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-2018-00030

May 15, 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 Foss Maritime Pier Maintenance Project, King County, Washington, COE Number: NWS-2017-44, HUC: 171100120400 – Lake Washington Ship Canal.

Dear Ms. Walker:

Thank you for your letter of April 3, 2017, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for U.S Army Corps of Engineers (COE) authorization of the Foss Maritime Pier Maintenance 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 NMFS pursuant to section 7(a)(2) of the ESA on the effects of the proposed action. In this Opinion, NMFS concludes that the proposed action is likely to adversely affect but not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon and PS Sound steelhead. NMFS also concludes that the proposed action is likely to adversely affect designated critical habitat for PS Chinook salmon but is not likely to result in the destruction or adverse modification of that designated critical habitat. As required by section 7 of the ESA, NMFS has provided an incidental take statement with this Opinion. The incidental take statement describes reasonable and prudent measures 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. 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. 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: Rory Lee, COE

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

for

Foss Maritime Pier Maintenance Project
King County, Washington (COE Number: NWS-2017-44)

NMFS Consultation Number: WCRO-2018-00030

Action Agency: U.S. Army Corps of Engineers

Affected Species and 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	N/A	N/A

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	No

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: May 15, 2019

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LIST OF ACRONYMS

ACZA – Ammoniacal Copper Zinc Arsenate
BMP – Best Management Practices
CFR – Code of Federal Regulations
COE – Corps of Engineers, US 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
HPA – Hydraulic Project Approval
HUC – Hydrologic Unit Code
Hz – Hertz (or cycles per second)
ITS – Incidental Take Statement
JARPA – Joint Aquatic Resource Permit Application Form
mg/l – Milligram per Liter
mg/kg – Milligram per Kilogram
MHHW – Mean Higher High Water
MPG – Major Population Group
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NMFS – National Marine Fisheries Service
NPDES – National Pollutant Discharge Elimination System
OWCO – Oregon Washington Coastal Office
PAH – Polycyclic Aromatic Hydrocarbons
PBF – Primary Biological Feature
PCB – Polychlorinated Biphenyl
PCE – Primary Constituent Element
PFMC – Pacific Fishery Management Council
PS – Puget Sound
PSSTRT – Puget Sound Steelhead Technical Recovery Team
PSTRT – Puget Sound Technical Recovery Team
PTS – Permanent Threshold Shift
RL – Received Level
RPM – Reasonable and Prudent Measure
SAV – Submerged Aquatic Vegetation
SL – Source Level
TTS – Temporary Threshold Shift
VSP – Viable Salmonid Population
WCR – Westcoast Region (NMFS)
WDFW – Washington State Department of Fish and Wildlife
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 portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 *et seq*.), and implementing regulations at 50 CFR 402.

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

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

On April 3, 2017, NMFS received a letter from the US Army Corps of Engineers (COE) requesting informal consultation for the proposed action (COE 2017a), and assigned it the NMFS consultation number WCR-2017-6656. The request included the COE's Memorandum for the Services (MFS) for the proposed action (COE 2017b) and the applicant's Specific Project Information Form (SPIF) and project drawings (Foss 2016; 2017). On August 14, 2017, NMFS informed the COE that formal consultation was required for the proposed action, and requested additional information. On April 18, 2018, NMFS closed that consultation due to lack of response. NMFS reminded the COE to request formal consultation and to submit the previously requested additional information with their request.

On September 17, 2018, the COE provided the requested additional information (Floyd-Snider 2018) and resubmitted their request for informal consultation. That request was assigned the NMFS consultation number WCR-2018-10684. On October 2, 2018, NMFS closed that consultation with a letter of non-concurrence. The COE requested formal consultation on October 5, 2018. Formal consultation for the proposed action was initiated on that date.

This Opinion is based on the review of the information and project drawings identified above; 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). A complete record of this consultation is on file at the Oregon Washington Coastal Office (OWCO) in Lacey, Washington.

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 proposes to authorize Foss Maritime (the applicant) to repair three piers at their commercial shipyard on the Lake Washington Ship Canal in Seattle, Washington (Figure 1). The project consists of two components: Decking maintenance for Piers D and E; and Decking maintenance and pile repairs for Pier G. These piers are used to moor dry docks and vessels that undergo maintenance and repair work. The COE's action would authorize work that would extend, by decades, the useful life of these piers. Maintenance and repair work and vessel activity at the piers would be interrelated and interdependent with the proposed action.

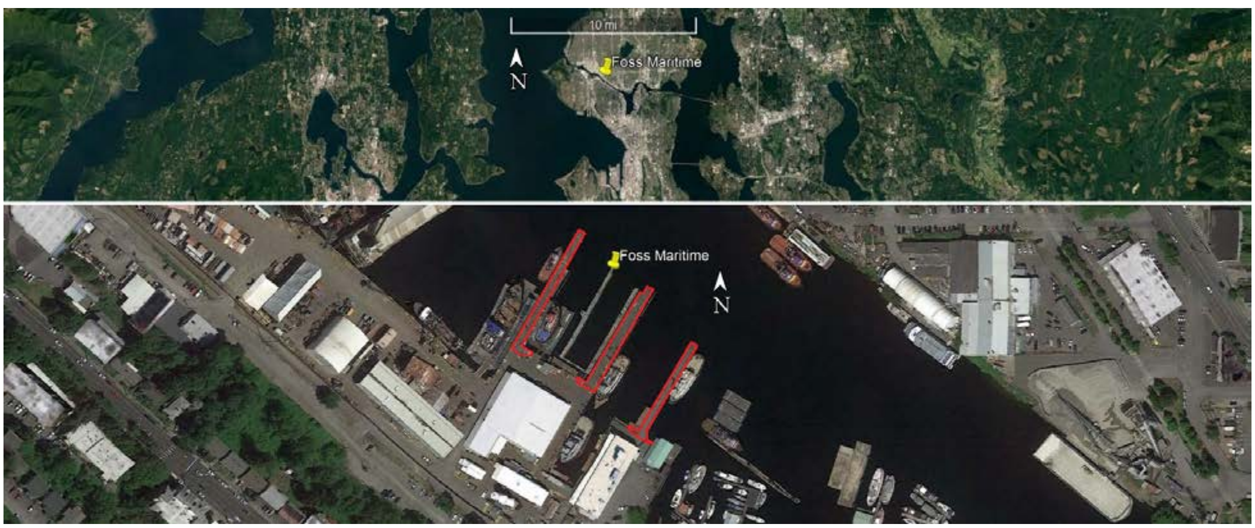

Figure 1. Google satellite photographs of the Foss Maritime Shipyard on the Lake Washington Ship Canal, Washington. The top image shows the project site between Lake Washington and Puget Sound. The City of Seattle extends north and south of the site. The lower image shows the shipyard along the bank of the canal. The piers to be repaired are outlined in red, and left to right are D, E, and G. The grey U-shaped structure between Piers D and E is a submerged dry dock.

<u>Decking maintenance for Piers D and E</u>: The applicant's contractors would conduct about 12 weeks of over-water work to remove and replace about 720 square feet of asphalt pavement and creosote-treated timber sub-decking from Piers D and E (Figure 2). Working from the top of the piers, they would first saw-cut the pavement around the boundaries of the work area. Debris screens and/or vacuums would be used for dust control. Then, with a jackhammer, they would break the pavement into manageable pieces, which would be collected with a front loader or similar equipment. Once the pavement is removed, dust and debris will be swept and/or vacuumed from the timber deck. Then the timber decking would be cut into pieces, and removed by excavator that would be operated from the pier or from a spud barge. If needed, the contractor

will install tarping below the deck to prevent debris from reaching the water. After removal, the decking would be replaced, new pavement would be installed, and about 120 linear feet of new timber bull rail would be installed along the sides of the piers. All new timber would be treated with ammoniacal copper zinc arsenate (ACZA), and the new pavement would be coal-tar-free.

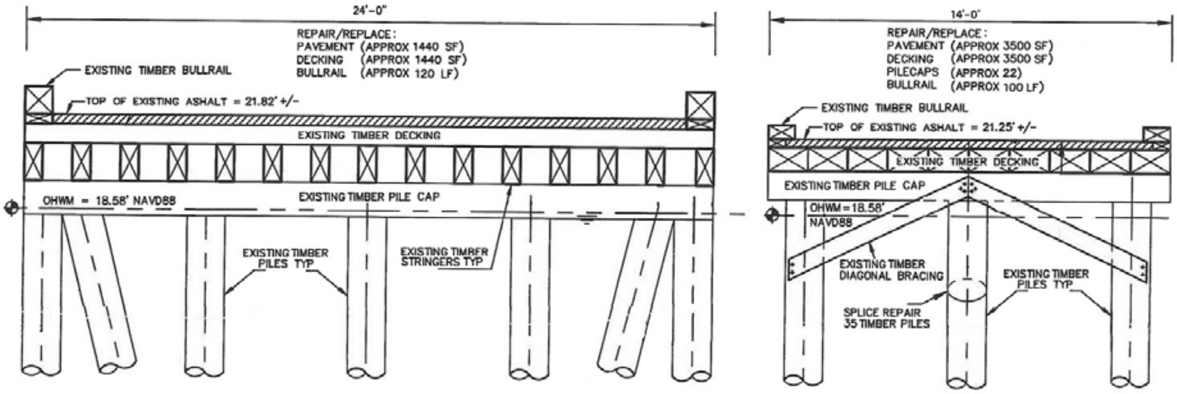

Figure 2. Cross-section drawings of the piers to be repaired, relative to the ordinary high water mark. The left drawing is representative of Piers D and E. The right drawing is representative of Pier G (Adapted from Foss 2016, Figures 3 & 4).

<u>Decking maintenance and pile repairs for Pier G</u>: The applicant's contractors would conduct about 5 months of over- and in-water work to remove and replace all of the asphalt pavement and creosote-treated timber sub-decking (about 3,500 square feet), remove and replace about 22 creosote-treated timber pile caps, and to splice-repair about 35 creosote-treated timber piles at Pier G (Figure 2). Decking repairs would be virtually identical to the work done for Piers D and E. While the decking is removed, damaged pile caps would be cut away and removed by excavator. Additionally, divers would use handheld pneumatic or hydraulic powered saws, drills, and other tools to cut off the damaged upper portions of about 35 creosote-treated timber piles, which would be removed from the water by the excavator. They would then splice new ACZA-treated timber pile sections on top of the pile stubs using bolted metal collars. About 22 new ACZA-treated timber pile caps would be installed. Then new ACZA-treated timber decking and coal-tar-free pavement would be installed, along with new ACZA-treated timber bull rails.

To reduce construction-related impacts, the applicant's contractors would be required to comply with the conservation measures and best management practices (BMPs) identified in the following project documents: the Washington State Joint Aquatic Resource Permit Application (JARPA) Form (Foss 2017b), the Hydraulic Project Approval (HPA, WDFW 2017a), and the SPIF, including items G16 through G19 (Floyd-Snider 2018). Further, construction would be limited to October 1 through April 15.

<u>Interrelated and interdependent activities</u>: The applicant's piers and the three dry docks moored to them are central to most of the vessel maintenance, repair, and modification services the shipyard provides to about 150 to 200 vessels annually. Typical work includes machinery repairs, welding, surface preparation and application of coatings. Inboard work and exterior work above the waterline is often done while vessels are moored to the piers. Exterior work below the waterline is typically done within a floating dry dock. For dry dock work, the dry dock's ballast

tanks of are flooded to allow its deck to submerge to a depth greater than the draft of a client vessel. The vessel is moved into the dry dock and held over blocks that are arranged on the dry dock's deck. The client vessel settles onto the blocks when the dry dock rises as water is pumped out of its ballast tanks. With the dry dock deck above the water and the client vessel on the blocks, the client vessel's lower hull, rudders, and propellers are readily accessible to shipyard workers who can work in the dry.

To reduce the impacts of the shipyard activities, Foss Maritime complies with the limits, measures, and practices identified in their National Pollutant Discharge Elimination System (NPDES) Permit (WDOE 2017a) and their County Industrial Wastewater Discharge Permit (King County 2014). Examples of control measures include required procedures for the proper storage, use, and disposal of toxic chemicals and spill containment and clean-up, and requirements to enclose work areas where dusts, chips, and paint spray would be generated, and to routinely sweep, vacuum, and clean work areas, including pier and dry dock decks to reduce the accumulation of materials that could enter the water (Floyd-Snider 2018).

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.

Table 1. ESA-listed species and critical habitat 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	N/A	05/11/07 (72 FR 26722) / 02/24/16 (81 FR 9252)

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: http://www.nmfs.noaa.gov/pr/species/fish/, 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.

Puget Sound (PS) Chinook Salmon: 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 is improved from current conditions, and when considered in the aggregate, persistence of the ESU is assured;
- Two to four Chinook salmon populations in each of the five biogeographical regions of the ESU (Table 1) 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: 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 fresh water for a year or more before entering marine waters. Conversely, ocean-type juveniles typically migrate out of their natal streams early in their first year of life. 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.

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).

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

Limiting Factors: 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

PS Chinook Salmon within the Action Area: The PS Chinook salmon populations that occur in the action area consist of fall-run Chinook salmon from the Cedar River population and the North Lake Washington / Sammamish River population (NWFSC 2015; WDFW 2019a). The Cedar River population is relatively small, with a total annual abundance fluctuating at close to 1,000 fish (NWFSC 2015; WDFW 2019b). Between 1965 and 2017, the total abundance for PS Chinook salmon in the basin has fluctuated between about 133 and 2,451 individuals, with the average trend being slightly negative. The 2015 status review reported that the 2010 through 2014 5-year geometric mean for natural-origin spawner abundance had shown a positive change since the 2010 status review, with natural-origin spawners accounting for about 82% of the population. WDFW data suggest that natural-origin spawners accounted for about 77% of a combined total return of 2033 fish in 2017 (WDFW 2019b). The North Lake Washington / Sammamish River population is also small. Abundance information for this population is based on the Sammamish River, where the total abundance has fluctuated between about 33 and 2,223 individuals from 1983 through 2017. Natural-origin spawners comprise a small proportion of the total population, and the trend in natural-origin spawners is negative (NWFSC 2015; WDFW 2019b). Natural-origin spawners accounted for only about 13% of the 1,524 total return in 2017 (WDFW 2019b).

All returning adults and out-migrating juveniles of these two populations, as well as the individuals that spawn in the numerous smaller streams across the basin, must pass the action area to complete their life cycles. Adult Chinook salmon pass through Chittenden Locks (aka Ballard Locks) between mid-June through September, with peak migration occurring in mid-August (City of Seattle 2008). Spawning occurs well upstream of the action area between early August and late October. Both stream- and ocean-type Chinook salmon are present in the basin, with the majority being ocean-types. Stream-type fish 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. Juvenile Chinook salmon are found in Lake Washington and Lake Sammamish between January and July, primarily in the littoral zone (Tabor *et al*. 2006). Outmigration through the ship canal and past the action area to the locks occurs between late-May and early-July, with the peak in June (City of Seattle 2008).

<u>Puget Sound (PS) steelhead:</u> 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 populations that occur in the action area consist of winter-runs from the Cedar River and North Lake Washington / Lake Sammamish populations. Both populations are among the smallest within the DPS (NWFSC 2015; WDFW 2019c). WDFW reports that the total PS steelhead abundance in the Cedar River basin has fluctuated between 0 and 900 individuals between 1984 and 2018, with a strong negative trend. Since 2000, the total annual abundance has remained under 50 fish. NWFSC (2015) suggests that the returns may have been above 1,000 individuals during the 1980s, but agrees with the steep decline to less than 100 fish since 2000. It is unclear what proportion of the returns are natural-origin spawners, if any, and a total of only 4 adults are thought to have returned in 2018 (WDFW 2019c). The Sammamish River population is even smaller. WDFW reports that the total abundance for PS steelhead in the North Lake Washington / Lake Sammamish basin fluctuated between 0 and 916 individuals between 1984 and the last survey in 1999, with a strong negative trend. Abundance never exceeded 45 fish after 1992, and was only 4 in 1999 (WDFW 2019c). NWFSC (2015) disagrees with WDFW in that returns may have been above 1,500 individuals during the mid-1980s, but NWFSC agrees with the steep decline to virtually no steelhead in the basin since 2000.

All returning adults and out-migrating juveniles of these two populations must pass the action area to complete their life cycles. Adult steelhead pass through Chittenden Locks (aka Ballard Locks) and the Lake Washington Ship Canal between January and May, and may remain within Lake Washington through June (City of Seattle 2008). The timing of steelhead spawning in the basin is uncertain, but occurs well upstream of the action area. Juvenile steelhead enter Lake Washington in April, and typically migrate through the ship canal and past the action area to the locks between April and May (City of Seattle 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.

Puget Sound Chinook Salmon Critical Habitat: 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.

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. The PBF for PS Chinook salmon CH are listed in Table 4. The PBF of PS Chinook salmon critical habitat that may be affected by the proposed action is limited to freshwater migration.

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).

Table 4. Physical or biological features (PBFs) of designated critical habitat for PS Chinook salmon, and corresponding life history events. Although offshore marine areas were identified in the final rule, none was designated as critical habitat.

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

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. 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).

<u>Critical Habitat within the Action Area</u>: Critical habitat has been designated for PS Chinook salmon along the entire length of the Lake Washington Ship Canal, all of Lake Washington,

about 950 yards upstream into in the Sammamish River, and well upstream into the Cedar River watershed. The critical habitat in the Lake Washington Ship Canal provides the Freshwater Migration PBF for PS Chinook (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 Section 2.5, structure-related noise within about 24 yards (22 m) around the project site would be the project-related stressor with the greatest range of effect. All other project-related effects, including indirect effects would be undetectable beyond that range. However, to be conservative, the action area for NMFS trust resources is considered to include the waters and substrates of the Lake Washington Ship Canal within 100 yards of the project site. This action area 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.

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 Seattle, along the southern shore of the Lake Washington Ship Canal (Figure 1). The geography and ecosystems in and adjacent to the action area have been dramatically altered by human activity since European settles first arrived in the 1800s. Historically, a small stream flowed from Lake Union to Shilshole Bay, with no surface water connection between Lake Union and Lake Washington. The waters of Lake Washington flowed south to the Duwamish River via the now absent Black River. The canal was created by intense dredging and excavation that began in the 1880s to provide a navigable passage between Lake Washington and the marine waters of Shilshole Bay. The canal is 8.6 miles long, about 150 to 260 feet wide in the cuts, and widens at Portage Bay, Lake Union, and Salmon Bay. The averages depth in the navigational channel is about 30 feet. Depths along the edges are typically between 10 and 20 feet.

The canal was completed in 1916. As part of this, the Hiram M. Chittenden Locks (aka Ballard Locks) were constructed near the west end of the canal to maintain navigable water levels in the canal and lakes. This permanently converted Salmon Bay from an estuary to freshwater. Flows through canal are highly controlled by the locks, and are typically very slow, and the canal supports high levels of commercial and recreational vessel traffic.

Little natural shoreline exists in the ship canal, which was constructed during a time when little was known about the environmental needs of the ESA-listed salmonids that now depend on it. In cross-section, the canal closely resembles an elongated box culvert along most of its length, and about 96% of the canal's banks are armored (City of Seattle 2008). Instead of slopes that gently rise to the surface, as typically occurs along the banks of natural streams, the bank slope along most of the canal is vertical, with depths of tens of feet.

The vast majority of the shoreline from Lake Washington to Shilshole Bay is lined by shipyards, industrial properties, large marinas, and residential piers. Unbroken urban development extends north and south immediately landward of both shorelines. With the exception of the southern shoreline of Portage Bay, and along the armored banks of the Fremont and Mountlake Cuts, very little riparian vegetation exists along the banks of the canal.

Water quality within the area is influenced by the inflow of freshwater from Lake Washington, by point and non-point discharges all along the waterway, and by a saltwater lens that intrudes through the Ballard Locks, underlays the outflowing freshwater, and occasionally extends into Lake Union. Industrial, commercial, and residential development has impacted water quality in the canal since before the canal was completed in 1916. Lumber and plywood mills, machine shops, metal foundries, fuel and oil facilities, concrete and asphalt companies, and power plants were quickly developed along the shoreline of the waterway, along with numerous shipyards, marinas, commercial docks, and houseboats. Virtually all of the early industrial, commercial, and residential facilities discharged untreated wastes directly to the waterway, some of which persisted into the 1940s and beyond. Tomlinson (1977) cites a 1943 Washington State Pollution Commission report that indicated that the Seattle Gas Plant (now Gasworks Park) discharged oily wastes so routinely that the water surface was covered and fish kills occurred in its vicinity. The report also identified raw sewage discharge into the waterway from most of the residences, commercial establishments, and all of the houseboats that lined the shoreline. Stormwater drainage has also contributed to pollutant loading. Most of the direct discharge of raw sewage was stopped and the gas plant ceased operation during the 1960s.

The City of Seattle (1987) reported water quality problems in the canal that included saltwater intrusion, low dissolved oxygen (DO), and elevated fecal coliform, as well as sediments that were contaminated with Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs), cadmium, chromium, lead, mercury, nickel, and zinc, particularly in the area off the former Seattle Gas Plant. Today, the overall water quality in the ship canal has improved substantially. However, Lake Union and the ship canal are included on the Washington State Department of Ecology's (WDOE) list of impaired and threatened water bodies for total phosphorus, fecal coliform bacteria, lead, and the insecticide aldrin in the water column, and for sediment bioassay (City of Seattle 2010). The most likely sources of phosphorus and fecal coliform are point and nonpoint stormwater discharges. Other sources of fecal coliform include wastes from domestic pets and waterfowl, and sewage from boats (City of Seattle 2010).

Although total copper and total lead concentrations have exceeded state water quality criteria for acute toxicity in the past (Herrera 1998), the mean concentrations of dissolved metals have typically been below the state water quality criteria for acute and chronic toxicity (Herrera 2005), and the concentrations of total and dissolved metals in the water are considered relatively low (City of Seattle 2010). Mercury is the primary metal of concern in Lake Union bottom sediments, with concentrations ranging from 0.35 to 9.18 mg/kg near certain South Lake Union discharges (City of Seattle 2010). Elevated concentrations of other pollutants also have been found in canal sediments along the north shoreline of the canal (metals, PAHs, PCBs, phthalates, and other organic compounds) (Herrera 1998; RETEC 2002).

Since 1979, water temperatures in the ship canal have increased an average of 1° Celsius (C, 1.8° F) per decade, with temperatures that can reach 20 to 22° C during the summer and early fall, and the number of days that temperatures are in that range is increasing (City of Seattle 2010). The preferred temperature limits for salmon are 13 to 18° C (55-64° F), and temperatures of 23 to 25° C (73-77° F) can be lethal. Saltwater intrusion through the locks creates a wedge of high-density saltwater that can extend into and past Lake Union during low flow periods. Freshwater typically floats over the saltwater with little mixing between the two water masses, and the saltwater wedge often becomes anoxic early in the summer as bacteria consume organics in the sediment. DO concentrations range from 9.5 to 12.6 mg/L during the winter and spring, but can decrease to as low as 1 mg/L during the summer months.

The artificial shorelines and widespread presence of overwater structures along the length of the canal and much of Lake Union provide habitat conditions that favor fish species that prey on juvenile salmonids, especially the non-native smallmouth bass. Other predators in the canal include the native northern pikeminnow and the non-native largemouth bass (Celedonia *et al*. 2008a and b; Tabor *et al*. 2004 and 2010). Tabor *et al*. (2004) estimated that about 3,400 smallmouth bass and 2,500 largemouth bass, large enough to consume salmon smolt (> 130 mm fork length), were in the ship canal. They also estimated that smallmouth bass consumed about 48,000 salmon smolts annually, while largemouth bass consumed about 4,200 smolts. Of those, over half were Chinook salmon smolts. Predation appeared to be highest in June, and near Portage Bay, when smolts made up approximately 50% of the diet for smallmouth bass, and about 45% for northern pikeminnow. Returning adult salmon and steelhead are often exposed to excessive predation by pinniped marine mammals (seals and sea lions) that feed on the fish that accumulate downstream of the fish ladder.

The applicant’s shipyard is located in a highly industrialized area, about midway between Lake Union and the Chittenden Locks. The canal is about 750 feet wide at the site, but numerous piers extend across more than half of that distance. The banks are fully armored, upland areas consist of a mix of pavement and large buildings, and riparian vegetation is absent. The applicant’s shipyard covers about 856,000 square feet, including about 35,000 square feet of overwater structure. The three piers that are the subject of this consultation, Piers D, E, and G, were constructed with creosote-treated timbers during the 1970s. They are solid-decked, and paved with concrete, with a combined overwater footprint of about 15,500 square feet. Their undersides are an average of about 2 feet above mean higher high water (MHHW). The piers provide moorage for three dry docks with a combined footprint of about 36,000 square feet, and moorage for client vessels. Based on the descriptions of the aquatic substrates for other projects in the canal, the substrate at the project site likely consists mostly of fine sands and silts, and sediment-coated debris. Depths are less than 20 feet relative to mean lower low water (MLLW, NOAA 2019).

The action area provides migratory habitat for adult and juvenile PS Chinook salmon and PS steelhead, and it is located along the only route to and from marine waters for those fish and all other anadromous salmonids in the Lake Washington and Lake Sammamish watersheds.

Therefore, those fish must pass through or close to the action area twice to reproduce; first as out-migrating juveniles, then again as returning adults. The area has also been designated as critical habitat for PS Chinook salmon. The past and ongoing anthropogenic impacts described above have established conditions that maintain low current velocities, as well as salinity and temperature gradients that hinder migration of both juvenile and adult salmonids, and expose PS Chinook salmon and PS steelhead to high levels of predation.

Climate Change: 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 ^{o}C), and up to 2° F (1.1 ^{o}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^{o} 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^{o}C increases in Columbia Basin streams and a peak temperature of 26^{o}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 applicant’s contractors would conduct in- and above-water work between October 1 through April 15 to repair three piers in the Lake Washington Ship Canal, about midway between Lake Union and Shilshole Bay. They would remove and replace about 720 square feet of asphalt pavement and creosote-treated timber sub-decking from Piers D and E. They would remove and replace all of the asphalt decking and creosote-treated timber sub-decking (about 3,500 square feet) from Pier G, where they would also remove and replace about 22 creosote-treated timber pile caps, and splice-repair about 35 creosote-treated timber piles.

As described in Section 2.2, PS Chinook salmon and PS steelhead inhabit the action area, and critical habitat has been designated for PS Chinook salmon within the action area. The proposed work window would avoid the typical migration periods for Chinook salmon, but it overlaps with in-migrating adult PS steelhead, and overlaps slightly with out-migrating juvenile steelhead.

Construction is likely to cause direct effects through construction-related elevated noise, and water quality impacts. Based on migration timing, adult and juvenile steelhead may be exposed to those effects. However, it is very unlikely that any Chinook salmon would be exposed to construction-related effects. The COE-authorized repairs would have the additional effect of extending the useful life of the piers for several decades beyond that of the existing structures. Over that time, the piers and their interrelated activities would cause effects on both species through impacts on water quality, contaminated forage, altered lighting, vessel noise, and propeller wash.

2.5.1 Effects on List Species

Construction-related Elevated Noise

Exposure to construction-related elevated noise would cause minor effects in PS steelhead, and it is very unlikely that any Chinook salmon would be exposed. Elevated in-water noise at levels capable of causing detectable effects in exposed fish would be caused by the in-water use of power saws and other handheld underwater power tools to repair piles. The above-water use of construction vehicles, jackhammers, and power saws to remove and replace pier decking would also cause elevated in-water noise levels because the direct contact between the water and the pier structure allows the transfer of the over-water construction noise into the water.

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.
Based on the best available information, as described in a recent acoustic assessment for a project that included the use of jackhammers and saws (NMFS 2016) and other sources, the source levels (SL) for all sources would be well below the 206 dB_{peak} threshold for the onset of injury in fish. However, the 150 dB_{SEL} isopleth could extend to about 52 feet (16 m) around the piers during jackhammer use (Table 5).

Table 5. Estimated in-water dB_{peak} and dB_{SEL} Source Levels for construction-related sound sources, along with source-specific ranges to the appropriate effects thresholds for fish. Applicable thresholds for each source are highlighted in grey.

Source	Acoustic Signature	Source Level	Threshold Range
Jackhammer	< 1 kHz Impulsive	188 dB_{peak}	206 @ N/A
Over-water work		168 dB_{SEL}	150 @ 16 m
Concrete Saw	0.1 - 4 kHz Non-Impulsive	145 dB_{peak}	206 @ N/A
In- and Over-water work		135 dB_{SEL}	150 @ N/A

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). Based on that equations; and α = absorption coefficient in the water in dB(R/km). 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 188 dB_{SEL} SL expected for jackhammering the pavement suggests that noise levels above the 150 dB_{SEL} isopleth could extend to about 52 feet (16 m) around the piers (Table 5).

The planned work window avoids the expected presence of Chinook salmon. Therefore, it is very unlikely that any Chinook salmon would be exposed to construction-related noise. However, adult and juvenile steelhead could be present during construction.

PS steelhead 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. Those at the far limit of the range are likely to experience the onset of temporary behavioral disturbances such as mild acoustic masking, alerting behaviors, and altered swimming patterns. The intensity of effect would increase with proximity to the source and duration of exposure, such that alerting and altered swimming may include avoidance or abandonment of an area, release of stress hormones, and reduced predator avoidance. Prolonged exposure to the sound, such that accumulated sound energy exceeds the 183/187 dB SEL_{cum} thresholds, is likely to cause injuries to auditory tissues. Non-auditory tissue injury is also possible.

The adult and juvenile steelhead that may be exposed to construction noise would be larger than 2 grams, would be 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 52 feet around the project site. The exposure would cause no measurable effects on the fitness of exposed individuals. Further, it is extremely unlikely that any avoidance of the project site would prevent adult fish from moving past the area, nor would it prevent them from accessing important habitat resources.

Construction-related Degraded Water Quality

Exposure to construction-related degraded quality would cause minor effects in PS steelhead, and it is very unlikely that any Chinook salmon would be exposed. Water quality at the site may be temporarily affected by the introduction of construction-related toxic materials that may be introduced to the water through construction related spills and discharges, and through the cutting of creosote-treated piles and timbers that may release creosote-related toxins into the water.

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 (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).

The project includes BMPs to reduce the risk and intensity of construction-related discharges, as well as required measures to capture and remove toxic materials that may enter the water, including any sawdust and oils that may enter the water when cutting creosote-treated piles and timbers. In the unlikely event of a construction-related spill or discharge, the amount of material released would likely be very small. Further, most of the petroleum-based fuels and lubricants that are used for this type of work typically float on the surface, so their residence time in the water column would likely be measured in minutes. While at the surface, the petroleum-based fluids would be restricted to small enclosed areas immediately around the work area, and quickly removed from the water by absorbent pads. Wood particles and other floating debris would be removed with fine-mesh nets and/or by hand.

Therefore, construction-related discharges are expected to be very infrequent, very small, and have very short in-water residence times. That, combined with the small size of the potentially affected area, and the low probability that juvenile steelhead may be present on any given day of construction, suggest that it is very unlikely that any juvenile steelhead would be exposed to construction-related discharges. In the unlikely event of fish exposure to a construction-related discharge, the in-water concentrations would likely be too low, and exposure too brief to cause detectable effects on the fitness or normal behaviors of an exposed individual.

Structure-related Degraded Water Quality

Structure-related impacts on water quality is likely to adversely affect PS Chinook salmon and PS steelhead. The repaired piers would retain large numbers of creosote-treated timber piles and timbers. The timber used for repair would be treated with ammoniacal copper zinc arsenate (ACZA), which contains copper, as does the anti-fouling paint that would coat the hulls of some of the ships that would moor at the piers. Additionally, it is very likely that pollutants from shipyard work, along with petroleum-based fuels and lubricants discharged by some of the ships that moor at the pier would enter the water. Unlike the small-scale and brief introduction of pollutants that may potentially occur during construction, the applicant's piers would be a continuous year-round source of pollutants for the duration of their functional lives.

Creosote-treated Timber Piles: The applicant reports that the piers were constructed in the 1970s using creosote-treated piles and timbers. Although they did not quantify the number of piles that support the piers, the sizes of the piers suggest that the number is likely in the low to mid hundreds. The project would replace the upper sections of about 35 piles using timber pile sections that have no creosote. However, the lower portions of those piles and the hundreds that would be unaffected by this project would exude PAHs into the water for years. The overwater creosote-treated timber that comprise the majority of the piers' upper structures would also leach PAHs into the water for years.

As described earlier, fish can absorb PAHs and other contaminants directly through their gills. The salmonids that are exposed to creosote-related PAHs from the applicant's piers would experience effects that would range from no detectable effects, through avoidance of the affected area, reduced growth, altered immune function, and mortality, depending largely on the concentration, and/or the duration of exposure. The in-water PAH concentrations and durations of exposure any individual fish may experience due to the retention of the applicant's creosote-treated piles and timbers, along with the intensity of the resulting effects, are unquantifiable with any degree of certainty. However, over the life of the applicant's piers, some juvenile Chinook salmon and steelhead are reasonably likely to be exposed to in-water PAHs at concentrations high enough to measurably reduce their fitness or alter their normal behaviors.

Copper from ACZA-treated Wood and Anti-fouling Hull Paints: Exposure to dissolved copper at concentrations between 0.3 to 3.2 µg/L above background levels has been shown to cause avoidance of an area, to reduce salmonid olfaction, and to induce behaviors that increase juvenile salmon's vulnerability to predators in freshwater (Giattina et al. 1982; Hecht et al. 2007; McIntyre et al. 2012; Sommers et al. 2016; Tierney et al. 2010).

The applicant would install about 4,940 square feet of timber decking, 220 feet of timber bull rail, 22 14-foot long timber pile caps, and 35 timber pile stubs to repair their piers. All new timber would be treated with ACZA. Wet ACZA-treated wood leaches some of the metals used for wood preservation. Of these metals, dissolved copper is of most concern to fish because of its higher leaching rate compared to arsenic and zinc (Poston 2001). Post-treatment BMPs reduce the intensity and duration of copper leaching from ACZA-treated wood, and the COE requires that any ACZA-treated wood used in this project must comply with the approved post-treatment BMPs. Copper leaching from ACZA-treated wood is highest when the treated wood is immersed in freshwater, but decreases sharply to low levels during the first few weeks after installation. The submerged pile stubs and any pile caps that become immersed would cause a detectable pulse of dissolved copper at the site that would decline quickly over a few weeks following construction. Above-water treated wood may also episodically release very small amounts of copper when that would is briefly exposed to waves and stormwater. The initial concentrations, and the distances from the piers that dissolved copper from ACZA-treated wood may be detectable are unknown. However, given the relatively small amounts of immersed wood, any detectable concentrations are expected to be limited to the area immediately adjacent to Pier G. It is very unlikely that Chinook salmon would be present in the action area when detectable levels of copper from ACZA-treated wood could be present. Steelhead are also unlikely to be exposed this source of copper because very few individuals would migrate through the canal during the work window, most of them would migrate area near the middle of the canal and well away from the piers, and detectable levels of copper from the treated wood would be present only briefly.

Copper-based anti-fouling paints leach copper into the water at fairly constant levels, and can be a significant source of dissolved copper in harbors and marinas with high boat occupancy and restricted water flows (Schiff *et al*. 2004). WDOE (2017b) reports that dissolved copper concentrations from anti-fouling paints can be above 5 µg/L in protected moorages, but below 0.5 µg/L in open moorages with high flushing rates. The proportion of the vessels that moor at the applicant's piers that would have copper-based antifouling paint is unknown, but is expected to be relatively high considering the common use of anti-fouling paints in the maritime industry. The initial concentrations, and the distances from the piers that dissolved copper from anti-fouling paints may be present at detectable levels are unknown. However, many large vessels with anti-fouling paint are likely to be present at the site year-round, and the currents within the canal are slow, especially along the banks where structures and large vessels would help to slow it. Based on the available information, NMFS expects that in the area immediately adjacent to the applicant's piers, the dissolved copper concentrations would be attributable to anti-fouling paints at the applicant's shipyard may periodically exceed 0.3 µg/L above background. Over the life of the applicant's piers, some juvenile Chinook salmon and steelhead are reasonably likely to be exposed to pier-related dissolved copper at levels high enough to measurably reduce their fitness or alter their normal behaviors.

<u>Shipyard Work:</u> Shipyard work includes the year-round use of many materials that contain hazardous substances. The most common pollutants include petroleum-based fuels and lubricants, paints, solvents, abrasive grits, and heavy metals that may enter the water directly from spills, overspray, and fugitive dusts. Contaminants that accumulate on the piers and decks of the vessels and dry docks also enter the water in stormwater runoff and when dry docks are submerged.

To reduce the likelihood of contaminants entering the water, the applicant complies with the limits, measures, and BMPs identified in their NPDES Permit (WDOE 2017a) and in their Industrial Wastewater Discharge Permit (King County 2014). Examples of control measures include procedures for the proper storage, use, and disposal of toxic chemicals; spill containment and clean-up procedures; requirements to enclose work areas where dusts, chips, and paint spray would be generated, and requirements to routinely sweep, vacuum, and clean work areas, including pier and dry dock decks to reduce the accumulation of materials that could enter the water. Despite these measures, small amounts of contaminants regularly enter the water at the site, particularly when dry docks submerge and during rain storms. For example, the NPDES permit allows the discharge into the canal of oil and grease at levels of up to 5 mg/L and turbidity of 10 percent above background levels during dry dock flooding, with required monitoring done only quarterly. Oil and grease contain PAHs and other harmful compounds. The increased turbidity would be caused by the introduction of fine particulates that would include a mix of pulverized paint chips, metal dusts, and abrasive grits that are also harmful to salmonids. The concentrations, and the distances from the piers that contaminants from shipyard work may be present at detectable levels are unknown. However, over the life of the applicant's piers, some juvenile Chinook salmon and steelhead are reasonably likely to be exposed to these contaminants at levels high enough to measurably reduce their fitness or alter their normal behaviors.

Vessel-related Petroleum-based Fuels and Lubricants: The vessels that moor at the applicant's piers would periodically discharge petroleum-based fuels and lubricants into canal waters. The currents within the canal are slow, especially along the banks where structures and large vessels would help to slow it, and petroleum-based pollutants tend to float and collect within the relatively protected areas between the vessels and the piers close to shore. The concentrations, and the distances from the piers that vessel-related contaminants may be present at detectable levels are unknown. However, over the life of the applicant's piers, some juvenile Chinook salmon and steelhead are reasonably likely to be exposed to these contaminants at levels high enough to measurably reduce their fitness or alter their normal behaviors.

Summary: Over the life of the applicant's piers, creosote-treated timber, anti-fouling hull paint, shipyard work, and moored vessels would continuously introduce low levels of harmful contaminants into the waters of the canal. The in-water concentrations, and the distances from the piers that these contaminants may be present at detectable levels are unknown, but expected to be limited to the area immediately adjacent to the applicant's piers. However, over the life of the applicant's piers, some juvenile Chinook salmon and steelhead are reasonably likely to be exposed to some combination of these contaminants at concentrations high enough to measurably reduce their fitness and/or alter their normal behaviors.

The annual number of juvenile PS Chinook salmon and PS steelhead that may be impacted by pier-related degraded water quality is unquantifiable with any degree of certainty, as is the intensity of the effects that an exposed individual may experience. However, the relatively small affected area suggests that the probability of exposure would be very low for any individual fish. Therefore, for both species, the numbers of fish that may be annually exposed to pier-related degraded water quality 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.

Contaminated Forage

Exposure to contaminated forage is likely to adversely affect PS Chinook salmon and PS steelhead. Contaminants such as PAHs and PCBs would be biologically available at the site into the foreseeable future due to the continuous input from the creosote-treated piles and other sources of pollution discussed above.

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 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 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.

Structure-related Altered Lighting

Structure-related altered lighting is likely to adversely affect PS Chinook salmon and PS steelhead. The applicant's repaired piers would maintain unnatural lighting conditions at the project site. The piers and the dry docks and vessels that moor alongside of them would create unnaturally harsh shade during the day and artificial illumination at night.

Shade: The three solid-decked piers and the three dry docks would be totally opaque, with a combined overwater footprint of about 51,500 square feet. Ships moored alongside the piers would add to the shaded area. The shadow would reduce aquatic productivity. It is also likely to alter migration and increase exposure and vulnerability to predators for juvenile salmonids. The intensity of these effects are likely to vary based on the brightness and angle of the sun, being most intense on sunny days, and less pronounced to possibly inconsequential on cloudy days.

Juvenile salmon feed on planktonic organisms such as amphipods, copepods, and euphausiids, as well as the larvae of many benthic species and fish (NMFS 2006). Shade limits primary production and can reduce the diversity of the aquatic communities under over-water structures (Nightingale and Simenstad 2001; Simenstad *et al*. 1999). Because the piers and dry docks cast a hard shadow over water and substrate that would otherwise be supportive of submerged aquatic vegetation (SAV) and benthic invertebrates, those structures reduce the quantity and diversity of prey organisms for juvenile salmonids.

Shade affects juvenile salmon migration. 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). Swimming around overwater structures increases the migratory distance, which has been positively correlated with increased mortality in juvenile Chinook salmon (Anderson *et al*. 2005). If situated alone along a stretch of undisturbed shoreline, the shadow from the applicant's piers and dry docks would alter the migratory behavior of juvenile salmon by delaying their passage under the structures, or by inducing them to swim around them. However, because the applicant's shipyard is but one of many long-standing similar structures that line this artificial waterway, the shadow caused by the piers and dry docks would not alter the behavior of juvenile salmonids per se. Instead, the shipyard's shadow, in combination with the shadows of the adjacent structures, would act to effectively force juvenile Chinook salmon to migrate in the open and relatively deep waters near the middle of the canal, which is well documented (Celedonia *et al*. 2008a and b; Tabor *et al*. 2000 and 2010) and contrary to normal migratory behavior for juvenile Chinook salmon at this life stage. Off-bank migration places juvenile Chinook salmon in relatively deep water where foraging is likely to have higher energetic costs than in shallow shoreline waters (Heerhartz and Toft 2015). Therefore, the juvenile Chinook salmon that swim around the shadow are likely to experience some degree of reduced fitness due to increased energetic costs.

Pier and dry dock shade is likely to increase juvenile salmonid exposure and vulnerability to predators. Shade and deep water both favor freshwater predatory species, such as smallmouth bass and northern pikeminnow that are known to prey heavily on juvenile salmonids (Celedonia *et al*. 2008a; Tabor *et al*. 2010). The applicant's piers and dry docks would cast about 51,500 square feet of shade that would extend more than 300 feet from the shoreline where bottom depths approach 20 feet. The shadow would not increase the population of predatory fish in the action area, but it is likely to concentrate predatory fish within it.

Therefore, juvenile Chinook salmon and steelhead would be more likely to encounter predatory fish at the project site than they would in the absence of the piers and dry docks. The risk of predation would be further increased for the juvenile Chinook salmon that swim around the piers simply due the increased distance traveled in proximity to the predator-friendly shadow. The depth of the water at the project site further increases the risk of predation because the increased water volume allows predators to attack from below and from the sides instead of from just one side as would be the case in shallow water along the shore. In summary, juvenile Chinook salmon and steelhead are more likely to be exposed to predators near the applicant's piers than away from them, and some of those individuals would be more vulnerable to attack than they would be in the absence of the shadow. Those that fail to escape 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 shipyard, 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 pier and dry dock shadows.

Artificial Lighting: The piers and moored dry docks have lighting systems that would cause artificial illumination of canal waters. Artificial lighting attracts fish (positive phototaxis) and often shifts nocturnal behaviors toward more daylight-like behaviors. It may also affect light-mediated behaviors such as migration timing.

Tabor and Piaskowski (2002) report that juvenile Chinook salmon in lacustrine environments typically feed and migrate during the day, and are inactive at night, residing at the bottom in shallow waters. They tend to move off the bottom and become increasingly active at dawn when light levels reach 0.8 to 2.1 lumens per square meter. Tabor *et al*. (2017) found that subyearling salmon (Chinook, coho, and sockeye) exhibit strong nocturnal phototaxic behavior when exposed to levels of 5.0 to 50.0 lumens per square meter, with phototaxis positively correlated with light intensity. Celedonia and Tabor (2015) found that juvenile Chinook salmon in the Lake Washington Ship Canal were attracted to artificially lit areas at 0.5 to 2.5 lumens per square meter. They also found that the quality of the light played a role, with orange-colored sodium lamps being more attractive to juvenile Chinook salmon than fluorescent and cooler wavelength lights. The authors also reported that attraction to artificial lights may delay the onset of morning migration by up to 25 minutes for some juvenile Chinook salmon migration through the Lake Washington Ship Canal.

The lighting systems for the piers and dry docks are undescribed. However, current satellite imagery of the shipyard shows numerous tall light poles lining the edges of the piers and dry docks. NMFS recently completed a consultation for a bridge replacement project that included a lighting system designed to limit illumination of the water yet still meet roadway safety standards (NMFS 2019). That system was predicted to illuminate the water’s surface along the sides of the bridge at 1.08 lumens per square meter, which exceeds the 0.5 lumen per square meter level where phototaxis has been documented in Chinook salmon (Celedonia and Tabor 2015). Given the industrial nature and age of the shipyard, NMFS expects that the overwater illumination caused by the existing lighting systems would be above the threshold where the onset of daylight activities and phototaxis would occur. Therefore, juvenile salmonids that are near the piers and dry docks are likely experience some level of nocturnal phototaxis, and may experience other altered behaviors, such as delayed resumption of migration in the morning. Over the life of the piers, it is likely that a small subset of the exposed individuals would experience reduced fitness and/or altered behaviors that could reduce their overall likelihood of survival.

Summary: Structure-related altered lighting 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.

Structure-related Vessel Noise

Structure-related noise would cause adverse effects in juvenile PS Chinook salmon and PS steelhead, and minor effects in adults of both species. Based on satellite imagery of the applicant's piers and dry docks, the client vessels and support craft that would be operated at the applicant's piers would be fishing vessels and tugboats between about 100 to 200 feet long (Figure 1). Vessel operations near piers typically consist of episodic brief periods of relatively low-speed operations that may last a couple hours while the vessels maneuver. Occasionally, the vessels' auxiliary systems would also cause continuous in-water noises while they are moored at the piers. Unlike construction noises, vessel noise would occur year-round. Numerous sources describe the source levels for ocean-going ships and tugboats operating at transit speeds (Blackwell and Greene 2006; McKenna *et al*. 2012; Picciulin *et al*. 2010; Reine *et al*. 2014; Richardson *et al*. 1995). Table 6 summarizes the expected sound levels for some of those vessels, with ranges to applicable effects thresholds for fish.

Table 6. In-water Source Levels for vessels with noise levels similar to those likely to moor at the applicant's piers, with estimated ranges to effects thresholds for fish.

Source	Acoustic Signature	Source Level	Threshold Range
85 foot long tourist ferry	< 2 kHz Combination	187 dB_{peak}	206 @ N/A
Episodic brief periods measured in minutes		177 dB_{SEL}	150 @ 63 m
Tugboat	< 2 kHz Combination	185 dB_{peak}	206 @ N/A
Episodic brief periods measured in minutes		170 dB_{SEL}	150 @ 22 m

It is unlikely that client vessels and tugs would operate at anything approaching maximum speeds when near the pier. However, they may briefly use high power settings while maneuvering, and some of the vessels' auxiliary systems could be very loud and operated continuously while moored. To be conservative, NMFS estimates that noise levels approaching that of tugboat operations may be present at the applicant's piers anytime ships are present.

The best available information suggests that no vessel-related sound sources would exceed the 206 dB_{peak} exposure threshold. However, the 150 dB_{SEL} isopleth may extend as far as 72 feet (22 m) around the piers, and any juvenile Chinook salmon and steelhead that are within that isopleth would likely experience behavioral disturbance, such as acoustic masking, startle responses, altered swimming patterns, avoidance, and increased risk of predation. The intensity of these effects would increase with increased proximity to the source and/or duration of exposure.

Given the short duration and episodic nature of vessel noise events, the small size of the affected area, and the low numbers of juvenile PS Chinook salmon and PS steelhead that may be present at the project site at any given time, the numbers of individuals that may be exposed to structure-related noise 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 any detectable population-level effects.

Structure-related Propeller Wash

Propeller wash is likely to adversely affect juvenile PS Chinook salmon and PS steelhead, but have minor effects on adults of both species. Spinning propellers can kill fish and small aquatic organisms (Killgore *et al*. 2011; VIMS 2011). Spinning propellers also generate fast-moving turbulent water known as propeller wash that can displace and disorient small fish. Propeller wash can also mobilize sediments and dislodge aquatic organisms and SAV, particularly in shallow water and/or at high power settings. This is called propeller scour.

The episodic vessel operations at the applicant's piers would involve spinning propellers and cause propeller wash. Adult Chinook salmon and steelhead migrating through the area tend to stay close to the bottom and toward the middle of the canal, and they would likely avoid the area near the applicant's piers. Further, they would be able to swim against most propeller wash they might be exposed to, without any measurable effect on their fitness of normal behaviors. Conversely, the juvenile Chinook salmon and steelhead that migrate past the piers are likely to be relatively small and close to the surface where they may be exposed to spinning propellers and propeller wash. Those juveniles would be too small to effectively swim against the wash. Individuals that are struck or very nearly missed by propeller blades would be injured or killed by the exposure. Those that are caught in the propeller wash, are likely to experience displacement that could increase energetic costs and reduce feeding success. Some may experience increased vulnerability to predators as they tumble stunned or disoriented in the wash.

Although the likelihood of this interaction is very low for any individual fish or any individual vessel trip, it is likely that over the life of the piers, at least some juvenile Chinook salmon and steelhead would experience reduced fitness or mortality from exposure to spinning propellers and/or propeller wash at the site. The annual number of individuals that may be impacted by this stressor is unquantifiable with any degree of certainty. However, based on the expectation that exposed individuals would be very small subsets of the cohorts from their respective populations, the numbers of exposed fish would be too low to cause 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 Primary 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.

Puget Sound Chinook Salmon Critical Habitat: The proposed action is likely to adversely affect critical habitat that has been designated for PS Chinook salmon. The essential PBFs of PS Chinook salmon critical habitat are listed below. The expected effects on those PBFs from completion of the planned project, including full application of the conservation measures and BMPs, would be limited to the impacts on the PBF of freshwater migration corridors 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:
   a. Free of obstruction and excessive predation – The proposed action would cause long-term effects on this PBF. Extending the life of the piers would maintain long-standing shading and elevated noise levels at the project site, which in combination with adjacent structures act to greatly limit access to shoreline areas for juvenile Chinook salmon, and support the presence and success of predatory species that feed on those juveniles.
   b. Water quantity – The proposed project would cause no effect on water quantity.
   c. Water quality – The proposed action would cause long-term effects on this PBF. Construction would cause short-term minor effects on water quality. However, the retention of creosote-treated piles and timbers would maintain long-standing input of PAHs, and interrelated shipyard activities would maintain the persistent input of low levels of contaminants at the site. The action would cause no measurable changes in water temperature or salinity.
   d. Natural Cover – The proposed action would cause long-term effects on this PBF. Extending the life of the piers would maintain previously altered habitat conditions at the site that limits the growth of submerged aquatic vegetation at the project site, which in combination with adjacent structures acts to greatly limit the availability of natural cover in the action area.
4. Estuarine areas – None in the action area.
5. Nearshore marine areas – None in the action area.
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.

NMFS is unaware of any specific future non-federal activities that are reasonably certain to affect the action area. However, NMFS is reasonably certain that future non-federal actions such as the previously mentioned shoreline and upstream 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 the waters within the action area are 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 PBF 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 DO, 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 both 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.

<u>PS Chinook salmon</u>

The long-term abundance trend of the PS Chinook salmon ESU is slightly negative, and the South Puget Sound MPG, which includes the Cedar River and North Lake Washington / Sammamish River PS Chinook salmon populations, is considered at high risk of extinction due to low abundance and productivity. 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 along the Lake Washington Ship Canal, which provides the only route to and from marine waters for adults and juveniles of the Cedar River and North Lake Washington / Sammamish 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 maritime activities. The baseline has also been degraded by nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

The timing of project-related work would effectively avoid the presence of juvenile and adult Chinook salmon. However, over the next several decades, out-migrating juveniles that pass close to the project site are likely to be exposed to reduced water quality, contaminated forage, altered lighting and acoustic conditions, and propeller wash as a result of this action. These stressors, both individually and collectively, are likely to cause a range of effects that would include some combination of altered behaviors, reduced fitness, and mortality in exposed individuals.

The annual number of juveniles that are likely to be injured or killed by exposure to action-related stressors is unknown, but is 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 abundance trend between 1984 and 2016 is strongly negative for the Cedar River and North Lake Washington / Lake Sammamish DIPs. 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 along the Lake Washington Ship Canal, which provides the only route to and from marine waters for adults and juveniles of the Cedar River and North Lake Washington / Lake Sammamish PS steelhead DIPs. The environmental baseline within the action area has been degraded by the effects of intense streambank and shoreline development and by maritime activities. The baseline has also been degraded by nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

Project-related work is expected to cause no more than minor effects in exposed individuals. However, over the next several decades, out-migrating juveniles that pass close to the project site are likely to be exposed to reduced water quality, contaminated forage, altered lighting and acoustic conditions, and propeller wash as a result of this action. These stressors, both individually and collectively, are likely to cause a range of effects that would include some combination of altered behaviors, reduced fitness, and mortality in exposed individuals.

The annual number of juveniles that are likely to be injured or killed by exposure to action-related stressors is unknown, but is 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 populations. 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.

Chinook salmon critical habitat

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 PBF for PS Chinook salmon critical habitat in the action area is limited to freshwater migration corridors free of obstruction and excessive predation. The site attributes of that PBF that would be affected by the action are limited to freedom from obstruction and excessive predation, water quality, and natural cover. As described above, the project site is located along a heavily impacted waterway, and all of these site attributes currently function at greatly reduced levels as compared to undisturbed freshwater migratory corridors. The long-term presence of the applicant's piers and their interrelated activities would cause long term effects on the three site attributes identified above.

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 the freshwater migration corridors PBF in the action area. Therefore, this critical habitat will maintain its current level of functionality, and retain its current ability for PBF to become functionally established, to serve the intended conservation role for PS Chinook salmon.

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 PS Chinook salmon.

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).

This ITS provides a take exemption for the COE for any take caused by the direct effects of the proposed action, as well as for some of the indirect effects that would be caused by the extended functional life of the applicant’s piers. However, this ITS does not include an exemption for any take caused by vessel-related noise and propeller wash from vessel operations that would be interrelated and interdependent to the applicant’s piers. Although those stressors are identified in the Opinion and below, an exemption is not provided for that take because there is no way to identify the third-party vessel operators, and because the COE has no jurisdiction over the vessel activities at the applicant’s piers. Therefore, we cannot mandate reasonable and prudent measures or terms and conditions to minimize the impacts of take caused by vessel activities.

2.9.1 Amount or Extent of Take

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

Harm of PS Chinook salmon from exposure to:

- contaminated forage,
- structure-related degraded water quality,
- structure-related altered lighting,
- structure-related noise, and
- structure-related propeller wash.

Harm of PS steelhead from exposure to:

- contaminated forage,
- structure-related degraded water quality,
- structure-related altered lighting,
- structure-related noise, and
- structure-related propeller wash.

NMFS cannot predict with meaningful accuracy the number of PS Chinook salmon and PS steelhead that are reasonably certain to be injured or killed 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, 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. The size and configuration of the applicant's piers is the best available surrogate for the extent of take of juvenile PS Chinook salmon and PS steelhead from exposure to contaminated forage, and to structure-related degraded water quality and altered lighting. The number of existing creosote-treated timber piles that support the piers is the best available surrogate for the extent of take of juvenile PS Chinook salmon and PS steelhead from exposure to contaminated forage and structure-related contaminated water. This is because both would be positively correlated with the number of creosote-treated timber piles that would be present at the site to introduce PAHs into the trophic web and/or into the water. As the number of creosote-treated timber piles increases, the number of contaminated prey organisms and the concentration of water-borne PAHs would increase. As either of those measures increase, the number of juvenile PS Chinook salmon and PS steelhead that would be exposed and/or the intensity the effects of exposure would increase.

The size of the applicant's piers is the best available surrogate for the extent of take of juvenile PS Chinook salmon and PS steelhead from exposure to structure-related altered lighting. This is because the size of the area that would be artificially shaded during the day and illuminated at night is positively correlated with size and the pier. As the size of an overwater structure increases, the sizes its shadow and the artificially illuminated area around it would also increase. As the size of the shadow increases, the likelihood of avoidance, and the distance required to swim around it would increase, either of which is likely to intensify the effects on exposed juvenile PS Chinook salmon and PS steelhead. As the size of the artificially illuminated area increases, the number of juvenile PS Chinook salmon and PS steelhead that would be exposed to it would increase.

In summary, the extent of take for this action is defined as:

Puget Sound Chinook salmon:

- The size and configuration of the existing piers, as described in the proposed action section of this biological opinion.

Puget Sound steelhead:

- The size and configuration of the existing piers, 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 PS Chinook salmon (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. Implement 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, Implement a monitoring and reporting program to confirm that the take exemption for the proposed action is not exceeded, the applicant shall 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. Documentation of all replaced timber components to confirm that no new creosote-treated wood is installed, and that treated wood installation is limited to ACZA-treated wood;
        ii. Documentation of the pavement type to confirm that only coal-tar-free pavement is installed; and
        iii. Documentation of the post-construction size of the repaired piers.
    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. 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-2018-00030 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 and the applicant should encourage contracted tugboat operator(s) and client vessel operators to use the lowest safe maneuvering speeds and power settings when maneuvering near their facility, with the intent to minimize propeller wash effects and mobilization of sediments at the site.
2. The COE should encourage the applicant to develop a long-term plan to reduce the environmental impacts of their overwater structures. Suggested measures include:
    a. Replacement or full encapsulation of all creosote-treated piles;
    b. Replacement of all creosote-treated timbers;
    c. Installation or adjustment of shipyard lighting systems to meet operational and safety needs yet also minimize nighttime illumination of canal waters;
    d. Transition lubricants and fluids used in shipyard equipment operated near the water to those composed of biodegradable base oils such as vegetable oils, synthetic esters, and polyalkylene glycols; and
    e. Institute or continue a program to improve the removal of pollutants from stormwater and dry dock discharges.

2.11 Reinitiation of Consultation

This concludes formal consultation for the U.S. Army Corps of Engineers' authorization of the Foss Maritime Pier Maintenance Project King County, Washington. 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.

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 NMFS to recommend measures that can be taken by the action agency to conserve EFH. This analysis is based, in part, on the description of EFH for Pacific Coast salmon contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC 2014) and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The proposed action and action area for this consultation are described in section 1 of this document. The waters and substrate of Lake Union and the Lake Washington Ship Canal are designated as EFH for various life-history stages of Pacific Coast Salmon. EFH for Pacific salmon is identified and described in Appendix A to the Pacific Coast salmon fishery management plan (PFMC 2014).

3.2 Adverse Effects on Essential Fish Habitat

The ESA portion of this document describes the adverse effects of this proposed action on ESA-listed species and critical habitat, and is relevant to the effects on EFH for Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species. Based on the analysis of effects presented in Section 2.5 the proposed action will cause small scale adverse effects on this EFH through direct or indirect physical, chemical, or biological alteration of the water or substrate, and through alteration of benthic communities, and the reduction in prey availability. Therefore, we have determined that the proposed action would adversely affect the EFH identified above.

3.3 Essential Fish Habitat Conservation Recommendations

The proposed action includes design features that are expected to reduce impacts on the quantity and quality of Pacific Coast salmon EFH. It also includes a comprehensive set of conservation measures and BMP to minimize construction-related effects. NMFS knows of no other reasonable measures to further reduce the level of these effects. Therefore, additional conservation recommendations pursuant to MSA (§305(b)(4)(A)) are not necessary.

3.4 Statutory Response Requirement

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

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

3.5 Supplemental Consultation

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this Opinion is the COE. Other users could include WDFW, the governments and citizens of King County and the City of Seattle, 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 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.

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