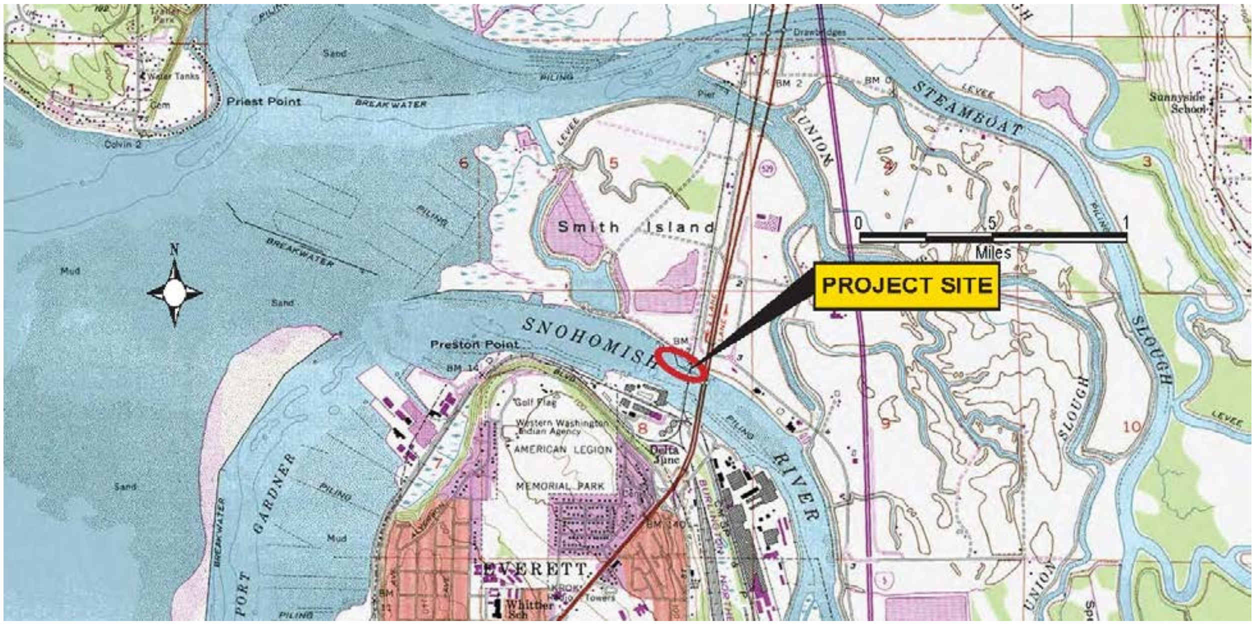


Figure 1. BNSF Bridge 37.0 North Fender Replacement Project Site in the Snohomish River at Everett, Washington (Adapted from Jacobs 2019a Figure 2).

The existing north fender is about 360 feet long, and extends east and west from under the north end of the railway bridge. It is composed of about 200 creosote-treated 12-inch diameter timber piles, with creosote-treated 2- by 6-inch timber planks that are bolted laterally across the upper 10 feet of the piles on south side of the fender (Figure 2). The proposed replacement fender would also be 360 feet long, and effectively remain within the existing fender's footprint. However, it would be composed of 42, 24-inch-diameter steel pipe piles, with 9 composite-plank fender panels that would be about 40 feet wide affixed to the south sides of the piles.

Figure 2. BNSF Bridge 37.0 North Fender. BNSF Bridge 37.0, is visible on the left side of the photograph, and the State Route (SR) 529 Bridge is visible on the right side (Adapted from Jacobs 2019a Figure 3).

BNSF's contractors would operate two barges; a 50- by 100-foot derrick barge, and a 40- by 150-foot material/debris barge to remove and replace the north fender and to remove about 200 additional derelict timber piles (Figure 3). A tugboat would be used to move the barges. The barges would hold position with spuds and soft lines. They would typically be positioned end-to-end, parallel to the navigation channel, and in close proximity to each other. In general, the barges would remain in one spot for about a week prior to being moved as the work progresses from one end of the fender to the other.

Pile extraction and installation would be performed with a crane-mounted vibratory pile extractor/driver. No impact proofing of the new piles is planned, and any timber piles that are too deteriorated to be pulled would be cut off at the mud line by divers using handheld underwater saws. Extraction of the existing timber piles (both structural and derelict) and installation of the new steel piles would occur concurrently, but neither would be a continuous activity. The applicant predicts that they would be able to remove up to 50 timber piles per 10-hour work day, and that they would install up to 4 steel piles per day, with about 1 hour of vibratory installation required per pile. In summary, vibratory pile extractor/driver use would be episodic, but could occur at any time during any workday during the project, and that up to 4 hours of that noise could be from pile installation.

Figure 3. Overhead photograph of the BNSF Bridge 37.0 North Fender to be replaced and the derelict piles to be removed. BNSF Bridge 37.0, is visible on the left side of the photograph, and the SR 529 Bridge is visible on the right side (Adapted from Jacobs 2019a Figure 3).

In general, the sequence of work would begin with demolition work to remove sections of the existing fender and nearby derelict piles, followed by installation of sections of the new fender. The contractors would operate handheld power tools and saws to disassemble the timber fender as needed to allow the removal of the fender planks and piles. Using a crane, they would remove the planks and pull the fender and derelict piles that are within reach. The demolition debris would be placed onto a debris barge that would be outfitted with appropriate containment (discussed below). As an area becomes sufficiently clear, the contractors would install steel pipe piles and install prefabricated fender panels onto the new piles. Each panel would consist of composite planks that are bolted to a metal frame that has sleeves that would fit over 4 or 6 piles. After sufficient steel piles have been installed, the contractors would lower prefabricated fender panels onto them with the crane.

The Project is anticipated to take about 14 to 16 weeks of in-water work. Typical workweeks would consist of 5 10-hour workdays. To help reduce the project's environmental impacts, construction would occur between July 16 and February 15, and the applicant would require the contractors to comply with the impact minimization measures identified in the project BE. These including, but are not limited to requirements to: 1) Install a debris/oil containment boom around the work area prior to conducting timber pile extraction and other construction; 2) Comply with the 2017 Washington State Department of Natural Resources (WDNR) Best Management Practices (BMP) for the removal and disposal of derelict creosote pilings (WDNR 2017); 3) Outfit the debris barge with fabric and hay bales to contain sediments and water from extracted piles; and 4) Transport all debris to an appropriate facility where it would be containerized and taken to an approved lined leachate disposal site.

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

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

As described above in Section 1.2, the COE determined that the proposed action may affect PS Chinook salmon, PS steelhead, and the designated critical habitats for both species. They also determined that it would have no effect on PS/GB bocaccio, PS/GB yelloweye rockfish, SR killer whales, and the designated critical habitats for all of those species. Because the proposed action is likely to adversely affect PS Chinook salmon, PS steelhead, and both of their designated critical habitats, the NMFS has proceeded with formal consultation for those species and critical habitats. Further, as described below in section 2.12, the NMFS has concluded that the proposed action may affect, but is not likely to adversely affect PS/GB bocaccio, PS/GB yelloweye rockfish, SR killer whales, and the designated critical habitats for those three species (Table 1).

Table 1. ESA-listed species and critical habitats that may be affected by the proposed action.

ESA-listed species and critical habitat likely to be adversely affected (LAA)				
Species	**Status**	**Species**	**Critical Habitat**	**Listed / CH Designated**
Chinook salmon (*Oncorhynchus tshawytscha*) Puget Sound	Threatened	LAA	LAA	06/28/05 (70 FR 37160) / 09/02/05 (70 FR 52630)
steelhead (*O. mykiss*) Puget Sound	Threatened	LAA	LAA	05/11/07 (72 FR 26722) / 02/24/16 (81 FR 9252)
ESA-listed species and critical habitat not likely to be adversely affected (NLAA)				
Species	**Status**	**Species**	**Critical Habitat**	**Listed / CH Designated**
bocaccio (*Sebastes paucispinis*) Puget Sound/Georgia Basin	Endangered	NLAA	NLAA	04/28/10 (75 FR 22276) / 11/13/14 (79 FR 68041)
yelloweye rockfish (*S. ruberrimus*) PS/GB	Threatened	NLAA	NLAA	04/28/10 (75 FR 22276) / 11/13/14 (79 FR 68041)
killer whales (*Orcinus orca*) southern resident	Endangered	NLAA	NLAA	11/18/05 (70 FR 57565) / 11/29/06 (71 FR 69054)

LAA = likely to adversely affect NLAA = not likely to adversely affect
N/A = not applicable. The action area is outside designated critical habitat, or critical habitat has not been designated.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that 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 for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214).

Past critical habitat designations have used the terms primary constituent element (PCE) or essential feature (EF) to identify important habitat qualities. However, the new critical habitat regulations (81 FR 7414; February 11, 2016) replace those terms with physical or biological features (PBF). This shift in terminology does not change the approach used in conducting our analysis, whether the original designation identified PCE, EF, or PBF. For simplicity, we universally apply the term PBF in this Opinion for all critical habitat, regardless of the term used in the specific critical habitat designation.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or to cause the destruction or adverse modification of designated critical habitat:

- Identify the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.

- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
- If necessary, suggest a reasonable and prudent alternative (RPA) to the proposed action.

2.2 Range-wide Status of the Species and Critical Habitat

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

The summaries that follow describe the status of the ESA-listed species, and their designated critical habitats, that occur within the action area and are considered in this opinion. More detailed information on the biology, habitat, and conservation status and trend of these listed resources can be found in the listing regulations and critical habitat designations published in the Federal Register and in the recovery plans and other sources at: https://www.fisheries.noaa.gov/species-directory/threatened-endangered, and are incorporated here by reference.

Listed Species

Viable Salmonid Population (VSP) Criteria: For Pacific salmonids, we commonly use four VSP criteria (McElhany *et al*. 2000) to assess the viability of the populations that 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.

"Abundance" generally refers to the number of naturally-produced adults that return to their natal spawning grounds.

"Productivity" refers to 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 in decline.

For species with multiple populations, we assess the status of the entire species based on the biological status of the constituent populations, using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany *et al*. 2000).

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

<u>Puget Sound (PS) Chinook Salmon:</u> The PS Chinook salmon evolutionarily significant unit (ESU) was listed as threatened on June 28, 2005 (70 FR 37160). We adopted the recovery plan for this ESU in January 2007. The recovery plan consists of two documents: the Puget Sound salmon recovery plan (SSPS 2007) and the final supplement to the Shared Strategy's Puget Sound salmon recovery plan (NMFS 2006). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus *et al*. 2002). The PSTRT's biological recovery criteria will be met when all of the following conditions are achieved:

- The viability status of all populations in the ESU (Table 2) 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 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 all the Viable Salmon Population (VSP) parameters are sustained to provide ecological functions and preserve options for ESU recovery.

General Life History: Chinook salmon are anadromous fish that require well-oxygenated water that is typically less than 63º F (17º C), but some tolerance to higher temperatures is documented with acclimation. Adult Chinook salmon spawn in freshwater streams, depositing fertilized eggs in gravel "nests" called redds. The eggs incubate for three to five months before juveniles hatch and emerge from the gravel. Juveniles spend from three months to two years in freshwater before migrating to the ocean to feed and mature. Chinook salmon spend from one to six years in the ocean before returning to their natal freshwater streams where they spawn and then die.

Chinook salmon are divided into two races, stream-types and ocean-types, based on the major juvenile development strategies. Stream-type Chinook salmon tend to rear in freshwater for a year or more before entering marine waters. Conversely, ocean-type juveniles tend to leave their natal streams early during their first year of life, and rear in estuarine waters as they transition into their marine life stage. Both stream- and ocean-type Chinook salmon are present, but ocean-type Chinook salmon predominate in Puget Sound populations.

Chinook salmon are further grouped into "runs" that are based on the timing of adults that return to freshwater. Early- or spring-run chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and finally spawn in the late summer and early autumn. Late- or fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas, and spawn within a few days or weeks. Summer-run fish show intermediate characteristics of spring and fall runs, without the extensive delay in maturation exhibited by spring-run Chinook salmon. In Puget Sound, spring-run Chinook salmon tend to enter their natal rivers as early as March, but do not spawn until mid-August through September. Returning summer- and fall-run fish tend to enter the rivers early-June through early-September, with spawning occurring between early August and late-October.

Yearling stream-type fish tend to leave their natal rivers late winter through spring, and move relatively directly to nearshore marine areas and pocket estuaries. Out-migrating ocean-type fry tend to migrate out of their natal streams beginning in early-March. Those fish rear in the tidal delta estuaries of their natal stream for about two weeks to two months before migrating to marine nearshore areas and pocket estuaries in late May to June. Out-migrating young of the year parr tend to move relatively directly into marine nearshore areas and pocket estuaries after leaving their natal streams between late spring and the end of summer.

Table 2. Extant PS Chinook salmon populations in each biogeographic region (Ruckelshaus *et al*. 2002, NWFSC 2015).

Biogeographic Region	Population (Watershed)
Strait of Georgia	North Fork Nooksack River
	South Fork Nooksack River
Strait of Juan de Fuca	Elwha River
	Dungeness River
Hood Canal	Skokomish River
	Mid Hood Canal River
Whidbey Basin	Skykomish River
	Snoqualmie River
	North Fork Stillaguamish River
	South Fork Stillaguamish River
	Upper Skagit River
	Lower Skagit River
	Upper Sauk River
	Lower Sauk River
	Suiattle River
	Upper Cascade River
Central/South Puget Sound Basin	Cedar River
	North Lake Washington/ Sammamish River
	Green/Duwamish River
	Puyallup River
	White River
	Nisqually River

Spatial Structure and Diversity: The PS Sound Chinook salmon ESU includes all naturally spawning populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. The ESU also includes the progeny of numerous artificial propagation programs (NWFSC 2015). The PSTRT identified 22 extant populations, grouped into five major geographic regions, based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity. The PSTRT distributed the 22 populations among five major biogeographical regions, or major population groups (MPGs), that are based on similarities in hydrographic, biogeographic, and geologic characteristics (Table 2).

Hatchery-origin spawners are present in high fractions in most populations within the ESU, with the Whidbey Basin the only MPG with consistently high fractions of natural-origin spawners. Between 1990 and 2014, the fraction of natural-origin spawners has declined in many of the populations outside of the Skagit watershed (NWFSC 2015).

Abundance and Productivity: Available data on total abundance since 1980 indicate that abundance trends have fluctuated between positive and negative for individual populations, but productivity remains low in most populations, and hatchery-origin spawners are present in high fractions in most populations outside of the Skagit watershed. Available data now show that most populations have declined in abundance over the past 7 to 10 years. Further, escapement levels for all populations remain well below the PSTRT planning ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the PSTRT as consistent with recovery (NWFSC 2015). The current information on abundance, productivity, spatial structure and diversity suggest that the Whidbey Basin MPG is at relatively low risk of extinction. The other four MPGs are considered to be at high risk of extinction due to low abundance and productivity (NWFSC 2015). The most recent 5-year status review concluded that the ESU should remain listed as threatened (NMFS 2017).

<u>Limiting Factors:</u> Factors limiting recovery for PS Chinook salmon 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
- Severely altered flow regime

<u>PS Chinook Salmon within the Action Area:</u> The PS Chinook salmon that occur in the action area would consist of summer run fish from the Skykomish River population, and fall run fish from the Skykomish and Snoqualmie River populations (NWFSC 2015; WDFW 2019a). Both stream- and ocean-type Chinook salmon are present in the basin, with the majority being ocean-types. Since 1965, the estimated total abundance for returning adult PS Chinook salmon has fluctuated between about 1,200 and 7,600 in the Skykomish River basin, and about 321 and 3,600 in the Snoqualmie River basin (WDFW 2019b), with the average trend being slightly negative in all three populations, and natural productivity in the Skykomish considered below replacement for all years since the mid-1980s (NWFSC 2015). In 2018, the total numbers of returning adults were about 3,048 and 1,162 for the Skykomish and Snoqualmie Rivers, respectively (WDFW 2019b). Since 1997, the fraction of natural-origin spawners has fluctuated between about 34 to 83 percent, and 65 to 93 percent, respectively. The 2018 fraction of natural-origin spawners was about 74 and 70 percent, respectively (WDFW 2019b).

Adult and juvenile Chinook salmon utilize the lower Snohomish River as a migration corridor. Juvenile Chinook salmon also utilize the lower Snohomish River for foraging during their outmigration. No spawning habitat occurs in the action area. Returning adult Chinook salmon tend to enter the Snohomish River and migrate past the project site June through September to mid-October. Spawning occurs well upstream of the action area, mostly from mid-September to mid-November. Young of the year juveniles are reported in the Snohomish River estuary February through September, with peak density occurring between May and June (Rice *et al*. 2014; Rowes and Fresh 2003).

Puget Sound (PS) Steelhead

The PS steelhead distinct population segment (DPS) was listed as threatened on May 11, 2007 (72 FR 26722). The recovery plan for this DPS is under development. In 2013, the Puget Sound Steelhead Technical Recovery Team (PSSTRT) identified 32 demographically independent populations (DIPs) within the DPS, based on genetic, environmental, and life history characteristics. Those DIPs are distributed among three geographically-based major population groups (MPGs); Northern Cascades, Central and South Puget Sound; and Hood Canal and Strait de Fuca (Myers *et al*. 2015) (Table 3).

In 2015, the PSSTRT concluded that the DPS is at "very low" viability; with most of the 32 DIPs and all three MPGs at "low" viability based on widespread diminished abundance, productivity, diversity, and spatial structure when compared with available historical evidence (Hard *et al.* 2015). Based on the PSSTRT viability criteria, the DPS would be considered viable when all three component MPG are considered viable. A given MPG would be considered viable when: 1) 40 percent or more of its component DIP are viable; 2) mean DIP viability within the MPG exceeds the threshold for viability; and 3) 40 percent or more of the historic life history strategies (i.e., summer runs and winter runs) within the MPG are viable. For a given DIP to be considered viable, its probability of persistence must exceed 85 percent, as calculated by Hard *et al.* (2015), based on abundance, productivity, diversity, and spatial structure within the DIP.

General Life History: PS steelhead exhibit two major life history strategies. Ocean-maturing, or winter-run fish typically enter freshwater from November to April at an advanced stage of maturation, and then spawn from February through June. Stream-maturing, or summer-run fish typically enter freshwater from May to October at an early stage of maturation, migrate to headwater areas, and hold for several months prior to spawning in the following spring. After hatching, juveniles rear in freshwater from one to three years prior to migrating to marine habitats (two years is typical). Smoltification and seaward migration typically occurs from April to mid-May. Smolt lengths vary between watersheds, but typically range from 4.3 to 9.2 inches (109 to 235 mm) (Myers et al. 2015). Juvenile steelhead are generally independent of shallow nearshore areas soon after entering marine water (Bax et al. 1978, Brennan et al. 2004, Schreiner et al. 1977), and are not commonly caught in beach seine surveys. Recent acoustic tagging studies (Moore et al. 2010) have shown that smolts migrate from rivers to the Strait of Juan de Fuca from one to three weeks. PS steelhead feed in the ocean waters for one to three years (two years is again typical), before returning to their natal streams to spawn. Unlike Chinook salmon, most female steelhead, and some males, return to marine waters following spawning (Myers et al. 2015).

Table 3. PS steelhead Major Population Groups (MPGs), Demographically Independent Populations (DIPs), and DIP Viability Estimates (Modified from Figure 58 in Hard *et al*. 2015).

Geographic Region (MPG)	Demographically Independent Population (DIP)	Viability
Northern Cascades	Drayton Harbor Tributaries Winter Run	Moderate
	Nooksack River Winter Run	Moderate
	South Fork Nooksack River Summer Run	Moderate
	Samish River/Bellingham Bay Tributaries Winter Run	Moderate
	Skagit River Summer Run and Winter Run	Moderate
	Nookachamps River Winter Run	Moderate
	Baker River Summer Run and Winter Run	Moderate
	Sauk River Summer Run and Winter Run	Moderate
	Stillaguamish River Winter Run	Low
	Deer Creek Summer Run	Moderate
	Canyon Creek Summer Run	Moderate
	Snohomish/Skykomish Rivers Winter Run	Moderate
	Pilchuck River Winter Run	Low
	North Fork Skykomish River Summer Run	Moderate
	Snoqualmie River Winter Run	Moderate
	Tolt River Summer Run	Moderate
Central and South Puget Sound	Cedar River Summer Run and Winter Run	Low
	North Lake Washington and Lake Sammamish Winter Run	Moderate
	Green River Winter Run	Low
	Puyallup River Winter Run	Low
	White River Winter Run	Low
	Nisqually River Winter Run	Low
	South Sound Tributaries Winter Run	Moderate
	East Kitsap Peninsula Tributaries Winter Run	Moderate
Hood Canal and Strait de Fuca	East Hood Canal Winter Run	Low
	South Hood Canal Tributaries Winter Run	Low
	Skokomish River Winter Run	Low
	West Hood Canal Tributaries Winter Run	Moderate
	Sequim/Discovery Bay Tributaries Winter Run	Low
	Dungeness River Summer Run and Winter Run	Moderate
	Strait of Juan de Fuca Tributaries Winter Run	Low
	Elwha River Summer Run and Winter Run	Low

Spatial Structure and Diversity: The PS steelhead DPS includes all naturally spawned anadromous steelhead populations in streams in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive). The DPS also includes six hatchery stocks that are considered no more than moderately diverged from their associated natural-origin counterparts (USDC 2014). PS steelhead are the anadromous form of *O. mykiss* that occur below natural barriers to migration in northwestern Washington State (NWFSC 2015). Non-anadromous ‘‘resident’’ *O. mykiss* (a.k.a. rainbow trout) 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*. 2015). As stated above, the DPS consists of 32 DIP that are distributed among three geographically-based MPG. An individual DIP may consist of winter-run only, summer-run only, or a combination of both life history types. Winter-run is the predominant life history type in the DPS (Hard *et al.* 2015).

Abundance and Productivity: Available data on total abundance since the late 1970s and early 1980s indicate that abundance trends have fluctuated between positive and negative for individual DIP. However, low productivity persists throughout the 32 DIP, with most showing downward trends, and a few showing sharply downward trends (Hard *et al.* 2015, NWFSC 2015). Since the mid-1980s, trends in natural spawning abundance have also been temporally variable for most DIP but remain predominantly negative, and well below replacement for at least 8 of the DIP (NWFSC 2015). Smoothed abundance trends since 2009 show modest increases for 13 DIP. However, those trends are similar to variability seen across the DPS, where brief periods of increase are followed by decades of decline. Further, several of the upward trends are not statistically different from neutral, and most populations remain small. Nine of the evaluated DIP had geometric mean abundances of fewer than 250 adults, and 12 had fewer than 500 adults (NWFSC 2015). Over the time series examined, the over-all abundance trends, especially for natural spawners, remain predominantly negative or flat across the DPS, and general steelhead abundance across the DPS remains well below the level needed to sustain natural production into the future (NWFSC 2015). The PSSTRT recently concluded that the PS steelhead DPS is currently not viable (Hard *et al.* 2015). The DPS's current abundance and productivity are considered to be well below the targets needed to achieve delisting and recovery. Growth rates are currently declining at 3 to 10% annually for all but a few DIPs, and the extinction risk for most populations is estimated to be moderate to high. The most recent 5-year status review concluded that the DPS should remain listed as threatened (NMFS 2017).

Limiting Factors: Factors limiting recovery for PS steelhead include:

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

PS Steelhead within the Action Area: The PS steelhead that occur in the action area would be summer-run steelhead from the North Fork Skykomish and Tolt River DIPs, and winter-run steelhead from the Pilchuck, Snohomish/Skykomish, and Snoqualmie River DIPs. NWFSC

(2015) reported that abundance trends for the period between 1999 and 2014 was negative for all of the Snohomish system DIPs. Despite brief upward swings, recent information suggests that the overall trend continues to be negative (WDFW 2018c). Since 1981, the estimated total abundance for returning adult PS steelhead in the Snohomish system has fluctuated between about 279 and 1,706; 372 and 4,760; and 292 and 2,536 in the Pilchuck; Snohomish/Skykomish; and Snoqualmie DIPs, respectively. The estimated total abundance for returning adult PS steelhead in the Tolt DIP has fluctuated between about 16 and 366 since 1985. No return data is available for the North Fork Skykomish DIP. In 2018, the total number of returning adults was about 588; 372; 292; and 30 in the Pilchuck; Snohomish/Skykomish; Snoqualmie; and Tolt DIPs, respectively (WDFW 2018c).

The project reach provides migratory habitat for juvenile and adult PS steelhead. Summer-Run adults typically enter the river from May to October. Adult winter-run steelhead typically return to the Snohomish River from November to early May. Hatchery fish predominate from November to February, while wild winter-run steelhead typically enter from February to April (R2 2008). Juveniles may be present year-round, but typically migrate to marine waters between April and mid-May when they smoltify (Myers *et al*. 2015; R2 2008).

Critical Habitat

This section describes the status of designated critical habitat that would be affected by the proposed action by examining the condition and trends of physical or biological features (PBFs) that are essential to the conservation of the listed species throughout the designated areas. The PBFs are essential because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration and foraging). The proposed project would affect critical habitat for PS Chinook salmon and PS steelhead.

The NMFS designated critical habitat for PS Chinook salmon on September 2, 2005 (70 FR 52630). That critical habitat is located in 16 freshwater subbasins and watersheds between the Dungeness/Elwha Watershed and the Nooksack Subbasin, inclusively, as well as in nearshore marine waters of the Puget Sound that are south of the US-Canada border and east of the Elwha River, and out to a depth of 30 meters. Although offshore marine is an area type identified in the final rule, it was not designated as critical habitat for PS Chinook salmon. On February 24, 2016, critical habitat for PS steelhead was designated in 18 freshwater subbasins between the Strait of Georgia Subbasin and the Dungeness-Elwha Subbasin, inclusively (81 FR 9252). No marine waters were designated as critical habitat for PS steelhead.

The PBFs of salmonid critical habitat include: (1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development; (2) Freshwater rearing sites with: (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) Water quality and forage supporting juvenile development; and (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks; (3) Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival; (4) Estuarine areas free of obstruction and excessive predation with: (i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation; (5) Nearshore marine areas free of obstruction and excessive predation with: (i) Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and (6) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation (Table 4).

Table 4. Physical or biological features (PBFs) of designated critical habitat for PS Chinook salmon and PS steelhead, and the corresponding life history events. Although nearshore and offshore marine areas were identified in both respective FR, no offshore marine areas were designated as critical habitat for PS Chinook salmon, and neither was designated as critical habitat for PS steelhead.

Physical or Biological Features		
Site Type	**Site Attribute**	**Life History Event**
Freshwater spawning	Water quantity Water quality Substrate	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Water quantity and Floodplain connectivity Water quality and Forage Natural cover	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	(Free of obstruction and excessive predation) Water quantity and quality Natural cover	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine	(Free of obstruction and excessive predation) Water quality, quantity, and salinity Natural cover Forage	Adult sexual maturation and “reverse smoltification” Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Nearshore marine	(Free of obstruction and excessive predation) Water quality, quantity, and forage Natural cover	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing
Offshore marine	Water quality and forage	Adult growth and sexual maturation Adult spawning migration Subadult rearing

Major tributary river basins in the Puget Sound basin include the Nooksack, Samish, Skagit, Sauk, Stillaguamish, Snohomish, Lake Washington, Cedar, Sammamish, Green, Duwamish, Puyallup, White, Carbon, Nisqually, Deschutes, Skokomish, Duckabush, Dosewallips, Big Quilcene, Elwha, and Dungeness rivers and Soos Creek. Critical habitat 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 wood (LW) from the waterways, intense urbanization, agriculture, alteration of floodplain and stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, logging, and mining. Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common limiting factors of critical habitat throughout the basin.

Land use practices have likely accelerated the frequency of landslides delivering sediment to streams. Fine sediment from unpaved roads also contributes to stream sedimentation. Unpaved roads are widespread on forested lands in the Puget Sound basin, and to a lesser extent, in rural residential areas. Historical logging removed most of the riparian trees near stream channels. Subsequent agricultural and urban conversion permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade and LW recruitment (SSPS 2007).

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

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

Peak stream flows have increased over time due to paving (roads and parking areas), reduced percolation through surface soils on residential and agricultural lands, simplified and extended drainage networks, loss of wetlands, and rain-on-snow events in higher elevation clear cuts (SSPS 2007). In urbanized Puget Sound, there is a strong association between land use and land cover attributes and rates of coho spawner mortality likely due to runoff containing contaminants emitted from motor vehicles (Feist *et al*. 2011).

Dams constructed for hydropower generation, irrigation, or flood control have substantially affected PS Chinook salmon populations in a number of river systems. The construction and operation of dams have blocked access to spawning and rearing habitat, changed flow patterns, resulted in elevated temperatures and stranding of juvenile migrants, and degraded downstream spawning and rearing habitat by reducing recruitment of spawning gravel and LW to downstream areas (SSPS 2007). These actions tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992).

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

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

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

Critical Habitat within the Action Area: The Snohomish River from Puget Sound to slightly upstream of Highway 2 has been designated nearshore marine critical habitat for PS Chinook salmon. Designated freshwater critical habitat for PS Chinook salmon overlaps with the nearshore marine critical habitat in the Snohomish River between Highways 2 and 529 (adjacent to the project site), and extends far upstream into the watershed. Designated freshwater critical habitat for PS steelhead in the Snohomish River begins about 0.5 mile downstream of the project site and extends far upstream into the watershed. No marine nearshore critical habitat has been designated for PS steelhead. This critical habitat primarily supports migration of juveniles and adults of both species (NOAA 2019; WDFW 2019a).

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). As described in sections 2.5

and 2.12, exposure to elevated noise would be the project-related stressor with the greatest range of effect. All other project-related effects, including indirect effects would be undetectable beyond the range of acoustic effects. The theoretical maximum distance to where detectable effects may occur in marine mammals that are exposed to the project's loudest noise sources is about 6.2 miles (10,000 m). However, as discussed in section 2.12, geographic features in the area are likely to greatly limit sound propagation into marine waters beyond about 1 mile from the project site. The maximum range for detectable effects in fish would be about 328 feet (100 m) around the project site. To be conservative, the NMFS estimates that the action area for this consultation would be limited to the waters and aquatic substrates within 6.2 miles around the BNSF Bridge 0050-37.0 North Fender. The action area described above overlaps with the geographic ranges and boundaries of the ESA-listed species and designated critical habitat identified earlier in Table 1. The action area also overlaps with areas that have been designated, under the MSA, as EFH for Pacific Coast salmon, Pacific Coast Groundfish, and Coastal Pelagic Species.

2.4 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

Environmental conditions at the project site and the surrounding area: The project site is located in the tidally influenced lower mainstem of the Snohomish River at about river mile 1.1. It is close to the southern shoreline of Smith Island, immediately north of the City of Everett, Washington (Figure 1). The Snohomish River basin is the second-largest watershed that flows into Puget Sound. It includes the Skykomish, Snoqualmie, Pilchuck, and Tolt Rivers, which join to become the Snohomish River. It originates on the western slopes of the Cascade Mountains, and drains about 1.2 million acres as it flows westerly through broad, glaciated lowland valleys, before it enters Puget Sound north of Everett. Average annual precipitation ranges from about 35 inches in the western lowlands to over 120 inches in the headwaters.

Since the mid-1800s, most of the land within the basin has been converted from dense old-growth forests to agricultural and low-density residential lands, with high density residential and industrial development occurring mostly near the Snohomish River estuary. Current land uses across the basin include forestry, agriculture, residential/ urban, infrastructure (roads and railroads; gas, water, and power lines), light industry, recreation, and mining. Agricultural lands, account for about 5% of the basin, but dominate the floodplains (SBSRF 2005). Rural residential development is also scattered throughout the lowlands and river floodplains, and many roads follow stream banks, resulting in the loss of mature riparian vegetation in many areas. Although conditions vary between individual reaches, in general, water quality, wetlands, streambanks, large-wood abundance, and floodplain connectivity are all considered degraded throughout the basin (SBSRTC 2002).

The Basin now includes large portions of King and Snohomish Counties, with a combined population of a bit over 2.9 million people, and an average annual growth rate of about 1.4 % since 2010 (King County 2017; Snohomish County 2017). The basin is the major source of municipal water for the area, including the cities of Everett and Seattle. It is also the receptor for the effluent from numerous municipal wastewater treatment plants.

Within the action area, the Snohomish River is a low gradient, partially confined, meandering river, with a channel bottom composed mostly of fine sands and silts. At the project site, the river is about 1,000 feet wide, and water depths range from 0 to about 15 feet, but average 8 to 10 feet (NOAA 2019b). Three bridges cross the river in the project area; BNSF Rail Bridge 37.0 and the two State Route (SR) 529 Bridges (Figures 1 and 3). A continuous series of protective fenders extends about 860 feet along the north riverbank, starting about 240 feet upstream of the northbound SR 529 Bridge, out and around the north bridge piers of the SR 529 and BNSF Bridges, and ending about 190 feet downstream of the BNSF Bridge. Several hundred derelict creosote-treated timber piles are present in the river between the BNSF fender and the north riverbank, and a routinely-dredged federal navigation channel that is about 8 feet deep runs immediately south of the fender system.

The project reach is not identified on the Washington State Department of Ecology (WDOE) 303d list for water quality or for contaminated sediment. However, numerous sites along the riverbanks adjacent to the project site have been the subjects of recent and/or ongoing remediation actions to address contamination from historic activities. Further, the existing creosote-treated timber piles at the project site have likely leached Polycyclic Aromatic Hydrocarbons (PAHs) and other pollutants into the water and sediments at the site for many years.

The riverbank within the action area is comprised primarily of concrete and sheet pile bulkheads, steeply sloped riprap banks, piers, wharves, and derelict piles. North of the riverbank, the uplands of Smith Island are zoned as light industrial. Although remnant wetlands still exist, the area is dominated by facilities for log/timber processing and storage, commercial composting, concrete production, and the associated road and railway infrastructure. Additionally, a new railway terminal is under development on the north side of the island. South of the riverbank, the uplands are dominated by storage facilities, shipping terminals, railway infrastructure, and roads. From there, the City and Port of Everett extend to the south. Currently, Everett is the 5th largest city on the Puget Sound.

The past and ongoing anthropogenic impacts described above have reduced the action area's ability to support PS Chinook salmon PS steelhead. However, the action area continues to provide migratory habitat for adults and juveniles of both species, and has been designated as critical habitat for both species.

<u>Climate Change:</u> Climate change has affected the environmental baseline of aquatic habitats across the region and within the action area. However, the effects of climate change have not been homogeneous across the region, nor are they likely to be in the future. During the last century, average air temperatures in the Pacific Northwest have increased by 1 to 1.4° F (0.6 to 0.8 $^{\circ}$C), and up to 2° F (1.1 $^{\circ}$C) 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*. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10° F (1.7 to 5.6° C), with the largest increases predicted to occur in the summer (Mote *et al*. 2014).

Decreases in summer precipitation of as much as 30% by the end of the century are consistently predicted across climate models (Mote *et al*. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote *et al*. 2013 and 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 3.5-5.3°C increases in Columbia Basin streams and a peak temperature of 26°C in the Willamette (NWFSC 2015). Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua *et al*. 2009).

Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Isaak *et al*. 2012; Mantua *et al*. 2010). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier *et al*. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer *et al*. 1999; Raymondi *et al*. 2013; Winder and Schindler 2004). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier *et al*. 2008; Raymondi *et al*. 2013; Wainwright and Weitkamp 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 (Lawson *et al*. 2004; McMahon and Hartman 1989).

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.

2.5 Effects of the Action on Species and Designated Critical Habitat

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Direct effects are caused by exposure to action-related stressors that occur at the time of the action. Indirect effects are effects caused by the proposed action that occur later in time but are still reasonably certain to occur.

As described in Section 1.3, the COE proposes to authorize BNSF to replace the Bridge 37.0 north fender and to remove about 200 additional derelict timber piles in the main stem Snohomish River (Figures 1-3). BNSF's contractors would conduct about 16 weeks of in-water work between July 16 and February 15, primarily using a barge-mounted crane with a vibratory pile extractor/driver.

As described in Section 2.2, some PS Chinook salmon and PS steelhead are reasonably likely to be present in the action area year-round. Adult PS Chinook salmon migrate through the area June through September to mid-October. Young of the year juvenile PS Chinook salmon migrate through the action area February through September, but most move through between May and June. Summer-run adult PS steelhead typically pass through from May to October, while winter-run adults typically return from November to early May. Juveniles may be present year-round, but typically migrate to marine waters between April and mid-May. The proposed work window would avoid the expected peak out-migration of the juveniles for both species. However, it would still overlap with the expected presence of adults and juveniles of both species.

Therefore, the planned construction is likely to cause direct effects on PS Chinook salmon, PS steelhead, and the PBFs of their critical habitats through exposure to construction-related elevated noise, degraded water quality, and propeller wash. Construction would also cause indirect effects on juveniles of both species through exposure to contaminated forage. The new fender would also cause structure-related effects.

<u>2.5.1 Effects on List Species</u>

<u>Construction-related Elevated Noise</u>

Exposure to construction-related noise would cause adverse effects in PS Chinook salmon and PS steelhead. Elevated in-water noise at levels capable of causing detectable effects in exposed fish would be caused by the in-water use of vibratory pile extraction and installation equipment, tugboats, barge spuds, and handheld underwater power saws.

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

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

The NMFS uses two metrics to estimate the onset of injury for fish exposed to high intensity impulsive sounds. The metrics are based on exposure to peak sound level and sound exposure level (SEL), respectively. Both are expressed in decibels (dB). The metrics are: 1) exposure to 206 dB_{peak}; and 2) exposure to 187 dB SEL_{cum} for fish 2 grams or larger, or 183 dB SEL_{cum} for fish under 2 grams. Any received level (RL) below 150 dB_{SEL} is considered "Effective Quiet". The distance from a source where the RL drops to 150 dB_{SEL} is considered the maximum distance from that source where fishes can be affected by the noise, regardless of accumulation of the sound energy (Stadler and Woodbury 2009). Therefore, when there is a difference between the ranges to the isopleths for effective quiet and SEL_{cum}, the shorter range shall apply.

The discussion in Stadler and Woodbury (2009) makes it clear that the thresholds likely overestimate the potential effects of exposure to impulsive sounds. Further, the assessment did not consider non-impulsive sound because it is believed to be less injurious to fish than impulsive sound. Therefore, any application of the criteria to non-impulsive sounds is also likely to overestimate the potential effects in fish. However, this assessment applies the criteria to both impulsive and non-impulsive sounds for continuity, and as a tool to gain a conservative idea of the sound energies that fish may be exposed to during the majority of this project.

The estimated in-water source levels (SL, sound level at 1 meter from the source) used in this assessment are based on the best available information, as described in a recent acoustic assessment for a similar project (NMFS 2018a) and in other sources (CalTrans 2009; COE 2011; DEA 2011; FHWA 2017). Based on the best available information, the SLs for all sources would be below the 206 dB_{peak} threshold for the onset of instantaneous injury in fish. However, as described below, sound levels above the 150 dB_{SEL} threshold would extend 72 to 328 feet (22 to 100 m) around the project site during various project activities.

In the absence of location-specific transmission loss data, variations of the equation RL = SL – #Log(R) are often used to estimate the received sound level at a given range from a source (RL = received level (dB); SL = source level (dB, 1 m from the source); # = spreading loss coefficient;

and R = range in meters (m). Acoustic measurements in shallow water environments support the use of a value close to 15 for projects like this one (CalTrans 2009). This value is considered the practical spreading loss coefficient. Application of the practical spreading loss equation to the expected project-related SLs suggests that noise levels above the 150 dB_{SEL} threshold could extend to about 328 feet (100 m) around the vibratory installation of 24-inch diameter steel pipe piles. Noise levels above the 150 dB_{SEL} threshold from all other construction-related sources would extend only about half as far or less around the project site (Table 5).

Table 5. Estimated in-water dB_{peak} and dB_{SEL} Source Levels for construction-related sound sources. The ranges to the applicable source-specific effects thresholds for fish are highlighted in grey.

Source	Acoustic Signature	Source Level	Threshold Range
Spuds	< 1,600 Hz Impulsive	201 dB_{peak}	206 @ N/A
About 4 impacts per day when barges are moved (about weekly).		176 dB_{SEL}	183 @ N/A
		176 dB_{SEL}	187 @ N/A
		176 dB_{SEL}	150 @ 54 m
Vib. Install 24-inch Steel Pipe Piles	< 2.5 kHz Non-Impulsive	193 dB_{peak}	206 @ N/A
Up to 4 hours of cumulative vibratory noise per day any time during the 16-week project		180 dB_{SEL}	183 @ 321 m
		180 dB_{SEL}	187 @ 203 m
		180 dB_{SEL}	150 @ 100 m
Vib. Extract Timber Piles	< 2.5 kHz Non-Impulsive	181 dB_{peak}	206 @ N/A
Up to 8 hours of cumulative vibratory noise per day any time during the 16-week project		171 dB_{SEL}	183 @ 185 m
		171 dB_{SEL}	187 @ 100 m
		171 dB_{SEL}	150 @ 25 m
Tug Propulsion	< 1 kHz Combination	185 dB_{peak}	206 @ N/A
Daily, with 2 hours of continuous vessel noise per day		170 dB_{SEL}	183 @ 46 m
		170 dB_{SEL}	187 @ 25 m
		170 dB_{SEL}	150 @ 22 m
Underwater Saw	< 4 kHz Non-Impulsive	145 dB_{peak}	206 @ N/A
Brief episodic use any time during 16-week project		135 dB_{SEL}	183 @ N/A
		135 dB_{SEL}	187 @ N/A
		135 dB_{SEL}	150 @ N/A

The applicant predicts that their contractors could extract up to 50 timber piles per day. They also predict that they could install up to 4 steel piles per day, with 1 hour of vibratory installation required per pile. They also report that pile extraction and installation would occur concurrently, but that neither would be a continuous activity. Given that and the knowledge that they would also need time to fit the fender panels onto the new pile sets, to reposition barges, and do other project-related activities, vibratory noise from pile extraction and installation would be episodic, but could occur at any time during any 10-hour workday over 16 weeks of work. A maximum of 4 hours of pile installation could occur on any day, and a minimum of 12 hours would elapse between the daily cessation and resumption of pile work. During pile work, in-water noise levels at or above the 150 dB_{SEL} threshold would likely occur within about 328 feet around pile installation and about 82 feet around pile extraction.

Most spud-barges have 2 spuds (steel pipes or girders) that they drop to the substrate and lock in place to hold their position; instead of using anchors. Spud deployment causes a brief impulsive sound event when the spud strikes the substrate. The applicant predicts that the barges would be moved about once per week. This suggests that spud deployment would cause 4 impulsive noise events about once every week. Noise levels above the 150 dB_{SEL} threshold would likely extend about 177 feet around spud deployment. Fish-detectable sound levels from all other construction-related sources would extend only about half as far as spuds. Further, the various sound sources are very unlikely to have any additive effects with each other due the differences in their frequencies. At most, the combination of the various types of equipment during any given day may cause fish-detectable in-water noise levels across the entire workday.

As explained at the beginning of this section, the planned work window avoids the periods of peak juvenile out-migration for both species. However, the work window overlaps with the expected presence of returning adults from both species, and low numbers of juveniles of both species are expected to occur within the action area year-round.

Chinook salmon and steelhead that are beyond the 150 dB_{SEL} isopleth would be unaffected by the exposure. However, fish within the 150 dB_{SEL} isopleth are likely to experience a range of impacts that would depend on their distance from the source and the duration of their exposure. All of the adults that may be exposed to construction noise would be much larger than 2 grams, independent of shoreline waters, and extremely unlikely to remain near enough to the project site to accumulate injurious levels of sound energy. The most likely effect of exposure to project-related noise would be temporary minor behavioral effects, such as avoidance of the area within about 82 to 328 feet around the project site during pile extraction and installation. The exposure would cause no measurable effects on the fitness of exposed adults, would not prevent access to important habitat resources, and given the width of the river at the site, it wouldn't prevent adults from moving past the area to move upstream.

The juvenile PS Chinook salmon that may be present would be shoreline obligated, and some may be smaller than 2 grams. Juvenile steelhead that may be present in the estuary would likely be larger, and largely independent of shoreline habitats. However, all juveniles that are within the 150 dB_{SEL} isopleth, are likely to experience behavioral disturbance, such as acoustic masking, startle responses, altered swimming patterns, avoidance, and increased risk of predation. Individuals that remain within the range where accumulated sound energy would exceed the 183/187 dB SEL_{cum} thresholds may also experience some level of auditory- and non-auditory tissue injury, which could reduce their likelihood of survival.

The numbers of juvenile PS Chinook salmon and PS steelhead that may be impacted by this stressor is unquantifiable with any degree of certainty. However, it is expected to be very low because the work window avoids the out-migration peaks for both species. Further, at its loudest, the area of acoustic effect would be limited to the northern half of the mainstem at the project site, and the mainstem is one of four routes taken by juveniles traveling to Puget Sound through the Snohomish River delta. Therefore, the numbers of juvenile PS Chinook salmon and PS steelhead that may be exposed to construction-related noise would comprise such small subsets of their respective cohorts, that should they be injured or killed due to the exposure, their loss would cause no detectable population-level effects.

Construction-related Degraded Water Quality

Exposure to construction-related degraded quality would cause minor effects in PS Chinook salmon and PS steelhead. Water quality would be temporarily affected through increased turbidity. It may also be temporarily affected by reduce dissolved oxygen (DO) concentrations and by toxic materials that may be introduced to the water through construction-related spills and discharges, during the removal of creosote-treated piles and timbers that may release creosote-related toxins into the water.

Turbidity: Pile removal would mobilize bottom sediments that would cause episodic, localized, and short-lived turbidity plumes with relatively low concentrations of total suspended sediments (TSS). The intensity of turbidity is typically measured in Nephlometric Turbidity Units (NTU) that describe the opacity caused by the suspended sediments, or by the concentration of TSS as measured in milligrams per liter (mg/L). A strong positive correlation exists between NTU values and TSS concentrations. Depending on the particle sizes, NTU values roughly equal the same number of mg/L for TSS (i.e. 10 NTU = ~ 10 mg/L TSS, and 1,000 NTU = ~ 1,000 mg/L TSS) (Campbell Scientific Inc. 2008; Ellison *et al*. 2010). Therefore, the two units of measure are easily compared.

The effects of turbidity on fish are somewhat species and size dependent. In general, severity typically increases with sediment concentration and duration of exposure, and decreases with the increasing size of the fish. Newcombe and Jensen (1996) reported minor physiological stress in juvenile salmon only after about three hours of continuous exposure to concentration levels of about 700 to 1,100 mg/l. Water quality is considered adversely affected by suspended sediments when turbidity is increased by 20 NTU for a period of 4 hours or more (Berg and Northcote 1985; Robertson *et al*. 2006).

Vibratory removal of hollow 30-inch steel piles in Lake Washington mobilized sediments that adhered to the piles as they were pulled up through the water column (Bloch 2010). Much of the mobilized sediment likely included material that fell out of the hollow piles. Turbidity reached a peak of about 25 NTU (~25 mg/L) above background levels at 50 feet from the pile, and about 5 NTU (~5 mg/L) above background at 100 feet. Turbidity returned to background levels within 30 to 40 minutes. Pile installation created much lower turbidity. The planned extraction of 12-inch derelict timber piles is extremely unlikely to mobilize as much sediment as described above, because the timber piles have much smaller surface areas for sediments to adhere to, and no tube to hold packed-in sediments. Therefore, the mobilization of bottom sediments, and resulting turbidity from the planned pile removal is likely to be less than that reported by Bloch. The applicant's agent reported that, during similar extractions, pile removal caused individual 4- to 6-foot wide by 6- to 8-foot long turbidity pulses that moved downstream and settled out quickly (COE 2019b). Lifting barge spuds would also mobilize sediments, but likely less than that of pile removal because the spuds would not be embedded as deeply as the piles described above.

Tugboats would also mobilize bottom sediments. Tugboat trips to the site would occur weekly, and last a low number of hours while it repositions the work barges. Therefore, the resulting propeller wash turbidity plumes would be episodic and low in number (about 16 events). The intensity and duration of the resulting turbidity plumes are uncertain. They would depend on a combination of the tugboat's thrust, the water depth under it, and the type of substrate. The higher the thrust and the finer the sediment, the more mobilized sediment. Fine material (silt) remains mobilized longer than coarse material (sand). The shallower the water, the more thrust energy that would reach the substrate.

A recent study described the turbidly caused by large tugboats operating in Navy harbors (ESTCP 2016). At about 13 minutes, the plume extended about 550 yards (500 m) and had a TSS concentration of about 80 mg/L. The plume persisted for hours and extended far from the event, but the TSS concentration fell to 30 mg/L within 1 hour and to 15 mg/L within 3 hours. The reported TSS concentrations are far below the 700 mg/L concentration required to elicit physiological responses reported by Newcombe and Jensen (1996). Further, the extent and duration of the Navy-reported turbidity plumes likely overestimate project-related conditions. The currents in Navy harbors are typically very low, and high levels of silt are present. Conversely, the project site is located where relatively strong river currents occur, and the bottom sediments consist mostly of fine sands.

The applicant's agent reports that no turbidity plumes have yet been reported for tugboat operations during fender replacement work. The applicant also reports that at 200 feet from the site, no project-related turbidity would exceed 10 NTU over background turbidity of 50 NTU or less, or to increase turbidity by more than 20 percent when background turbidity is above 50 NTU (COE 2019b). To be conservative, the NMFS estimates that project-related visible turbidity plumes could extend 300 feet from the site, and may last up to an hour after the disturbance.

Based on the best available information, construction-related turbidity would be very short-lived and at concentrations too low to cause more than temporary, non-injurious behavioral effects such as avoidance of the plume, mild gill flaring (coughing), and slightly reduced feeding rates in the juvenile PS Chinook salmon and PS steelhead that may be exposed to it. None of these potential responses, individually, or in combination would affect the fitness or normal behaviors in exposed fish.

<u>Dissolved Oxygen (DO):</u> Mobilization of anaerobic sediments can decrease dissolved oxygen (DO) levels (Hicks *et al*., 1991; Morton 1976). The impact on DO is a function of the oxygen demand of the sediments, the amount of material suspended in the water, the duration of suspension, and the water temperature (Lunz and LaSalle 1986; Lunz *et al*. 1988). Reduced DO can affect salmonid swimming performance (Bjornn and Reiser 1991), as well as cause avoidance of water with low DO levels (Hicks 1999). However, the small amount of sediments that would be mobilized and the high level of water mixing that would occur due to river currents suggests that any DO reductions would be too small and short-lived to cause detectable effects in exposed fish.

<u>Toxic Materials:</u> Toxic materials may enter the water through construction-related spills and discharges, the mobilization of contaminated sediments, and/or the release of PAHs from creosote-treated timber piles during their removal. Fish can uptake contaminants directly through their gills, and through dietary exposure (Karrow *et al*. 1999; Lee and Dobbs 1972; McCain *et al*. 1990; Meador *et al*. 2006; Neff 1982; Varanasi *et al*. 1993). Petroleum-based fuels, lubricants, and other fluids commonly used by construction-related equipment contain Polycyclic Aromatic

Hydrocarbons (PAHs). Other contaminants can include metals, pesticides, Polychlorinated Biphenyls (PCBs), phlalates, and other organic compounds. Depending on the pollutant, its concentration, and/or the duration of exposure, exposed fish may experience effects that can range from avoidance of an affected area, to reduced growth, altered immune function, and mortality (Beitinger and Freeman 1983; Brette *et al*. 2014; Feist *et al*. 2011; Gobel *et al*. 2007; Incardona *et al*. 2004, 2005, and 2006; Mcintyre *et al*. 2012; Meadore *et al*. 2006; Sandahl *et al*. 2007; Spromberg *et al*. 2015).

Many of the fuels, lubricants, and other fluids commonly used in motorized vehicles and construction equipment are petroleum-based hydrocarbons with PAHs that are known to be injurious to fish. However, the project includes BMPs to reduce the risk and intensity of discharges and spills during construction. In the unlikely event of a construction-related spill or discharge, the event would likely be very small, quickly contained and cleaned. Also, non-toxic and/or biodegradable lubricants and fluids are strongly encouraged by the State, and are commonly used by many of the local contractors. Based on the best available information, the in-water presence of spill and discharge-related contaminants would be very infrequent, very short-lived, and at concentrations too low to cause detectable effects should a listed fish be exposed to them.

The sediments that would be mobilized during derelict pile removal very likely contain PAHs from the creosote-treated piles. PAHs may also be released directly from timber piles should they break during their removal (Evans *et al*. 2009; Parametrix 2011; Smith 2008; Werme *et al*. 2010). As described above, the amount of sediment that would be mobilized by construction activities would be small, and any PAHs that may be mobilized would likely dissipate within a few hours, through evaporation at the surface, dilution in the water column (Smith 2008; Werme *et al*. 2010), or by settling out of the water with the sediments. Therefore, in-water contaminant concentrations would be very low and short-lived. The NMFS estimates that all detectable water quality impacts would limited to the extent of the project-related visible turbidity, which wouldn't exceed 300 feet and one hour from the cessation of work. In the unlikely event of exposure to waterborne contaminants, the in-water concentrations would be too low, and exposure too brief to cause detectable effects in exposed individuals.

The planned removal of about 400 creosote-treated piles would reduce the number of derelict piles that are sources of ongoing PAH contamination at the site. Their removal is likely to cause some long-term improvement of water quality within the action area. However, the amount of improvement and the exact effects that may have on salmonids and their habitat resources within the action area is uncertain, particularly given the large number of derelict timber piles that would remain in the area after the project is complete.

Based on the best available information, as described above, any fish that may be exposed to construction-related water quality impacts would experience no more than temporary low-level behavioral effects, which individually, or in combination would not affect the fitness of exposed individuals.

Construction-related Propeller Wash

Construction-related propeller wash is likely to adversely affect juvenile PS Chinook salmon and PS steelhead. Spinning boat propellers kill fish and small aquatic organisms (Killgore *et al*. 2011; VIMS 2011). Spinning propellers also generate fast-moving turbulent water that is known as propeller wash. Exposure to propeller wash can displace and disorient small fish. It can also mobilize sediments and dislodge aquatic organisms, including submerged aquatic vegetation (SAV), particularly in shallow water and/or at high power settings. This is called propeller scour.

During construction, weekly tugboat operations would cause propeller wash within the action area. Adult Chinook salmon and steelhead that migrate through the action area are likely to avoid construction-related noise and activity. Further, they would be able to swim against most propeller wash they might be exposed to without any measurable effect on their fitness or normal behaviors. Conversely, juvenile Chinook salmon that are within the area are likely to be relatively close to the surface and too small to effectively swim against the propeller wash. Individuals that are struck or very nearly missed by the propeller would be injured or killed by the exposure. Farther away, propeller wash may displace and disorient fish. Depending on the direction and strength of the thrust plume, displacement could increase energetic costs, reduce feeding success, and may increase the vulnerability to predators for individuals that tumble stunned and/or disoriented in the wash.

The number of individuals that would be affected by propeller wash is unquantifiable with any degree of certainty. However, based on the timing and location of the work, and on the relatively low number of tugboat trips that would occur (about 16), the numbers of affected individuals would represent such small subsets of their respective cohorts that their loss would cause no detectable population-level effects.

Construction-related propeller scour may also reduce SAV and diminish the density and diversity of the benthic community at the project site. However, the affected area would be limited to a regularly dredged navigation channel where very little SAV is believed to exist. Further, any affected resources, such as benthic invertebrates would likely recover very quickly after work is complete. Therefore, the effects of propeller scour would be too small to cause any detectable effects on the fitness and normal behaviors of juvenile Chinook salmon and steelhead in the action area.

Construction-related Contaminated Forage

Exposure to contaminated forage is likely to adversely affect juvenile PS Chinook salmon and PS steelhead. In addition to direct uptake of contaminants through their gills, salmonids may absorb contaminants through dietary exposure (Meador *et al*. 2006; Varanasi *et al*. 1993). The removal of creosote-treated derelict timber piles would mobilize small amounts of contaminated subsurface sediments that would settle onto the top layer of the substrate, where contaminants such as PAHs and PCBs may remain biologically available for years.

Romberg (2005) discusses the spread of contaminated sediments that were mobilized by the removal of creosote-treated piles from the Seattle Ferry Terminal, including digging into the sediment with a clamshell bucket to remove broken piles. Soon after the work, high PAH levels were detected 250 to 800 feet away, across the surface of a clean sand cap that had been installed less than a year earlier. Concentrations decreased with distance from the pile removal site, and with time. However, PAH concentrations remained above pre-contamination levels 10 years later. Lead and mercury values also increased on the cap, but the concentrations of both metals decreased to background levels after 3 years.

The applicant's project would remove about 400 creosote-treated timber piles. Although sediment mobilization due to the planned work would be much less severe than was described by Romberg (2005), the sediments that would be mobilized the project are almost certainly contaminated by PAHs of creosote origin. Most of the sediment, and therefore the highest concentrations of contaminants, would likely settle out of the water close to where the piles would be pulled from. However, river currents and tugboat propeller wash may act to spread contaminated sediments as far away as 300 feet downstream.

Amphipods and copepods uptake PAHs from contaminated sediments (Landrum and Scavia 1983; Landrum et al. 1984; Neff 1982), and pass them to juvenile Chinook salmon and other small fish through the food web. Varanasi et al. (1993) found high levels of PAHs in the stomach contents of juvenile Chinook salmon in a contaminated waterway (Duwamish). They also reported reduced growth, suppressed immune competence, as well as increased mortality in juvenile Chinook salmon that was likely caused by the dietary exposure to PAHs. Meador et al. (2006) demonstrated that dietary exposure to PAHs caused "toxicant-induced starvation" with reduced growth and reduced lipid stores in juvenile Chinook salmon. The authors surmised that these impacts could severely impact the odds of survival in affected juvenile Chinook salmon. Juvenile PS steelhead were not specifically addressed in the available literature, but it is reasonable to expect that they may be similarly affected by dietary uptake of contaminants.

The annual number of juvenile PS Chinook salmon and PS steelhead that may be exposed to contaminated forage that would be attributable to this action is unquantifiable with any degree of certainty, as is the amount of contaminated prey that any individual fish may consume, or the intensity of any effects that an exposed individual may experience. However, the relatively small affected area suggests that the probability of trophic connectivity to the contamination would be very low for any individual fish. Therefore, for both species, the numbers of fish that may be annually exposed to contaminated prey would likely comprise extremely small subsets of the cohorts from their respective populations, and the numbers of exposed fish would be too low to cause detectable population-level effects.

<u>Structure-related Effects</u>

The fender would create physical conditions that are likely to adversely affect PS Chinook salmon and PS steelhead. The fender would create a shadow, that combined with the line of 42 piles and the attached fender boards is likely to inhibit normal migratory behaviors in some of the juvenile salmonids that encounter it. The fender would also provide favorable conditions for avian and piscine piscivorous predators.

The 360-foot long BNSF fender comprises the downstream end of continuous series of protective fenders that totals about 860 feet. The upstream end begins within a few feet of high water mark along the north riverbank, and angles sharply away from shore to a distance of about 140 away from the bank. From there, the combined fenders remain close to that distance from shore along for more than 600 feet (Figures 2 and 3). Although the BNSF fender is unlikely to be the initial cause of altered migration, it would be responsible for about 40 percent of the distance along which affected juvenile salmonids would be exposed to the stressors described below.

The piles and fender boards would create a long narrow shadow along the length of the fender. Numerous studies demonstrate that juvenile salmonids, in both freshwater and marine habitats, are more likely to avoid the shadow of an overwater structure than to pass through it (Celedonia *et al*. 2008a and b; Kemp *et al*. 2005; Moore *et al*. 2013; Munsch *et al*. 2014; Nightingale and Simenstad 2001; Ono *et al*. 2010; Southard *et al*. 2006). The closely spaced piles may also act synergistically with the shadow to increase the shadow's barrier effect.

Depending on the specific conditions at the time when out-migrating juveniles encounter the upstream end of the fender, such as brightness of the daylight, angle of the sun, and flow rate, some individuals are likely to swim away from shore in an attempt to avoid the structure. Although the altered path would not add greatly to the migratory distance traveled by the affected individuals, the off-bank migration would place the juvenile salmonids in relatively deep water where foraging is likely to have higher energetic costs than shallow waters along the riverbank (Heerhartz and Toft 2015). Therefore, the juvenile Chinook salmon and steelhead that swim around the fender are likely to experience some degree of reduced fitness due to increased energetic costs.

The fender would not necessarily increase the population of predators in the action area, but it is likely to concentrate them near it. The piles and fender boards would provide over-water perching structure for avian predators of juvenile salmonids, such as cormorants, gulls, and kingfishers. The proximity of those perches to the migratory route of the juvenile salmonids that swim around the fender would likely improve the birds' predatory success. Similarly, the piles would provide velocity refugia for piscine ambush predators that would rest on the down-current side of the piles. Further, the shade from the fender would increase the ability of predatory fish to hide from the migrating juvenile salmonids, and the relatively deep water along the fender would increase the vulnerability of the juveniles to predatory attacks (Celedonia *et al*. 2008a and b; Tabor *et al*. 2010; Willette 2001).

Individuals that fail to escape a predator's attack would be killed. Individuals that do escape would experience reduced fitness due to increased energetic costs and stress-related effects that may reduce their overall likelihood of survival. The likelihood that any individual juvenile Chinook salmon or steelhead would be injured or killed due to increased exposure to predators at the site is expected to be very low, and that likelihood would vary greatly over time due to the complexities of predator/prey dynamics as well as variations in environmental conditions at the site. However, over the life of the new fender, it is extremely likely that at least some individuals would be killed due to the increased risk of predation that would be caused by the shade of the new mooring structures.

The planned removal of about 200 additional derelict piles would reduce the amount of predator-supportive habitat within the action area. However, it would not prevent or reduce the increased risk of predation along the fender that was described above.

In summary, the fender would cause a combination of altered behaviors and increased risk of predation that would reduce fitness or cause mortality for some juvenile PS Chinook salmon and juvenile PS steelhead that pass the site. The annual numbers of either species that would be impacted by this stressor is unquantifiable with any degree of certainty, and the numbers are likely to vary greatly over time. However, the available information suggests that the probability of exposure would be very low for any individual fish, and only a subset of the exposed individuals would be measurably affected. Therefore, for both species, the proportion of any year's cohort that would be killed or experience measurably reduced fitness due to this stressor would be too low to cause any detectable population-level effects.

2.5.2 Effects on Critical Habitat

This assessment considers the intensity of expected effects in terms of the change they would cause in affected Physical or Biological Features (PBFs) from their baseline conditions, and the severity of each effect, considered in terms of the time required to recover from the effect. Ephemeral effects are those that are likely to last for hours or days, short-term effects would likely last for weeks, and long-term effects are likely to last for months, years or decades.

Critical Habitat for Puget Sound Chinook Salmon and Puget Sound Steelhead: The proposed action is likely to adversely affect designated critical habitat for PS Chinook salmon and PS Steelhead. The essential PBFs of critical habitat for both species are listed below. The expected effects on those PBFs from completion of the planned project, including full application of the conservation measures and best management practices (BMPs), would be limited to the impacts on the PBFs of freshwater migration, estuarine, and nearshore marine areas free of obstruction and excessive predation as described below.

1. Freshwater spawning sites – None in the action area.
2. Freshwater rearing sites – None in the action area.
3. Freshwater migration corridors free of obstruction and excessive predation:
    a. Obstruction and predation – The proposed action would cause long-term minor adverse and beneficial effects on this PBF. The new fender is likely to alter the migratory behavior of some juvenile salmonids in that it would inhibit their access to riverbank habitat. The fender would also provide habitat for piscivorous predators. Conversely, the net removal of about 358 piles would reduce the availability of predator-friendly habitat within the action area.
    b. Water quantity – The proposed action would cause no effect on this PBF.
    c. Water quality – The proposed action would cause ephemeral minor adverse effects and long-term minor beneficial effects on this PBF. The action would cause no measurable changes in water temperature, but construction would briefly increase suspended solids and may slightly reduce DO and introduce low levels of contaminants. Conversely, the removal of about 400 derelict creosote-treated timber piles would reduce ongoing PAH contamination at the site. Detectable water quality impacts are expected to be limited to

the area within 300 feet downstream of the project site, with construction-related impacts persisting no more than an hour after work stops.

   d. Salinity – The proposed action would cause no effect on this PBF.
   e. Natural Cover – The proposed action would cause no effect on this PBF.

4. Estuarine areas free of obstruction and excessive predation:
   a. Obstruction and predation – Same as above.
   b. Water quality – Same as above.
   c. Water quantity – Same as above.
   d. Salinity – Same as above.
   e. Natural Cover – Same as above.
   f. Forage – The proposed action would cause long term minor adverse effects on this PBF. Construction would mobilize small amounts of PAH-contaminated sediments that could be taken up by benthic invertebrates that are forage resources for juvenile Chinook salmon and steelhead. Sediment distribution would likely be limited to the area within 300 feet downstream of the fender, but detectable levels of contaminants may last for years at continuously decreasing concentrations. The action would not affect forage fish.
5. Nearshore marine areas free of obstruction and excessive predation:
   a. Obstruction and predation – Same as above.
   b. Water quality – Same as above.
   c. Water quantity – Same as above.
   d. Forage – Same as above.
   e. Natural Cover – Same as above.
6. Offshore marine areas – None in the action area.

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 the consultation (50 CFR 402.02). Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the Environmental Baseline section (Section 2.4).

The current condition of ESA-listed species and designated critical habitat within the action area are described in the Status of the Species and Critical Habitat and the Environmental Baseline sections above. The contribution of non-federal activities to those conditions include past and on-going bankside development in the action area, as well as upstream forest management, agriculture, urbanization, road construction, water development, and restoration activities. Those actions were driven by a combination of economic conditions that characterized traditional natural resource-based industries, general resource demands associated with settlement of local and regional population centers, and the efforts of conservation groups dedicated to restoration and use of natural amenities, such as cultural inspiration and recreational experiences.

The NMFS is unaware of any specific future non-federal activities that are reasonably certain to affect the action area. However, the NMFS is reasonably certain that future non-federal actions such as the previously mentioned activities are all likely to continue and increase in the future as the human population continues to grow across the region. Continued habitat loss and degradation of water quality from development and chronic low-level inputs of non-point source pollutants will likely continue into the future. Recreational and commercial use of river waters within the action area is also likely to increase as the human population grows.

The intensity of these influences depends on many social and economic factors, and therefore is difficult to predict. Further, the adoption of more environmentally acceptable practices and standards may gradually reduce some negative environmental impacts over time. Interest in restoration activities has increased as environmental awareness rises among the public. State, tribal, and local governments have developed plans and initiatives to benefit ESA-listed PS Chinook salmon and PS steelhead within many of the watersheds that flow into the action area. However, the implementation of plans, initiatives, and specific restoration projects are often subject to political, legislative, and fiscal challenges that increase the uncertainty of their success.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) appreciably reduce 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 for the conservation of the species.

As described in more detail above at Section 2.4, climate change is likely to increasingly affect the abundance and distribution of the ESA-listed species considered in the Opinion. It is also likely to increasingly affect the PBFs of designated critical habitats. The exact effects of climate change are both uncertain, and unlikely to be spatially homogeneous. However, climate change is reasonably likely to cause reduced instream flows in some systems, and may impact water quality through elevated in-stream water temperatures and reduced dissolved oxygen, as well as by causing more frequent and more intense flooding events.

Climate change may also impact coastal waters through elevated surface water temperature, increased and variable acidity, increasing storm frequency and magnitude, and rising sea levels. The adaptive ability of listed-species is uncertain, but is likely reduced due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. The proposed action will cause direct and indirect effects on the ESA-listed species and critical habitats considered in the Opinion well into the foreseeable future. However, the action's effects on water quality, substrate, and the biological environment are expected to be of such a small scale that no detectable effects on ESA-listed species or critical habitat through synergistic interactions with the impacts of climate change are expected.

2.7.1 ESA-listed Species

PS Chinook salmon and PS steelhead are listed as threatened, based on declines from historic levels of abundance and productivity, loss of spatial structure and diversity, and an array of limiting factors as a baseline habitat condition. Both species will be affected over time by cumulative effects, some positive – as recovery plan implementation and regulatory revisions increase habitat protections and restoration, and some negative – as climate change and unregulated or difficult to regulate sources of environmental degradation persist or increase. Overall, to the degree that habitat trends are negative, as described below, effects on viability parameters of each species are also likely to be negative. In this context we consider the effects of the proposed action's effect on individuals of the listed species at the population scale.

PS Chinook salmon

The long-term abundance trend of the PS Chinook salmon ESU is slightly negative. The PS Chinook salmon in the action areas are summer and fall run fish from the Skykomish River population, and fall run fish from the Skykomish and Snoqualmie River populations. All three populations have slightly negative general trends, and relatively large proportions of those populations' spawners are hatchery-origin fish. Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS Chinook salmon. Commercial and recreational fisheries also continue to impact this species.

The project site is located in the tidally influenced lower mainstem of the Snohomish River, which provides one of several routes to and from marine waters for adults and juveniles of the Skykomish and Snohomish River PS Chinook salmon populations. The environmental baseline within the action area has been degraded by the effects of intense streambank and shoreline development and by industrial and maritime activities. The baseline has also been degraded by upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

Short- and long-term construction-related impacts, and long-term structure-related impacts are likely to cause a range of effects that both individually and collectively would cause altered behaviors, reduced fitness, and possible mortality in low numbers of exposed individuals for decades to come. The annual numbers of individuals that are likely to be impacted by action-related stressors is unknown, but they are expected to be very low.
Based on the best available information, the scale of the direct and indirect effects of the proposed action, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause detectable effects on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for the affected PS Chinook salmon populations. Therefore, the proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species.

PS Steelhead

The PS steelhead DPS is currently considered “not viable”, and the extinction risk for most DIPs is estimated to be moderate to high. Long-term abundance trends have been predominantly negative or flat across the DPS, especially for natural spawners, and growth rates are currently declining at 3 to 10% annually for all but a few DIPs. The PS steelhead in the action area are summer-run steelhead from the North Fork Skykomish and Tolt River DIPs, and winter-run steelhead from the Pilchuck, Snohomish/Skykomish, and Snoqualmie River DIPs. For all 5 DIPs, the number of returning adults has fluctuated greatly over time, with the general trend being negative. The viability of the Pilchuck River DIP is considered low. The other 4 DIPs are considered moderate. Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS steelhead. Fisheries activities also continue to impact this species.

The project site is located in the tidally influenced lower mainstem of the Snohomish River, which provides one of several routes to and from marine waters for adults and juveniles of the 5 PS steelhead DIPs, identified above. The environmental baseline within the action area has been degraded by the effects of intense streambank and shoreline development and by industrial and maritime activities. The baseline has also been degraded by upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

Short- and long-term construction-related impacts, and long-term structure-related impacts are likely to cause a range of effects that both individually and collectively would cause altered behaviors, reduced fitness, and possible mortality in low numbers of exposed individuals for decades to come. The annual numbers of individuals that are likely to be impacted by action-related stressors is unknown, but they are expected to be very low.

Based on the best available information, the scale of the direct and indirect effects of the proposed action, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause detectable effects on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for the affected PS steelhead DIPs. Therefore, the proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species.

2.7.2 Critical Habitat

As described above at Section 2.5, the proposed action is likely to adversely affect designated critical habitat for PS Chinook salmon and PS steelhead.

Critical Habitat for PS Chinook Salmon and PS Steelhead

Past and ongoing land and water use practices have degraded salmonid critical habitat throughout the Puget Sound basin. Hydropower and water management activities have reduced or eliminated access to significant portions of historic spawning habitat. Timber harvests, agriculture, industry, urbanization, and shoreline development have adversely altered floodplain and stream morphology in many watersheds, diminished the availability and quality of estuarine and nearshore marine habitats, and reduced water quality across the region.

Global climate change is expected to increase in-stream water temperatures and alter stream flows, possibly exacerbating impacts on baseline conditions in freshwater habitats across the region. Rising sea levels are expected to increase coastal erosion and alter the composition of nearshore habitats, which could further reduce the availability and quality of estuarine habitats. Increased ocean acidification may also reduce the quality of estuarine habitats.

In the future, non-federal land and water use practices and climate change are likely to increase. The intensity of those influences on salmonid critical habitat is uncertain, as is the degree to which those impacts may be tempered by adoption of more environmentally acceptable land use practices, by the implementation of non-federal plans that are intended to benefit salmonids, and by efforts to address the effects of climate change.

The PBFs for PS salmonid critical habitat in the action area are limited to freshwater migration corridors, estuarine, and nearshore marine areas that are free of obstruction and excessive predation. The site attributes of those PBFs that would be affected by the action are limited to obstruction and predation, water quality, and forage. As described above, the proposed action would cause short- and long-term minor adverse effects, as well as long-term minor beneficial effects on the site attributes of those PBFs within about 300 feet downstream of the fender.

Based on the best available information, the scale of the proposed action's effects, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause any detectable long-term negative changes in the quality or functionality of any of the site attributes of critical habitat PBFs in the action area. Therefore, the critical habitats will maintain their current level of functionality, and retain their current ability for PBFs to become functionally established, to serve the intended conservation role for PS Chinook salmon and PS steelhead.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS' opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon and PS steelhead, nor is it likely to destroy or adversely modify designated critical habitat for either species.

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). "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 incidental take statement (ITS).

2.9.1 Amount or Extent of Take

The NMFS determined that incidental take is reasonably certain to occur as follows:

Harm of juvenile Puget Sound Chinook salmon and Puget Sound steelhead from

- exposure to construction-related noise,
- exposure to construction-related propeller wash,
- exposure to construction-related contaminated forage, and
- exposure structure-related effects.

The NMFS cannot predict with meaningful accuracy the number of juvenile PS Chinook salmon and juvenile PS steelhead that are reasonably certain to be injured or killed annually by exposure to any of these stressors. The distribution and abundance of the fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and spatial scales than are affected by the proposed action. Thus, the distribution and abundance of fish within the action area cannot be attributed entirely to habitat conditions, nor can NMFS precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by the proposed action.

Additionally, the NMFS knows of no device or practicable technique that would yield reliable counts of individuals that may experience these impacts. In such circumstances, NMFS uses the causal link established between the activity and the likely extent and duration of changes in habitat conditions to describe the extent of take as a numerical level of habitat disturbance. The most appropriate surrogates for take are action-related parameters that are directly related to the magnitude of the expected take.

For this action, the timing and duration of work, the type and size of the piles to be extracted and installed, and the method of their extraction and installation are the best available surrogates for the extent of take of juvenile PS Chinook salmon and juvenile PS steelhead from exposure to construction-related noise. The timing and duration of work is also the best available surrogate for the extent of take of juvenile PS Chinook salmon and juvenile PS steelhead from exposure to construction-related propeller wash.

Timing and duration of work is applicable for construction-related take because the planned work window was selected to reduce the potential for juvenile salmonid presence at the project site. Therefore, working outside of the planned work window and/or working for longer than planned could increase the number of fish likely to be exposed to construction-related noise and propeller wash. The piles and the method of their extraction and installation are applicable for construction-related noise because the intensity of effect is positively correlated with the loudness of the sound, which is determined by the type and size of the pile and the method of extraction and/or installation. Further, the number of fish that would be exposed to the noise is positively correlated with the size of the area of acoustic effect and the number of days that the area would be ensonified. In short, as the sound levels increase, the intensity of effect and the size of the ensonified area increases, and as the size of the ensonified area increases, and/or as the number of days the area is ensonified increases, the number of juvenile Chinook salmon and steelhead that would be exposed to the sound would increase despite the low density and random distribution of individuals of these species in the action area. Based on the best available information about the planned pile extraction and installation, as described in Section 2.5, the applicable ranges of effect for this project are driven by the type and size of the piles and the method of their extraction and installation, not by the daily duration of vibratory work. Therefore, daily duration of vibratory work is not considered a measure of take for this action.

The removal method and the extent of the visible turbidity plumes around that work are the best available surrogates for the extent of take of juvenile PS Chinook salmon and PS steelhead from exposure to construction-related contaminated forage. This is because the intensity of contamination on the surface of the riverbed would be positively correlated with the amount of contaminated subsurface sediments that would be brought to the surface, and the numbers of contaminated prey organisms and/or exposed fish would be positively correlated with the size of the affected area. The use of removal methods such as excavators or water-jetting would mobilize more contaminated sediments than the proposed vibratory extraction of the piles. As the amount of mobilized contaminated sediments increase, the amount of biologically available contaminants would increase. Also, as the size of the visible turbidity plume increases, the size of the area where contaminated sediments would be biologically available would increase. Therefore, as the amount of mobilized contaminated sediments and/or the size of the visible turbidity plumes increase, the number of prey organisms that may become contaminated and then eaten by juvenile PS Chinook salmon and PS steelhead would increase, despite the low density and random distribution of juveniles of both of these species in the action area.

The size and configuration of the applicant’s new fender are the best available surrogates for the extent of take of juvenile PS Chinook salmon and PS steelhead from exposure to structure-related effects. Increasing the fender’s size (length, thickness, and number of piles) would increase the size and intensity of its shadow, which would increase the likelihood that any juvenile Chinook salmon and steelhead that are on the side of the fender opposite to the riverbank would continue to travel along the fender instead of returning to more optimal bankside habitat. Increasing the distance that juvenile fish travel along the fender instead of returning to the riverbank would increase their risk of exposure to the avian and piscene predators that are likely to inhabit the structure. Increasing the number of piles would also increase the amount predatory-supportive habitat, which may increase predator density at the site and further increase the risk of exposure to predators for juvenile Chinook salmon and steelhead.

In summary, the extent of PS Chinook salmon and PS steelhead take for this action is defined as:

- Up to 16 weeks of in-water work between July 16 and February 15;
- Vibratory extraction of about 400 timber piles;

- Vibratory installation of 42 steel pipe piles no larger than 24-inches in diameter;
- A visible turbidity plume not to exceed 300 feet from the project site during any portion of the project, including movement of the contractor's tugboats; and
- The size and configuration of the replaced fender, as described in the proposed action section of this biological opinion.

Exceedance of any of the exposure limits described above would constitute an exceedance of authorized take that would trigger the need to reinitiate consultation.

Although these take surrogates could be construed as partially coextensive with the proposed action, they nevertheless function as effective reinitiation triggers. If the size and configuration of the structure exceeds the proposal, it could still meaningfully trigger reinitiation because the Corps has authority to conduct compliance inspections and to take actions to address non-compliance, including post-construction (33 CFR 326.4).

2.9.2 Effect of the Take

In the Opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to jeopardize the continued existence of PS Chinook salmon and PS steelhead, nor is it likely to destroy or adversely modify designated critical habitat for either species (Section 2.8).

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" (RPMs) are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02).

The COE shall require the applicant to:

1. Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to construction-related noise and propeller wash.

2. Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to contaminated forage.

3. Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to structure-related effects.

4. Ensure the implementation of monitoring and reporting to confirm that the take exemption for the proposed action is not exceeded.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary. The COE or any applicant must comply with them in order to implement the RPM (50 CFR 402.14). 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. To implement RPM Number 1, Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to construction-related noise and propeller wash, the COE shall require the applicant to require their contractors to:
    a. Limit in-water work, including the use of tugboats, to 16 weeks between July 16 and February 15;
    b. Limit pile extraction and installation to vibratory equipment. No impact pile driving shall be done; and
    c. Limit pile installation to a maximum of 42 steel pipe piles no larger than 24 inches in diameter.

2. To implement RPM Number 2, Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to contaminated forage, the COE shall require the applicant to require their contractors to:
    a. Extract piles slowly by pulling. No water-jetting or clamshell digging shall be used;
    b. Ensure that extracted piles are not shaken, hosed off, left hanging to dry, or that any other actions are taken to remove adhering material from piles while they are suspended over the water; and
    c. Adjust pile extraction and tugboat operations to ensure that the visible turbidity plume does not exceed 300 feet from the project site, and to halt work should the visible turbidity plume approach and that range.

3. To implement RPM Number 3, Minimize incidental take PS Chinook salmon and PS steelhead from exposure to structure-related effects, the COE shall require the applicant to ensure that the size and configuration of the replaced fender does not exceed the dimensions described in the proposed action section above. In particular:
    a. The new fender shall be no longer than 360 feet long; and
    b. The new fender shall include no more than 42 steel pipe piles.

4. To implement RPM Number 4, Implement monitoring and reporting to confirm that the take exemption for the proposed action is not exceeded, the COE shall require the applicant to develop and implement a plan collect and report details about the take of listed fish. That plan shall:
    a. Require the contractor to maintain and submit construction logs to verify that all take indicators are monitored and reported. Minimally, the logs should include:
        i. The dates (with workday start and stop times) and descriptions of all in-water work;
        ii. The type, size, and number of piles extracted and/or installed, per day;
        iii. The method of pile extraction and/or installation;
        iv. A description of best management practices and conservation measures employed; and
        v. The extent (feet) and duration of visible turbidity plumes around pile work and during tugboat operations.

b. Require the contractor to establish procedures for the submission of the construction logs and other materials to the appropriate COE office and to NMFS; and
c. Require the contractor to submit an electronic post-construction report to NMFS within six months of project completion. Send the report to: projectreports.wcr@noaa.gov. Be sure to include Attn: WCRO-2019-01086 in the subject line.

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).

1. The COE should encourage the applicant to install perching deterrent devices on the tops of the new piles and along the upper edge of the topmost fender planks.

2. The COE should encourage the applicant to develop and implement a plan for the removal of all derelict piles at the project site.

2.11 Reinitiation of Consultation

This concludes formal consultation for the U.S Army Corps of Engineers' authorization of the BNSF North Fender Replacement Project at Railway Bridge 0050-37.0, Everett, Washington, (NWS-2019-65). As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitats in a manner or to an extent not considered in this Opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitats that was not considered in this Opinion, or (4) a new species is listed or critical habitat is designated that may be affected by the action.

2.12 Not Likely to Adversely Affect Determinations

This assessment was prepared pursuant to section 7(a)(2) of the ESA, implementing regulations at 50 CFR 402 and agency guidance for preparation of letters of concurrence.

As described in section 1.2, the COE determined the proposed action would have no effect on PS/GB bocaccio, PS/GB yelloweye rockfish, SR killer whales, and the designated critical habitats for those three species. However, given the action's proximity to marine waters, and the extent of the action area, the NMFS concluded that the proposed action may affect those species and critical habitats. Detailed information about the biology, habitat, and conservation status and trends of these listed resources can be found in the listing regulations and critical habitat designations published in the Federal Register, as well as in the recovery plans and other sources at: http://www.nmfs.noaa.gov/pr/species/fish/, and are incorporated here by reference.

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.

For simplicity, the effects analysis in this section relies heavily on the descriptions of the proposed action and project site conditions discussed in Sections 1.3 and 2.4, and on effects analyses presented in Section 2.5. As described in Section 2.5, action-related stressors would cause no measurable effects in fish beyond about 328 feet (100 m) around the fender. Based on the current understanding of marine mammal acoustic sensitivity (NMFS 2018b), the maximum theoretical range to the onset of behavioral disturbance in whales would be about 6.2 miles (10,000 m) during vibratory installation of 42 24-inch steel pipe piles.

2.12.1 Effects on Listed Species

The project site is located in the tidally influenced lower mainstem of the Snohomish River (Figure 1). The site is about 1 to 1.3 miles upstream of a sharp bend in the river, where the channel is bordered to the north and west by very shallow intertidal substrates and Jetty Island.

PS/GB bocaccio and PS/GB yelloweye rockfish: Based on the expected range of effects on fish, and the location of the project site relative to the closest habitats that are reasonably likely to support any life stage of PS/GB bocaccio and PS/GB yelloweye rockfish, it is extremely unlikely that any individuals of either of these marine species would be exposed to any action-related stressors capable of causing measurable effects. Therefore, the action is not likely to adversely affect those species.

SR killer whale: The physical features of the river to the west of the project site, and of the Port Gardner Channel to the south suggest that it is extremely unlikely that any SR killer whales would be present within river west of the project site. Therefore it is extremely unlikely that any individuals of this species would approach close enough to the project site to be exposed to any project-related effects other than noise and to possible indirect effects through the trophic web.

The peak noise levels of all project-related sound sources would be non-injurious to SR killer whales and other marine mammals (NMFS 2018b), but in-water sound levels at or above the 120 dB_{RMS} threshold for the onset of behavior disturbance for exposure to non-impulsive noise could theoretically extend to about 6.2 miles from the site. However, the physical features of the river about a mile west of the project site would block and absorb most of the noise.

In the very unlikely event that a killer whale entered that area during vibratory pile installation, it would be exposed to sound levels of only about 131 dB_{RMS}. The high levels of local shipping and other boat traffic, and the relatively high ambient noise levels in the area (Bassett *et al*. 2010) support the expectation that even the loudest project-related noise would be barely detectable by SR killer whales at that range. Any project related sound that may radiate beyond that range and enter Puget Sound would likely attenuate more than normal due to increased scattering and absorption that would be caused by the very shallow water between the river and the sound. Any SR killer whales that approach close enough to hear and respond to project-related noise would, at most, experience brief periods of low-level acoustic masking, and possible temporary minor avoidance of the mouth of the Snohomish River. The exposure would not impact their fitness, nor would it meaningfully change their normal behaviors.

The proposed action would also cause no measurable trophic effects on SR killer whales because it would cause no population-level effects on the Chinook salmon that are their main prey resource (Section 2.5). Therefore, the action is not likely to adversely affect SR killer whales.

2.12.2 Effects on Critical Habitat

This assessment considers the intensity of expected effects in terms of the change they would cause in affected PBFs from their baseline conditions, and the severity of each effect, considered in terms of the time required to recover from the effect. Ephemeral effects are those that are likely to last for hours or days, short-term effects would likely to last for weeks, and long-term effects are likely to last for months, years or decades.

The action area extends 6.2 miles from the project site, which overlaps with designated deepwater critical habitat for PS/GB bocaccio and PS/GB yelloweye rockfish about 4 miles west of the site. However, the project would cause no stressors that would detectably impact any of the PBF of rockfish critical habitat. Therefore, the proposed action is not likely to adversely affect rockfish critical habitat.

Designated critical habitat for SR killer whales extends into the Snohomish River to a point about 750 yards (2,250 feet) downstream from the project site. As described in Section 2.5, the action would cause temporary minor effects on water quality that would be undetectable SR killer whale critical habitat. The annual levels of juvenile Chinook salmon take would be too low to cause population-levels effects, or to cause detectable effects on prey availability for SR killer whales. Finally, any reduction in the passage PBF, would be too limited in range and duration to measurably reduce its ecological function for SR killer whale. Based on this information, the proposed action is not likely to adversely affect SR killer whale critical habitat.

In summary, the NMFS has concluded that the proposed action is not likely to adversely affect PS/GB bocaccio, PS/GB yelloweye rockfish, SR killer whales, and the designated critical habitats for these three species.

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

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

3.1 Essential Fish Habitat Affected by the Project

The project site is located in the tidally influenced lower mainstem of the Snohomish River (Figure 1). The action area includes waters and substrates that have been designated as EFH for various life-history stages of Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species. The action area also includes areas that qualify as habitat areas of particular concern (HAPC).

Freshwater and marine EFH for Pacific Coast Salmon is identified and described in Appendix A to the Pacific Coast salmon fishery management plan (PFMC 2014). The major components of freshwater EFH are: Spawning and incubation; Juvenile rearing; Juvenile migration corridors; and Adult migration corridors and holding habitat. For marine EFH, the major components are: Estuarine rearing; Ocean rearing; and juvenile and adult migration. The combined important features of Pacific Coast Salmon EFH are: (1) Water quality (e.g., dissolved oxygen, nutrients, temperature, etc.); (2) Water quantity, depth, and velocity; (3) Riparian-stream-marine energy exchanges; (4) Channel gradient and stability; (5) Prey availability; (6) Cover and habitat complexity (e.g., LWD, pools, aquatic and terrestrial vegetation, etc.); (7) Space; (8) Habitat connectivity from headwaters to the ocean (e.g., dispersal corridors); (9) Groundwater-stream interactions; (10) Connectivity with terrestrial ecosystems; and (11) Substrate composition. Pacific Coast Salmon HAPC include: Complex channels and floodplain habitats; Thermal refugia; Spawning habitat; Estuaries; and Marine and estuarine submerged aquatic vegetation.

Pacific Coast Groundfish EFH is identified as: All marine waters and substrate from mean higher high water (MHHW) or the upriver extent of saltwater intrusion out to depths less than or equal to 11,484 feet (3,500 m); Certain specifically identified seamounts in depths greater than 11,484 feet; and Areas designated as HAPCs not already identified by the above criteria (PFMC 2005). Pacific Coast Groundfish HAPC includes: Estuaries; Canopy Kelp; Seagrass; Rocky Reefs; and Areas of interest. For Coastal Pelagic Species, EFH is identified as all marine and estuarine waters from the shoreline to the offshore limits of the exclusive economic zone (EEZ) and above the thermocline where sea surface temperatures range between 10°C to 26°C (PFMC 1998).

Succinct identification of specific habitat features that are necessary to support the full life cycles of Groundfish and Pelagic Species are absent from their respective EFH descriptions. This is caused primarily by the large number of species, and the wide range of habitats that are considered in the associated fishery management plans (FMPs). However, the important features identified for Salmon EFH comprehensively address the habitat features that are necessary to support the full life cycle for all three species groups that may be affected by the proposed action. Therefore, the important features of Salmon EFH are used below to assess the impacts on EFH for all three species groups.

3.2 Adverse Effects on Essential Fish Habitat

The ESA portion of this document (Sections 1 and 2) describes the proposed action and its adverse effects on ESA-listed species and critical habitat, and is relevant to the effects on EFH. Based on the analysis of effects presented in Section 2.5 the proposed action will cause minor short- and long-term adverse effects, and minor long-term beneficial effects on EFH for Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species as summarized below.

1. <u>Water quality:</u> – The proposed action would cause a mix of ephemeral minor adverse effects and long-term minor beneficial effects on water quality. Construction would briefly increase suspended solids and may temporarily introduce low levels of contaminants. Also, low levels of pollutants from equipment may enter the water during construction. Conversely, the removal of about 400 creosote-treated timber piles would reduce ongoing PAH contamination at the site. Detectable effects would be limited to the area within about 300 feet of the project site. No changes in water temperature or salinity are expected.

2. <u>Water quantity, depth, and velocity:</u> – The proposed action may cause long-term minor adverse effects on water velocity. The fender may slightly alter the direction and velocity of water flows immediately adjacent to it. No changes in water quantity or depth are expected.

3. <u>Riparian-stream-marine energy exchanges:</u> – No changes expected.

4. <u>Channel gradient and stability:</u> – No changes expected.

5. <u>Prey availability:</u> – The proposed action would cause long term minor adverse effects on prey availability. Mobilization of subsurface sediments during pile removal would slightly increase PAH contamination in the invertebrate prey organisms within about 300 feet of the project site.

6. <u>Cover and habitat complexity:</u> – No changes expected.

7. <u>Space:</u> – No changes expected.

8. <u>Habitat connectivity from headwaters to the ocean:</u> – No changes expected.

9. <u>Groundwater-stream interactions:</u> – No changes expected.

10. <u>Connectivity with terrestrial ecosystems:</u> – No changes expected.

11. Substrate composition: – No changes expected.

The Estuaries HAPC is the only HAPC likely to be affected by the proposed action because the project would take place within estuarine waters, and no other HAPC occur with the expected range of effects. All effects on the Estuaries HAPC are identified above at 1, 2, and 5.

3.3 Essential Fish Habitat Conservation Recommendations

The proposed action includes conservation measures, BMP, and design features to reduce construction- and structure-related impacts on the quantity and quality of EFH for Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species. It also includes the removal of about 200 derelict creosote-treated timber piles. With the exception of the following conservation recommendations to reduce impacts on water quality and prey availability, the NMFS knows of no other reasonable measures to further reduce effects on EFH.

To reduce adverse impacts on water quality and prey availability, the COE should require the applicant to require their contractors to:

1. Extract piles slowly by pulling with no use of water-jetting or clamshell digging;
2. Ensure that extracted piles are not shaken, hosed off, left hanging to dry, or that any other actions are taken to remove adhering material from piles while they are suspended over the water; and
3. Adjust pile extraction and tugboat operations to ensure that turbidity does not exceed 300 feet from the project site, and to halt work should the visible turbidity plume approach and that range.

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 the 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 the NMFS' EFH Conservation Recommendations unless the NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, 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 the 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, the 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 the 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 user of this Opinion is the COE. Other users could include WDFW, the government and citizens of Snohomish County and the City of Everett, the Port of Everett, and Native American tribes. Individual copies of this Opinion were provided to the COE. The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by the NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

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

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

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

5. REFERENCES

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

Bassett, C., J. Thomson, and B. Polagye. 2010. Characteristics of underwater ambient noise at a proposed tidal energy site in Puget Sound. In Proceedings of the Oceans 2010 Conference, September 23–25, Seattle WA. Presentation Slides. 15 pp.

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

Berg, L. and T.G. Northcote. 1985. Changes in Territorial, Gill-Flaring, and Feeding Behavior in Juvenile Coho Salmon (*Oncorhynchus kisutch*) Following Short-Term Pulses of Suspended Sediment. Canadian Journal of Fisheries and Aquatic Sciences 42: 1410-1417.

Beitinger, T.L. and L. Freeman. 1983. Behavioral avoidance and selection responses of fishes to chemicals. In: Gunther F.A., Gunther J.D. (eds) Residue Reviews. Residue Reviews, vol 90. Springer, New York, NY.

Bjornn, T. C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication 19:83-139.

Bloch, P. 2010. SR 520 Test Pile Turbidity Monitoring Technical Memorandum. Washington State Department of Transportation. Olympia, WA. July 19, 2010. 10 pp.

Brennan, J. S., K. F. Higgins, J. R. Cordell, and V. A. Stamatiou. 2004. Juvenile Salmon Composition, Timing, Distribution, and Diet in Marine Nearshore Waters of Central Puget Sound, 2001-2002. Prepared for the King County Department of Natural Resources and Parks, Seattle, WA.

Brette, F., B. Machado, C. Cros, J.P. Incardona, N.L. Scholz, and B.A. Block. 2014. Crude Oil Impairs Cardiac Excitation-Contraction Coupling in Fish. Science Vol 343. February 14, 2014. 10.1126/science.1242747. 5 pp.

CalTrans. 2009. Final Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. Including the Oct 2012 update to the Appendix 1 - Compendium of Pile Driving Sound Data. Prepared for: California Department of Transportation 1120 N Street Sacramento, CA 94274. Prepared by: ICF Jones & Stokes 630 K Street, Suite 400 Sacramento, CA 95818 and: Illingworth and Rodkin, Inc. 505 Petaluma Blvd. South Petaluma, CA 94952. February 2009. 367 pp.

Campbell Scientific, Inc. 2008. Comparison of Suspended Solids Concentration (SSC) and Turbidity. Application Note Code: 2Q-AA. April 2008. 5 pp.

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

Celedonia, M.T., R.A. Tabor, S. Sanders, D.W. Lantz, and J. Grettenberger. 2008b. Movement and Habitat Use of Chinook Salmon Smolts and Two Predatory Fishes in Lake Washington and the Lake Washington Ship Canal. 2004–2005 Acoustic Tracking Studies. U.S. Fish and Wildlife Service, Lacey, WA. December 2008. 129 pp.

Codarin, A., L.E. Wysocki, F. Ladich, and M. Picciulin. 2009. Effects of ambient and boat noise on hearing and communication in three fish species living in a marine protected area (Miramare, Italy). Marine Pollution Bulletin 58 (2009) 1880–1887.

Corps of Engineers, U.S. Army (COE). 2011. Snohomish River Dredging – Sound Pressure Levels Associated with Dredging – Acoustic Monitoring Report Final. Prepared by: Science Applications International Corporation Bothell, Washington and RPS/Evans-Hamilton, Inc. Seattle, Washington. May 31, 2011. 68 pp.

COE. 2019a. ESA Consultation Request – NWS-2019-65 – BNSF Railway Company (Snohomish). June 13, 2019. 2 pp.

COE. 2019b. FW: [Non-DoD Source] RE: More NMFS Comments/Questions: BNSF Railway Bridge 37.0 North Fender (NWS-2019-65). e-mail from R. Wilcox with information from the applicant's agent. August 2, 2019. 2 pp.

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

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

David Evans and Associates, Inc. (DEA). 2011. Columbia River Crossing Test Pile Project – Hydroacoustic Monitoring – Final Report. Agreement Number Y-9246, Task AH, Amendment No. 7. July 2011. 256 pp.

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

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

Ellison, C.A., R.L. Kiesling, and J.D. Fallon. 2010. Correlating Streamflow, Turbidity, and Suspended-Sediment Concentration in Minnesota's Wild Rice River. 2nd Joint Federal Interagency Conference, Las Vegas, NV, June 27 - July 1, 2010. 10 pp.

Environmental Security Technology Certification Program (ESTCP). 2016. Evaluation of Resuspension from Propeller Wash in DoD Harbors. ER-201031. SPAWARSYSCEN Pacific, 53560 Hull Street, San Diego, CA 92152–5001. May 2016. 53 pp.

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

Federal Highway Administration (FHWA). 2017. On-line Construction Noise Handbook – Section 9.0 Construction Equipment Noise Levels and Ranges. Updated: June 28, 2017. Accessed March 5, 2019 at: https://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

Feist, B.E., E.R. Buhle, P. Arnold, J.W. Davis, and N.L. Scholz. 2011. Landscape ecotoxicology of coho salmon spawner mortality in urban streams. Plos One 6(8):e23424.

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

Gobel, P., C. Dierkes, & W.C. Coldewey. 2007. Storm water runoff concentration matrix for urban areas. Journal of Contaminant Hydrology, 91, 26–42.

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

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

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

Hard, J.J., J.M. Myers, E.J. Connor, R.A. Hayman, R.G. Kope, G. Lucchetti, A.R. Marshall, G.R. Pess, and B.E. Thompson. 2015. Viability criteria for steelhead within the Puget Sound distinct population segment. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-NWFSC-129. May 2015. 367 pp.

Heerhartz, S.M. and J.D. Toft. 2015. Movement patterns and feeding behavior of juvenile salmon (*Oncorhynchus* spp.) along armored and unarmored estuarine shorelines. Enviro. Biol. Fishes 98, 1501-1511.

Hicks, B. J., J. D. Hall, P. A. Bisson, and J. R. Sedell. 1991. Responses of salmonids to habitat change. American Fisheries Society Special Publication 19:483-519.

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

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

Incardona, J.P., T.K. Collier, and N.L. Scholz. 2004. Defects in cardiac function precede morphological abnormalities in fish embryos exposed to polycyclic aromatic hydrocarbons. Toxicology and Applied Pharmacology 196:191-205.

Incardona, J.P., M.G. Carls, H. Teraoka, C.A. Sloan, T.K. Collier, and N.L. Scholz. 2005. Aryl hydrocarbon receptor-independent toxicity of weathered crude oil during fish development. Environmental Health Perspectives 113:1755-1762.

Incardona, J.P., H.L. Day, T.K. Collier, and N.L. Scholz. 2006. Developmental toxicity of 4-ring polycyclic aromatic hydrocarbons in zebrafish is differentially dependent on AH receptor isoforms and hepatic cytochrome P450 1A metabolism. Toxicology and Applied Pharmacology 217:308-321.

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

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

Jacobs Engineering Inc. (Jacobs). 2019a. Biological Evaluation – BNSF Railway Bridge 0050-0037.0, North Fender Replacement Project, Snohomish County, Washington. U.S. Army Corps of Engineers Reference Number: NWS-2019-65. Prepared for: BNSF Railway Co., 4515 Kansas Ave., Kansas City, KS 66106. Prepared by: Jacobs, 1100 112th Ave. NE Ste. 500, Bellevue, WA 98004. January 8, 2019. 77 pp.

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

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

Killgore, K.J, L.E. Miranda, C.E. Murphy, D.M. Wolff, J.J. Hoover, T.M. Keevin, S.T. Maynord, and M.A. Cornish. 2011. Fish Entrainment Rates through Towboat Propellers in the Upper Mississippi and Illinois Rivers. Transactions of the American Fisheries Society, 140:3, 570-581, DOI: 10.1080/00028487.2011.581977.

King County. 2017. King County website. Accessed October 31, 2017 at: http://www.kingcounty.gov/depts/executive/performance-strategy-budget/regional-planning/Demographics.aspx.

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

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

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

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

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

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

Lunz, J.D. and M.W. LaSalle. 1986. Physiochemical alterations of the environment associated with hydraulic cutterhead dredging. Am. Malacol. Bull. Spec. Ed. No. 3: 31-36.

Lunz, J.D., M.W. LaSalle, and L. Houston. 1988. Predicting dredging impacts on dissolved oxygen. Pp.331-336. In Proceedings First Annual Meeting Puget Sound Research, Puget Sound Water Quality Authority, Seattle, WA.

Mantua, N., I. Tohver, and A. Hamlet. 2009. Impacts of Climate Change on Key Aspects of Freshwater Salmon Habitat in Washington State. *In* The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, edited by

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

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

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

McIntyre, J.K, D.H. Baldwin, D.A. Beauchamp, and N.L. Scholz. 2012. Low-level copper exposures increase visibility and vulnerability of juvenile coho salmon to cutthroat trout predators. Ecological Applications, 22(5), 2012, pp. 1460–1471.

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

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

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

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

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

Morton, J. W. 1976. Ecological effects of dredging and dredge spoil disposal: a literature review. Technical Paper 94. U.S. Fish and Wildlife Service. Washington D.C. 33 pp.

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

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

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

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

Myers, J.M., J.J. Hard, E.J. Connor, R.A. Hayman, R.G. Kope, G. Lucchetti, A.R. Marshall, G.R. Pess, and B.E. Thompson. 2015. Identifying historical populations of steelhead within the Puget Sound distinct population segment U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-128. 149 pp.

National Marine Fisheries Service (NMFS). 2006. Final Supplement to the Shared Strategy's Puget Sound Salmon Recovery Plan. Prepared by NMFS Northwest Region. November 17, 2006. 47 pp.

NMFS. 2017. 2016 5-Year Review: Summary and Evaluation of Puget Sound Chinook Salmon, Hood Canal Summer-run Chum Salmon, and Puget Sound Steelhead. NMFS West Coast Region, Portland, Oregon. April 6, 2017. 98 pp.

NMFS. 2018a. Memorandum to the Record Re: WCR-2017-7601 WA Parks Pier Replacement, Cornet Bay, Whidbey Island, Washington – Acoustic Assessment for Planned Pile Extraction and Driving, and for Recreational Boat Use at the Pier. March 26, 2018. 15 pp.

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

National Oceanic and Atmospheric Administration (NOAA). 2019a. Environmental Response Management Application – Pacific Northwest. On-line mapping application. Accessed on July 29, 2019 at: https://erma.noaa.gov/northwest/erma.html#/layers=1&x=-121.60061&y=46.17343&z=7&panel=layer

NOAA. 2019b. Navigational Chart for Everett. Chart No. 18444 17th Ed., Nov. 2009. Last Correction: May 31, 2019. Accessed July 29, 2019 at: http://www.charts.noaa.gov/OnLineViewer/18444.shtml.

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

Neo, Y.Y., J. Seitz, R.A. Kastelein, H.V. Winter, C. Cate, H. Slabbekoorn. 2014. Temporal structure of sound affects behavioural recovery from noise impact in European seabass. Biological Conservation 178 (2014) 65-73.

Newcombe, C.P. and J.O. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management, 16:693-727.

Nightingale, B. and C.A Simenstad. 2001. Overwater structures: Marine issues white paper. Prepared by the University of Washington School of Marine Affairs and the School of Aquatic and Fishery Sciences for the Washington State Department of Transportation. May 2001. 177 pp.

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

Ono, K., C.A. Simenstad, J.D. Toft, S.L. Southard, K.L. Sobocinski, and A. Borde. 2010. Assessing and Mitigating Dock Shading Impacts on the Behavior of Juvenile Pacific Salmon (Oncorhynchus spp.): Can Artificial Light Mitigate the Effects? Prepared for Washington State Dept. of Transportation. WA-RD 755.1 July 2010. 94 pp.

Pacific Fishery Management Council (PFMC). 1998. Description and identification of essential fish habitat for the Coastal Pelagic Species Fishery Management Plan. Appendix D to Amendment 8 to the Coastal Pelagic Species Fishery Management Plan. PFMC, Portland, Oregon. December 1998. 41 pp.

PFMC. 2005. Amendment 18 (bycatch mitigation program), Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington groundfish fishery – Appendix B Part 3 – Essential Fish Habitat text Descriptions. PFMC, Portland, Oregon. November 2005. 361 pp.

PFMC. 2014. Appendix A to the Pacific Coast salmon fishery management plan, as modified by amendment 18 to the pacific coast salmon plan: identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon. PFMC, Portland, OR. September 2014. 196 p. + appendices.

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

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

R2 Resource Consultants, Inc. (R2). 2008. Snohomish Basin Steelhead Trout (Onchorhynchus mykiss) "State of the Knowledge" – Technical Memorandum. Prepared for: Snohomish Basin Recovery Technical Team. R2, 15250 NE 95th St., Redmond, Washington 98052. January 10, 2008. 141pp.

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

Rice, C., J. Chamberlin, J. Hall, T. Zachery, J. Schilling, J. Kubo, M. Rustay, F. Leonetti, and G. Guntenspergen. 2014. Monitoring Ecosystem Response to Restoration and Climate Change in the Snohomish River Estuary. Report to Tulalip Tribes. December 31, 2014. 76 pp.

Robertson, M.J., D.A. Scruton, R.S. Gregory, and K.D. Clarke. 2006. Effect of suspended sediment on freshwater fish and fish habitat. Canadian Technical Report of Fisheries and Aquatic Sciences 2644, 37 pp.

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

Rowse, M., and K. Fresh. 2003. Juvenile Salmonid Utilization of the Snohomish River Estuary, Puget Sound. Proceedings of the 2003 Georgia Basin/Puget Sound Research Conference. 9 pp.

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

Sandahl, J.F., D. Baldwin, J.J. Jenkins, and N.L. Scholz. 2007. A Sensory System at the Interface between Urban Stormwater Runoff and Salmon Survival. Environmental Science and Technology. 2007, 41, 2998-3004.

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

Schreiner, J. U., E. O. Salo, B. P. Snyder, and C. A. Simenstad. 1977. Salmonid outmigration studies in Hood Canal. Final Report, Phase II, to U.S. Navy, Fish. Res. Inst., Univ. Wash., Seattle, WA. FRI-UW-7715. 64 pp.

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

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

Simpson, S.D., A.N. Radford, S.L. Nedelec, M.C.O. Ferrari, D.P. Chivers, M.I. McCormick, and M.G. Meekan. 2016. Anthropogenic noise increases fish mortality by predation. Nature Communications 7:10544 DOI: 10.1038/ncomms10544 www.nature.com/naturecommunications February 5, 2016. 7 pp.

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

Snohomish Basin Salmon Recovery Forum (SBSRF). 2005. Snohomish River Basin Salmon Conservation Plan. Snohomish County Department of Public Works, Surface Water Management Division. Everett, WA. June 2005. 402 pp.

Snohomish Basin Salmonid Recovery Technical Committee (SBSRTC). 2002. Snohomish River Basin Salmonid Habitat Conditions Review. September 2002. Everett, WA. 174 pp.

Snohomish County. 2017. Snohomish County website. Accessed October 31, 2017 at: https://snohomishcountywa.gov/Faq.aspx?QID=596.

Southard, S.L., R.M. Thom, G.D. Williams, T.J. D. Toft, C.W. May, G.A. McMichael, J.A. Vucelick, J.T. Newell, and J.A. Southard. 2006. Impacts of Ferry Terminals on Juvenile Salmon Movement along Puget Sound Shorelines. Prepared for WSDOT by Battelle Memorial Institute, Pacific Northwest Division. PNWD-3647. June 2006. 84 pp.

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

Spromberg, J.A, D.H. Baldwin, S.E. Damm, J.K. McIntyre, M. Huff, C.A. Sloan, B.F. Anulacion, J.W. Davis, and N.L. Scholz. 2015. Coho salmon spawner mortality in western US urban watersheds: bioinfiltration prevents lethal storm water impacts. Journal of Applied Ecology. DOI: 10.1111/1365-2264.12534.

Stadler, J.H., and D.P. Woodbury. 2009. Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria. 8 pp.

Tabor, R.A., S.T. Sanders, M.T. Celedonia, D.W. Lantz, S. Damm, T.M. Lee, Z. Li, and B.E. Price. 2010. Spring/Summer Habitat Use and Seasonal Movement Patterns of Predatory Fishes in the Lake Washington Ship Canal. Final Report, 2006-2009 to Seattle Public Utilities. U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Fisheries Division, 510 Desmond Drive SE, Suite 102, Lacey, Washington 98503. September 2010. 88 pp.

Tillmann, P. and D. Siemann. 2011. Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region. National Wildlife Federation.

U.S. Department of Commerce (USDC). 2014. Endangered and threatened wildlife; Final rule to revise the Code of Federal Regulations for species under the jurisdiction of the National Marine Fisheries Service. U.S Department of Commerce. Federal Register 79(71):20802-20817.

Varanasi, U., E. Casillas, M.R. Arkoosh, T. Hom, D.A. Misitano, D.W. Brown, S.L. Chan, T.K. Collier, B.B. McCain, and J.E. Stein. 1993. Contaminant Exposure and Associated Biological Effects in Juvenile Chinook Salmon (Oncorhynchus tshawytscha) from Urban and Nonurban Estuaries of Puget Sound. NOAA Technical Memorandum NMFS-NWFSC-8. NMFS NFSC Seattle, WA. April 1993. 69 pp.

Virginia Institute of Marine Science (VIMS). 2011. Propeller turbulence may affect marine food webs, study finds. ScienceDaily. April 20, 2011. Accessed September 12, 2019 at: https://www.sciencedaily.com/releases/2011/04/110419111429.htm

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

Washington State Department of Fish and Wildlife (WDFW). 2019a. SalmonScape. Accessed on July 26, 2019 at: http://apps.wdfw.wa.gov/salmonscape/map.html.

WDFW. 2019b. WDFW Conservation Website – Species – Salmon in Washington – Chinook. Accessed on July 26, 2019 at: https://fortress.wa.gov/dfw/score/score/species/chinook.jsp?species=Chinook

WDFW. 2019c. WDFW Conservation Website – Species – Salmon in Washington – Steelhead. Accessed on July 26, 2019 at: https://fortress.wa.gov/dfw/score/score/species/steelhead.jsp?species=Steelhead

Washington State Department of Natural Resources (WDNR). 2017. Derelict Creosote Piling Removal Best Management Practices for Pile Removal & Disposal. Updated January 25, 2017. 5 pp.

Werme C., J. Hunt, E. Beller, K. Cayce, M. Klatt, A. Melwani, E. Polson, and R. Grossinger. 2010. Removal of Creosote-Treated Pilings and Structures from San Francisco Bay. Prepared for the California State Coastal Conservancy. Contribution No. 605. San Francisco Estuary Institute, Oakland, California. December 2010. 247 pp.

Willette, T.M. 2001. Foraging behaviour of juvenile pink salmon (*Oncorhynchus gorbuscha*) and size-dependent predation risk. *Fisheries Oceanography*. 10:110-131.

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

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