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

Refer to NMFS No:
WCRO-2020-02417

November 29, 2021

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

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Explorer and Stella Pier Replacement, King County, Washington (USACE Number: NWS-2020-0360, HUC: 171100120400 – Lake Washington Ship Canal)

Dear Ms. Printz:

Thank you for your letter of September 2, 2020, 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 (USACE) authorization of the Explorer and Stella Pier Replacement.

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

The enclosed document contains the biological opinion (Opinion) prepared by the NMFS pursuant to section 7 of the ESA on the effects of the proposed action. In this Opinion, the NMFS concludes that the proposed action would adversely affect but is not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon and PS Sound steelhead. The 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. This opinion also documents our conclusion that the proposed action may affect, but is not likely to adversely affect southern resident (SR) killer whales and their designated critical habitat.

This Opinion includes an incidental take statement (ITS) that describes reasonable and prudent measures (RPMs) the NMFS considers necessary or appropriate to minimize the incidental take associated with this action, and sets forth nondiscretionary terms and conditions that the USACE 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.

Section 3 of this document includes our analysis of the action's likely effects on EFH for Pacific Coast Salmon pursuant to Section 305(b) of the MSA. Based on that analysis, the NMFS concluded that the action would adversely affect designated EFH for Pacific Coast Salmon. Therefore, we have provided conservation recommendations that can be taken by the USACE to avoid, minimize, or otherwise offset potential adverse effects on EFH. Because the NMFS concurs with the USACE's determination that the action would not adversely affect EFH for coastal pelagic species and Pacific Coast groundfish, consultation under the MSA is not required for those EFHs.

Section 305(b) (4) (B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving this recommendation. If the response is inconsistent with the EFH conservation recommendations, the USACE must explain why the recommendations will not be followed, including the scientific justification for any disagreements over the effects of the action and recommendations. 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 request that in your statutory reply to the EFH portion of this consultation you clearly identify the number of conservation recommendations accepted.

Please contact Janet Curran in the North Puget Sound Branch of the Oregon/Washington Coastal Office by electronic mail janet.curran@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: Colleen Anderson, USACE

bcc: (OWCO – PDF (Read File)
OWC/NPS – PDF (Babcock)
OWC/NPS – PDF (Curran)

PDF Copies sent to the following:

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Colleen Anderson
Colleen.C.Anderson@usace.army.mil

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

Explorer and Stella Pier Replacement
King County, Washington (USACE Number: NWS-2015-0478)

NMFS Consultation Number: WCRO-2020-02417

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
Killer whale (*Orcinus orca*) Southern Resident	Endangered	No	No	No	No

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

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

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

Consultation Conducted By: National Marine Fisheries Service
West Coast Region

Issued By: ______________

dministrator
Oregon Washington Coastal Office

Date: November 29, 2021

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1. INTRODUCTION

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

1.1 Background

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

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 (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository (https://repository.library.noaa.gov/welcome). A complete record of this consultation is on file at the Oregon Washington Coastal Office.

1.2 Consultation History

On September 2, 2020, NMFS received a letter from the U.S. Army Corps of Engineers (USACE) requesting formal consultation for the proposed action. The request included the USACE's Memorandum for the Services (MFS) for the proposed action, a Biological Evaluation and project drawings (NEC 2020). Between September 2020 and June 2021, the NMFS worked with the USACE to modify the project to fit within the Integrated Restoration and Permitting Program (IRRP). However, the project does not fit all of the parameters for that program. The project was re-assigned within NMFS and formal consultation was initiated on June 16, 2021. The USACE determined that the project would adversely affect PS Chinook salmon and PS steelhead. The USACE also determined that the project would not adversely affect PS Chinook salmon critical habitat. NMFS disagrees with the not likely to adversely affect determination for critical habitat and we have included it in this opinion. Critical habitat for PS steelhead is not designated within the action area.

1.3 Proposed Federal Action

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

The USACE proposes to authorize the applicant to replace an existing pier in the Lake Washington Ship Canal with a smaller pier. The proposed project is located in Salmon Bay, within the Lake Washington Ship Canal at 5209 & 5109 Shilshole Ave NW, Seattle, Washington (47.66023 N latitude, -122.37109 W longitude), within a marina. A fire-damaged pier will be demolished and replaced with a shared structure. The existing pier has solid concrete and wood decking with wood and steel piles. The replacement pier and finger piers will be grated, with all steel piles. The concrete bulkhead will be repaired by removing the top concrete cap and driving sheet pile just in front and on the landward side of the original bulkhead (approximately 180 linear feet).

As the result of a fire that occurred at the marina, some of the existing fixed piers will be removed, along with floats, moorage sheds, gangways, and associated piles and dolphins (approx. 17,167 square feet and 126 piles). New pier and finger pier structures will be installed with associated piles (approx. 4,101 square feet and 43 piles). In order to provide a shared walkway with the adjacent property, to reduce overall overwater coverage, the proposal is to replace the existing deteriorated solid decked concrete fixed pier (main walkway), wood fixed pier, and associated piles (approx. 1,972 square feet and 32 piles, 18-to-30-inch diameter steel) on the 5109 Shilshole Ave NW parcel, and install a new fully grated fixed pier structure with associated piles. The new finger piers from parcel 5209 Shilshole Ave NW will be attached to the main walkway in order to create a shared pier configuration. The overall project will result in a reduction of 13,066 square feet of overwater coverage and a reduction of 83 in-water piles. The piles being removed are a combination of steel, wood and creosote. The project will also result in an overall reduction of approximately 170 lineal feet or moorage area from approximately 1,005 to 836 lineal feet.

Proposed work window:

The work will take about 3 weeks, to be performed during the 2021-22 work window October 1-April 15.

Other conservation measures:

- Piles will be driven with a vibratory hammer and impact proofing will not be necessary.
- Grated decking will be used on the walkway and finger piers, further reducing their effective overwater coverage.
- A floating boom will be placed around the project area while work is being done. The area inside the boom will be cleared of floating debris before the boom is removed. Spill containment and removal materials will be kept onsite.
- Piles will be removed completely or cut off 2 feet below the mudline. Holes left by pile removal will be filled, if needed, with clean sand that matches the existing substrate in texture and composition.
- Treated piles that have been removed will be cut into 4-foot sections and disposed of at a licensed upland facility.
- The work barge will not be permitted to ground out on the sediments at any time.

Other Related Actions

The project supports continued recreational boating, which has been identified as a limiting factor for salmonid populations in Lake Washington. It is difficult to quantify any impact to Lake Washington, as vessels using the Ship Canal marina may be used in the lake or taken through the Locks into Puget Sound waters. In any case, moorage capacity will not be increased.

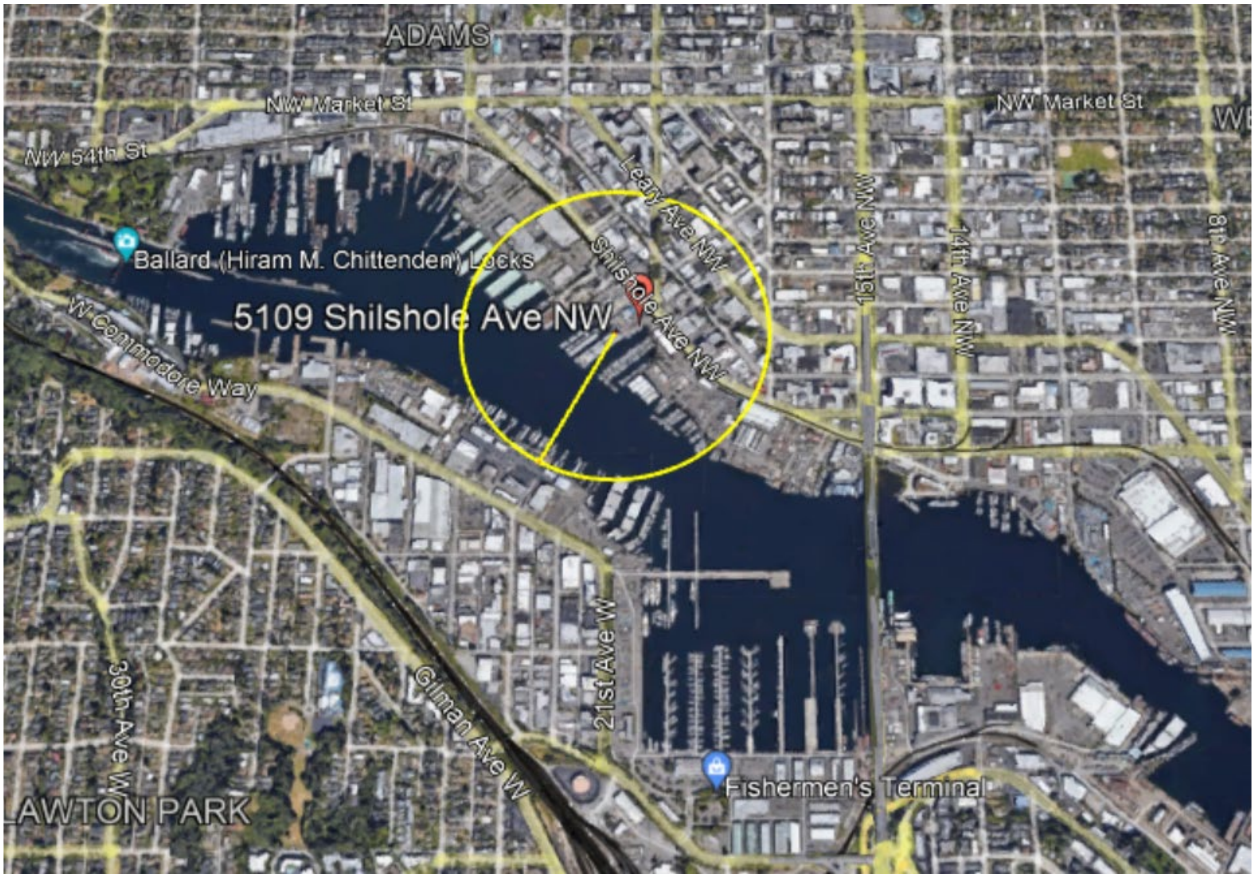

Figure 1. Project action area shown in yellow circle (approximately 800-foot diameter in-water action area) in Lake Washington Ship Canal.

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

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

The USACE determined that the proposed action is likely to adversely affect PS Chinook salmon and PS steelhead, is not likely to adversely affect designated (NLAA) critical habitat for PS Chinook salmon, and would have no effect on designated critical habitat for PS steelhead because the action area has been excluded from that designation (Table 1). We disagree with the NLAA determination for critical habitat of PS Chinook salmon and have included it in this opinion. Additionally, because of the trophic relationship between PS Chinook salmon and SR killer whales, the NMFS analyzed the action's potential effects on SR killer whales and their designated critical habitat in the "Not Likely to Adversely Affect" Determinations Section (2.11).

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)
Killer whale (*Orcinus orca*) Southern Resident	Endangered	NLAA	NLAA	11/18/05 (70 FR 57565) 11/29/06 (71 FR 69054)

LAA = 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 an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

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

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this opinion we use the terms "effects" and "consequences" interchangeably.
We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

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

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

Listed Species

Viable Salmonid Population (VSP) Criteria: For Pacific salmonids, we commonly use four VSP criteria (McElhany et al. 2000) to assess the viability of the populations that constitute the species. These four criteria (spatial structure, diversity, abundance, and productivity) encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment.

"Spatial structure" refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends on habitat quality and spatial configuration, and the dynamics and dispersal characteristics of individuals in the population.

"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation in single genes to complex life history traits.

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

"Productivity" refers to the number of naturally-spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is in decline.

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

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

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 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.

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

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

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

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

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).

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

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).

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 that are likely to occur in the action area would be fall-run Chinook salmon from the Cedar River population and from the North Lake Washington / Sammamish River population (NWFSC 2015; WDFW 2020a). Both stream- and ocean-type Chinook salmon are present in these populations, with the majority being ocean-types.

The Cedar River population is relatively small, with a total annual abundance fluctuating at close to 1,000 fish (NWFSC 2015; WDFW 2020b). Between 1965 and 2019, 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 percent of the population. WDFW data suggest that natural-origin spawners accounted for about 71 percent of a combined total return of 855 fish in 2019 (WDFW 2020b).

The North Lake Washington / Sammamish River population is also small, with a total abundance that has fluctuated between about 33 and 2,223 individuals from 1983 through 2019. Natural-origin spawners make up a small proportion of the total population, accounting for about 30 percent of the 365 total return in 2019, and the trend is rather flat to slightly negative (NWFSC 2015; WDFW 2020b).

All returning adults and out-migrating juveniles of these two populations, as well as individuals that spawn in the numerous smaller streams across the basin, must pass through 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. 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).

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

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

Geographic Region (MPG)	Demographically Independent Population (DIP)	Viability
	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

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.

<u>General Life History:</u> 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).

<u>Spatial Structure and Diversity:</u> 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 percent 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 2020c). 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 2020c). 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 2020c). 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.

The NMFS designated critical habitat for PS Chinook salmon on September 2, 2005 (70 FR 52630). That critical habitat is located in 16 freshwater subbasins and watersheds between the Dungeness/Elwha Watershed and the Nooksack Subbasin, inclusively, as well as in nearshore marine waters of the Puget Sound that are south of the US-Canada border and east of the Elwha River, and out to a depth of 30 meters. Although offshore marine is an area type identified in the final rule, it was not designated as critical habitat for PS Chinook salmon.

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.

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

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 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 large wood recruitment (SSPS 2007).

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

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

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

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

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

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

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

Critical Habitat within the Action Area: 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 (NOAA 2020; WDFW 2020a).

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 the BA, noise generated by the equipment used to install the piles (vibratory pile driver) will be the primary impact associated with the proposed project. Exposure to elevated noise would be the project-related stressor with the greatest range of effect. Underwater noise will reach up to 222 dB_{SEL} (169 dB_{RMS}) during vibratory pile driving. This estimate is based on noise levels measured for 30-inch piles (WSDOT 2019). The behavioral effects threshold for salmonids is 150 dB_{SEL}. The injury threshold for juvenile and adult salmonids, 206 dB_{PEAK}, may be reached for approximately 800 feet from the noise source, or the entire width of the Ship Canal at the project location. Because of the confined area of the Ship Canal, underwater noise cannot spread for miles as it does in open water, and may reach the behavioral effects threshold downstream approximately ½ mile to the Locks and upstream approximately ½ mile. Within this area the sound pressure waves are confined by land forms and bends in the canal.

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" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

Environmental conditions at the project site and the surrounding area: The project site is located in Seattle, along the northern 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 Ship Canal (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 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 percent 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 percent of the diet for smallmouth bass, and about 45 percent 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 aggregate downstream of the fish ladder.

The project site is located in a highly commercial area of the Ship Canal, about a 1/2 upstream of the Chittenden Locks. The canal is about 800-1,000 feet wide at this location. The banks are fully armored and upland areas consist of a mix of pavement and large buildings. The marina shoreline is paved and bulkheaded. The marina and surrounding area have been subject to historical dredging. Substrates consist of sand and mud, with no aquatic vegetation.

On average the ship canal passes 45,000 vessels each year, resulting in elevated ambient terrestrial and underwater noise conditions, including an acoustic deterrent system immediately downstream of the Ballard Locks, which generates 195 dB acoustic noise 24 hours a day, 365 days per year (USACE 2011).

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 °C), and up to 2° F (1.1 °C) in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014; Kunkel et al. 2013). Recent temperatures in all but two years since 1998 ranked above the 20th century average (Mote et al. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10° F (1.7 to 5.6° C), with the largest increases predicted to occur in the summer (Mote et al. 2014).

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

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

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

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

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

2.5 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

The proposed work window for the Lake Washington Ship Canal is between October 1 and April 15. This period would avoid the expected peak out-migration of juveniles and return of adult PS Chinook salmon and steelhead. Adult Chinook salmon pass through Chittenden Locks between mid-June through September, with peak migration occurring in mid-August (City of Seattle 2008). Juvenile Chinook salmon 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). Adult steelhead pass through Chittenden Locks and the Lake Washington Ship Canal between January and May, and may remain within Lake Washington through June (City of Seattle 2008). 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).

The action's in-water work windows avoid the normal migration season for returning adult PS Chinook salmon, but work in the early spring overlaps with the early part of emigration season for juveniles, which begin to enter Lake Washington in January, but very few would reach the Ship Canal by April. As such, adult PS Chinook salmon are extremely unlikely to present during the proposed in-water work, but very low numbers of juveniles could be present. The work windows also overlap with the normal migration seasons for juvenile and adult PS steelhead. However, PS steelhead are very rare in the Lake Washington watershed, which supports the expectation that very low numbers of PS steelhead would be within the action area during the proposed in-water work. Therefore, the work window avoids peak migration times, but very small numbers, relative to the respective populations, of PS Chinook salmon juveniles and PS steelhead adults and juveniles may occur in the action area during construction.

2.5.1 Effects on Listed Species

Exposure to the construction-related noise would adversely affect very small numbers of juvenile PS Chinook salmon and adult and juvenile PS steelhead. However, it is extremely unlikely that adult PS Chinook salmon would be in the action area during the in water window. The effects caused by a fish's exposure to noise vary with the hearing characteristics of the 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 (Stadler and Woodbury 2009). The metrics are based on exposure to peak sound level and sound exposure level (SEL). 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. Further, 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 the range to the 150 dB_{SEL} isopleth exceeds the range to the 187 dB SEL_{CUM} isopleth, the distance to the 150 dB_{SEL} isopleth is the range at which detectable effects would begin, with the 187 dB SEL_{CUM} isopleth identifying the distance within which sound energy accumulation would intensify effects. However, when the range to the 150 dB_{SEL} isopleth is less than the range to the 187 dB SEL_{CUM} isopleth, only the 150 dB_{SEL} isopleth would apply because fish would be extremely unlikely to detect or be affected by the noise outside of the 150 dB_{SEL} isopleth. For all project-related sources, the ranges to the SEL_{CUM} threshold isopleths exceed the range to 150 dB_{SEL} effective quite isopleth. Therefore, this assessment considers the range to the effective quiet isopleths as the maximum ranges for acoustic effects.

The discussion in Stadler and Woodbury (2009) indicate that these thresholds likely overestimate the potential effects of exposure to impulsive sounds. Further, Stadler and Woodbury's assessment did not consider non-impulsive sound, which is believed to be less injurious to fish than impulsive sound. Therefore, application of the criteria to non-impulsive sounds is also likely to overestimate the potential effects in fish. However, these criteria represent the best available information. Therefore, to avoid underestimating potential effects, this assessment applies these criteria to the non-impulsive sounds that are expected during this action's construction to gain a conservative idea of the potential effects that fish may experience due to exposure to project-related sounds.

Vibratory Pile Driving: Elevated in-water noise at levels capable of causing detectable effects in exposed fish would be caused by the in-water use of vibratory pile installation and boat operations. The estimated in-water source levels (SL, sound level at 1 meter from the source) used in this assessment are based on the best available information, as described in recent acoustic assessments for similar projects (NMFS 2017b, 2018), and in other sources (Blackwell and Greene 2006; CalTrans 2015; Richardson et al. 1995). The best available information supports the understanding that all of the SLs from vibratory pile driving would exceed the injury threshold within 800 feet of pile driving. Based on previous studies and the proposed number and size of piles, it is likely that the radius of the 150 dB_{SEL} isopleths would extend up to approximately 1/2 mile up and downstream of the pile driving.

Juvenile Chinook salmon and steelhead that remain outside of the 150 dB_{SEL} isopleths for these sources would be unaffected by the noise. However, fish within the 150 dB_{SEL} isopleth are likely to experience a range of effects that would depend on their distance from the source and the duration of their exposure. All juveniles that are within the 150 dB_{SEL} isopleth, are likely to experience behavioral disturbance, such as acoustic masking, startle responses, altered swimming patterns, avoidance, and increased risk of predation. It is doubtful that any individuals would approach close enough and remain long enough to accumulate sound energy in excess of 183 dB SEL_{cum} threshold. However, if any do, they may also experience some level of auditory- and non-auditory tissue injury, which could reduce their likelihood of their long-term survival.

Impulsive Sound: The applicant does not anticipate needing to proof piles, therefore we do not analyze effects of impulsive sound in this opinion.

The number of juvenile PS Chinook salmon and adult and juvenile PS steelhead that may be harmed by vibratory pile driving is unquantifiable with any degree of certainty. However, it is expected to be extremely low, relative to the respective populations, based on the timing and short duration of the work. Therefore, the numbers of fish that may be exposed to construction-related noise would comprise such a small subset of their cohort that any that are injured or killed due to the exposure would cause no detectable population-level effects.

Construction-related Water Contamination

Exposure to construction-related water contamination would cause minor effects in juvenile PS Chinook salmon and juvenile PS steelhead. It is extremely unlikely that adult PS Chinook salmon or adult PS steelhead would be would be exposed to this stressor because they would either not occur in the action area during the work window or would migrate quickly past the work area in deeper water, thereby minimizing direct exposure. The proposed pile extraction, pier demolition, and construction related boat operations would temporarily affect water quality through increased turbidity and mobilized contaminated sediments. It may also temporarily reduce dissolved oxygen concentrations, and may also temporarily introduce toxic materials from equipment-related spills and discharges. The NMFS estimates that all detectable water quality impacts would be limited to the extent of the project-related turbidity, which is expected to be limited to the area within 300 feet around the work area.

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

Water quality is considered adversely affected by suspended sediments when turbidity is increased by 20 NTU for a period of 4 hours or more (Berg and Northcote 1985; Robertson et al. 2006). The effects of turbidity on fish are somewhat species and size dependent. In general, severity typically increases with sediment concentration and duration of exposure, and decreases with the increasing size of the fish. Bjornn and Reiser (1991) report that adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that may be mobilized during storm and snowmelt runoff episodes. However, empirical data from numerous studies report the onset of minor physiological stress in juvenile and adult salmon after one hour of continuous exposure to suspended sediment concentration levels between about 1,100 and 3,000 mg/L, or to three hours of exposure to 400 mg/L, and seven hours of exposure to concentration levels as low as 55 mg/L (Newcombe and Jensen 1996). The authors reported that serious non-lethal effects such as major physiological stress and reduced growth were reported after seven hours of continuous exposure to 400 mg/L and 24 hours of continuous exposures to concentration levels as low as about 150 mg/L.

Vibratory removal of hollow 30-inch steel piles in Lake Washington mobilized sediments that adhered to the piles as they were pulled up through the water column (Bloch 2010). Much of the mobilized sediment likely included material that fell out of the hollow piles. Turbidity reached a peak of about 25 NTU (~25 mg/L) above background levels at 50 feet from the pile, and about 5 NTU (~5 mg/L) above background at 100 feet. Turbidity returned to background levels within 30 to 40 minutes. Pile installation created much lower turbidity. The applicant will slowly pull the old piles, which will reduce keep the amount of mobilized sediment to a minimum.

Tugboat propeller wash would also mobilize bottom sediments. The intensity and duration of the resulting turbidity plumes are uncertain, and would depend on a combination of the tugboat's thrust, the water depth under it, and the type of substrate. The higher the thrust and the finer the sediment, the more mobilized sediment. Fine material (silt) remains mobilized longer than coarse material (sand). The shallower the water, the more thrust energy that would reach the substrate. A recent study described the turbidly caused by large tugboats operating in Navy harbors (ESTCP 2016). At about 13 minutes, the plume extended about 550 yards (500 m) and had a TSS concentration of about 80 mg/L. The plume persisted for hours and extended far from the event, but the TSS concentration fell to 30 mg/L within 1 hour and to 15 mg/L within 3 hours. At its highest concentration, the plume was below the concentrations required to elicit physiological responses reported by Newcombe and Jensen (1996). The exact extent of turbidly plumes from tugboat operations for this project are unknown, but it is extremely unlikely that would rise to the levels described above. Project-related tugboat trips would be infrequent, and would likely last a low number of hours while the work barge is positioned. Therefore, the resulting propeller wash turbidity plumes would be low in number and episodic. The intensity and duration of the resulting turbidity plumes are uncertain. However, based on the information above, and on numerous consultations for similar projects in the region, sediment mobilization from tugboat propeller wash would likely consist of relatively low-concentration plumes that could extend up to about 300 feet from the site, and last a low number of hours hour after the disturbance ends.

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

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

<u>Toxic Materials:</u> Toxic materials may enter the water through construction-related spills and discharges, the mobilization of contaminated sediments, and/or the release of PAHs from creosote-treated timber piles during their removal. Fish can uptake contaminants directly through their gills, and through dietary exposure (Karrow et al. 1999; Lee and Dobbs 1972; McCain et al. 1990; Meador et al. 2006; Neff 1982; Varanasi et al. 1993). Many of the fuels, lubricants, and other fluids commonly used in motorized vehicles and construction equipment are petroleum-based hydrocarbons that contain Polycyclic Aromatic Hydrocarbons (PAHs), which are known to be injurious to fish. Other contaminants can include metals, pesticides, Polychlorinated Biphenyls (PCBs), phlalates, and other organic compounds. Depending on the pollutant, its concentration, and/or the duration of exposure, exposed fish may experience effects that can range from avoidance of an affected area, to reduced growth, altered immune function, and mortality (Beitinger and Freeman 1983; Brette et al. 2014; Feist et al. 2011; Gobel et al. 2007; Incardona et al. 2004, 2005, and 2006; Mcintyre et al. 2012; Meadore et al. 2006; Sandahl et al. 2007; Spromberg et al. 2015).

The project includes BMPs specifically intended to reduce the risk and intensity of discharges and spills during construction. In the unlikely event of a construction-related spill or discharge, the event would likely be very small, quickly contained and cleaned. Additionally, non-toxic and/or biodegradable lubricants and fluids are strongly encouraged by the State, and are commonly used by many of the local contractors. Based on the best available information, the in-water presence of spill and discharge-related contaminants would be very infrequent, very short-lived, and at concentrations too low to cause detectable effects should a listed fish be exposed to them.

Creosote-treated piles leach PAHs into the surrounding sediments, as well as directly into the water (Evans et al. 2009; Parametrix 2011; Smith 2008; Werme et al. 2010). Therefore, the sediments that would be mobilized during pile removal very likely contain PAHs from the creosote-treated piles. PAHs may also be released directly from timber piles should they break during their removal. As described above, the amount of sediment that would be mobilized by construction activities would be small, and any PAHs that may be mobilized would likely dissipate within a few hours, through evaporation at the surface, dilution in the water column (Smith 2008; Werme et al. 2010), or by settling out of the water with the sediments. Therefore, in-water contaminant concentrations would be very low and short-lived. The NMFS estimates that tugboat mobilized sediments wouldn't exceed 300 feet and one hour after the cessation of work. The in-water concentrations would most likely be too low, and the exposure too brief to cause detectable effects in exposed individuals.

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

Construction-related Propeller Wash

Exposure to construction-related propeller wash would adversely affect juvenile PS Chinook salmon and juvenile PS steelhead, but it is extremely unlikely that adult PS Chinook salmon or PS steelhead would be would be exposed to this stressor because they would either not be present or would they would be migrating quickly past the work area in deeper water. Work-related tugboat operations would cause propeller wash within the action area. Spinning boat propellers kill fish and small aquatic organisms (Killgore et al. 2011; VIMS 2011). Spinning propellers also generate fast-moving turbulent water (propeller wash) that can displace and disorient small fish, as well as dislodge benthic aquatic organisms and submerged aquatic vegetation (SAV), particularly in shallow water and/or at high power settings (propeller scour).

During project work, vessel operations by tugboats and small work boats would cause propeller wash within the action area. Juvenile salmonids that are within the area are likely to be relatively close to the surface and too small to effectively swim against the propeller wash. Individuals that are struck or very nearly missed by the propeller would be injured or killed by the exposure. Farther away, propeller wash may displace and disorient fish. Depending on the direction and strength of the thrust plume, displacement could increase energetic costs, reduce feeding success, and may increase the vulnerability to predators for individuals that tumble stunned and/or disoriented in the wash.

The number of juvenile PS Chinook salmon and juvenile PS steelhead that may be impacted by this stressor is unquantifiable with any degree of certainty. However, it is expected to be extremely low based on the relatively short duration and timing of the work, and on the relatively low number of tugboat trips that would occur. Therefore, the numbers of juveniles that may be exposed to construction-related propeller wash would represent such a small subset of their respective cohorts that their loss would cause no detectable population-level effects.

Construction-related propeller scour may also reduce submerged aquatic vegetation (SAV) and diminish the density and diversity of the benthic community at the project site, although the applicant reports that no SAV occurs at the project site. The disturbances would be brief and invertebrate-supporting substrate in the immediate area and invertebrates would likely recover very quickly after work is complete. Therefore, the effects of propeller scour would be too small to cause any detectable effects on the fitness and normal behaviors of juvenile Chinook salmon and juvenile steelhead in the action area.

<u>Construction-related Forage Contamination</u>

Exposure to construction-related contaminated forage would adversely affect juvenile PS Chinook salmon and juvenile PS steelhead. It is extremely unlikely that adults of either species would be exposed to this stressor. In addition to direct uptake of contaminants through their gills, fish can absorb contaminants through dietary exposure (Meador et al. 2006; Varanasi et al. 1993). The removal of the existing creosote-treated timber piles would each mobilize small amounts of contaminated subsurface sediments that would settle onto the top layer of the substrate, where, through the trophic web, contaminants such as PAHs and PCBs would remain biologically available to juvenile PS Chinook salmon and PS steelhead for years.

The normal behaviors of juvenile Chinook salmon in the freshwater out-migration phase of their life cycle includes a strong tendency toward shoreline obligation, which means that they are biologically compelled to follow and stay close to streambanks and shorelines, and likely to pass through and forage within close proximity to the pier. The normal behaviors of out-migrating juvenile steelhead is much less tied to shoreline habitats. However, over the decades-long life of the pier, some out-migrating juvenile steelhead are likely to pass through and forage within the action area.

As described above, under contaminated water, the sediments that would be mobilized during pile removal very likely contain PAHs from the creosote-treated piles, as well as low levels of other vessel-related contaminants. Amphipods and copepods can uptake PAHs from contaminated sediments (Landrum and Scavia 1983; Landrum et al. 1984; Neff 1982), and pass them to juvenile Chinook salmon and other small fish through the food web. Varanasi et al. (1993) found high levels of PAHs in the stomach contents of juvenile Chinook salmon in a contaminated waterway (Duwamish). They also reported reduced growth, suppressed immune competence, as well as increased mortality in juvenile Chinook salmon that was likely caused by the dietary exposure to PAHs. Meador et al. (2006) demonstrated that dietary exposure to PAHs caused “toxicant-induced starvation” with reduced growth and reduced lipid stores in juvenile Chinook salmon. The authors surmised that these impacts could severely impact the odds of survival in affected juvenile Chinook salmon.

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

Most of the mobilized sediment, and therefore the highest concentrations of contaminants, would settle onto the top layer of the substrate within approximately 300 feet of the work area. The mobilized sediments that settle to the bottom would remain biologically available to juvenile PS Chinook salmon and juvenile PS steelhead for years after project completion. While present, some of those contaminants are likely to be taken up by invertebrate prey organisms within the affected area.

Some subset of the juvenile PS Chinook salmon and juvenile PS steelhead that emigrate through the Ship Canal and Lake Washington are likely to pass through the affected work area. During their transit, at least some of those juveniles are likely to feed on the invertebrate resources, some of which would be contaminated by construction-mobilized sediments.

The annual number of juvenile PS Chinook salmon and juvenile PS steelhead that may be exposed to contaminated forage attributable to this action is unquantifiable with any degree of certainty and would be highly variable, 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.

The number of years that detectable amounts of contaminants would be biologically available, as well as the annual numbers of juvenile PS Chinook salmon and juvenile PS steelhead that may be exposed to construction-related contaminated forage is unquantifiable with any degree of certainty. Similarly, the amount of contaminated prey that any individual fish may consume, or the intensity of any effects that an exposed individual may experience is uncertain, and would be highly variable over time. However, the relatively small amount sediment that would be mobilized suggests that the number of years that detectable contaminants would be present would be low, and the affected areas would also be relatively small, which further suggests that the probability of trophic connectivity to the contamination would be very low for any individual fish. Therefore, the numbers of juvenile Chinook salmon and juvenile PS steelhead that would be annually exposed to project-related contaminated prey would likely comprise such small subsets of their respective cohorts that their loss would cause no detectable population-level effects.

Pier-related Altered Lighting

Pier-related altered lighting is likely to adversely affect juvenile PS Chinook salmon and juvenile PS steelhead, but cause minor effects in adults of both species. During the day, the pier and moored boats create unnatural daytime shade over the water and aquatic substrate. At night, those structures and vessels would also create over-water artificial illumination.

Shade: The shade of the new pier, as well as the vessels moored to them would maintain conditions within and adjacent to the pier's footprint that reduce aquatic productivity, but at a lesser extent than the removed structures did. The proposal reduces the total over water coverage by removing floating piers, solid covered moorage structures, and solid pier decking (net reduction in over water coverage of 13,066 square feet, 83 fewer piles, and 170 lineal foot reduction in moorage area). The new decking will be grated, which will somewhat ameliorate the shading cast by the pier. Artificial shade, where there is a strong light- dark contrast in the water, alters juvenile salmonid migratory behaviors, and increases juvenile salmonids' exposure and vulnerability to predators. As described above under contaminated forage, some subset of each year's cohort of out-migrating juvenile Chinook salmon, and to a lesser extent, out-migrating juvenile steelhead, would pass in close proximity or under the structure.

Shade limits primary productivity and can reduce the diversity of the aquatic communities under over-water structures (Nightingale and Simenstad 2001; Simenstad et al. 1999). 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). The shade would continue to reduce the quantity and diversity of natural cover and prey organisms for juvenile salmonids.

If situated alone along a stretch of undisturbed shoreline, the pier's impact on aquatic productivity might not be expected to measurably affect the fitness of migrating juvenile salmonids. However, because the pier is situated among many long-standing bankside over-water structures that line the Ship Canal, the shadow, in combination with the shadows of the adjacent structures, act to maintain long stretches of migratory habitat with inadequate shelter and forage for juvenile salmonids. Therefore, juvenile Chinook salmon and juvenile steelhead within the action area are likely to experience some degree of reduced fitness due to reduced availability of natural cover and prey that would be attributable to the applicant's pier.

The shade of over-water structures also negatively affects juvenile salmonid migration. Numerous studies demonstrate that juvenile salmonids, in both freshwater and marine habitats, are more likely to avoid an overwater structure's shadow 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; Tabor 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).

The shade would delay the passage under the structures for some, and/or induce some individuals to swim around the structures, effectively forcing them into open and relatively deep waters. The off-bank migration of these small fish increases migration distance and time, and increases the energetic costs (Heerhartz and Toft 2015). Additionally, 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), and deep water increases the risk of predation for migrating juvenile salmonids (Willette 2001). Shade-related altered migratory behaviors would mostly affect juvenile PS Chinook salmon, because the juvenile PS steelhead that pass through this waterway are relatively large and more shoreline independent, as are the adults of both species.

Artificial Illumination

Artificial lighting, especially after dark, can have numerous effects on fish (Simenstad et. al. 1999, Celedonia et.al. 2011). Juvenile salmonids can be attracted to areas of increased light at night. Delays in migration direction can occur when juveniles are confronted with conflicts in preferences among alternative light conditions. Increased predation can occur when larger fish and birds are attracted to the artificially high concentrations of juvenile fish near the water surface. Artificial lighting will be installed on the new pier for security and safety purposes. The applicant did not specify specific lighting design. Nighttime artificial illumination of the water's surface attracts fish (positive phototaxis) in marine and freshwater environments, it often shifts nocturnal behaviors toward more daylight-like behaviors, and it can affect light-mediated behaviors such as migration timing (Becker et al. 2013; Celedonia and Tabor 2015; Ina et al. 2017; Tabor and Piaskowski 2002; Tabor et al. 2017). 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 sub-yearling Chinook, coho, and sockeye salmon 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. 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. Because the applicant did not include specific conservation measures in their proposal, we assume that lighting on the pier will cause some migration delay and expose juvenile salmonids to increased predation.

In summary, pier shade 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 numbers are likely to be very low. This because relatively small subsets of each annual cohort are likely to pass in close proximity to the pier, and 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 altered lighting would be too low to cause any detectable population-level effects.

Pier-related Water and Forage Contamination

Pier-related pollutants would adversely affect PS Chinook salmon and PS steelhead through direct exposure to pollutants in the water column and through indirect exposure to pollutants through the trophic web. The timber used for pier and float repairs would be treated with ACZA, which contains copper, as does the anti-fouling paint that would coat the hulls of some of the vessels that would moor at the piers. Additionally, moored vessels are likely to discharge petroleum-based fuels and lubricants into the water. Unlike the small-scale and brief introduction of pollutants that may potentially occur during construction, the applicant's pier would be present a continuous year-round source of pollutants for the duration of its existence.

Copper: 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).

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. 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. Above-water treated timber episodically releases very small amounts of copper when it is exposed to waves and stormwater. The dissolved copper concentrations that would be attributable to action-related installation of ACZA-treated timber is uncertain. Detectable concentrations are expected to be very low, episodic, brief, and limited to the areas immediately adjacent to the pier because all treated timber would be installed above the water and not permanently immersed. However, any dissolved copper from the ACZA-treated timber would be additive to the copper from hull paints described below.

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 piers with high boat occupancy and restricted water flows (Schiff et al. 2004). This is most notable under conditions of high boat occupancy in enclosed moorages where water flows are restricted. WDOE (2017) 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 dissolved copper concentrations that would be attributable to action-related copper-based anti-fouling paints are uncertain, but would likely be very low because the Ship Canal has high flushing rates and the number of boats moored at the pier is very small compared to an enclosed marina. However, over the extended lives of the applicant's repaired pier, some juvenile Chinook salmon and juvenile steelhead are likely to be exposed to pier-related dissolved copper at levels high enough to measurably alter their normal behaviors and increase their risk of predation.

Petroleum-based fuels and lubricants: The vessels that would utilize the applicant's pier would periodically (albeit inadvertently) discharge petroleum-based fuels and lubricants into the water. As discussed above under construction-related water contamination, petroleum-based fuels and lubricants contain chemicals that are harmful to fish and other aquatic organisms.

Vessel discharges are likely to occur relatively infrequently, with the majority being very small. Additionally, some of the pollutants may evaporate relatively quickly (Werme et al. 2010), and currents would help to disperse the pollutants. However, those discharges would occur repeatedly over the decades-long life of the pier. Therefore, over the decades-long life of the repaired pier, some juvenile PS Chinook salmon and juvenile PS steelhead are likely to be directly exposed to petroleum-based pollutants at concentrations capable of causing some combination of behavioral disturbances, reduced growth, increased susceptibility to infection, and increased mortality.

Pier-related Forage Contamination: Marina-related contaminants that settle to the bottom would accumulate in the action areas and be biologically available for years (Romberg 2005). As described earlier under Construction-related Forage Contamination, amphipods and copepods uptake contaminants from contaminated sediments and pass them to fish through the food web, causing reduced growth, suppressed immune competence, and increased mortality in the juvenile fish that consumed them. Based on the available information, the NMFS expects that over the life of the pier, some juvenile Chinook salmon and juvenile steelhead are likely to be exposed to pier-related contaminated forage capable of causing some combination of reduced growth, increased susceptibility to infection, and increased mortality.

Summary: Subsets of the juvenile Chinook salmon and juvenile steelhead that annually emigrate through the Ship Canal are likely to pass in close proximity to the pier. Individuals that swim through the area are likely to be directly exposed to pier-related contaminated water. Additionally, at least some of those migrating juveniles are likely to feed on invertebrate resources during their transit through the action area, some of which may be contaminated by pier-related contaminants that have settled to the bottom.

The annual numbers of juveniles of either species that may be exposed to pier-related contaminated water and/or forage are unquantifiable with any degree of certainty and are likely to vary greatly over time, but are expected to be very low. Similarly, the contaminant concentration levels that any individual fish may be directly or indirectly exposed to, and the intensity of any effects that an exposed individual may experience would be uncertain and highly variable over time, but again are expected to typically be very low.

Based on the relatively small affected area, the PS Chinook salmon and PS steelhead that would annually pass in close proximity to the pier would be subsets of their cohorts. Further, the infrequency and small-scale of discharges combined with the migratory nature of juvenile salmonids in the area suggest that the probability and duration of exposure would be very low for any individual fish. Therefore, the annual numbers of PS Chinook salmon and PS steelhead that may be exposed to pier-related contaminated water and forage would represent extremely small subsets of their respective cohorts, and the numbers of exposed fish that would be meaningfully affected would be too low to cause detectable population-level effects.

Pier-related Noise

Pier-related noise would adversely affect PS Chinook salmon and PS steelhead. The vessels would cause in-water noise capable of causing detectable effects in fish. Unlike construction noises, vessel noise could occur year-round. Individual vessel operations around a mooring structure typically consist of brief periods of relatively low-speed movement as boats are driven to the pier and floats and tied up. Their engines are typically shut off within minutes of arrival. The engines of departing vessels are typically started a few minutes before the boats are untied and driven away.

Numerous sources describe sound levels for ocean-going ships, tugboats, and recreational vessels (Blackwell and Greene 2006; McKenna et al. 2012; Picciulin et al. 2010; Reine et al. 2014; Richardson et al. 1995). The best available information about the source levels from vessels close in size to those that would operate at the pier is described in the acoustic assessment done for a similar project (NMFS 2018). In the current assessment, we used vessel noise from an 85-foot long ferry, tugboats, and a 23-foot long power boat as surrogates for the mix of vessels likely to moor at the applicant's pier.

All of the expected peak source levels are below the 206 dB_{peak} threshold for instantaneous injury in fish. Application of the practical spreading loss equation to the expected SEL SLs suggests that noise levels above the 150 dB_{SEL} threshold would extend between about 33 feet (10 m) and 207 feet (63 m) from the representative vessels (Table 5).

Table 5. Estimated in-water source levels for vessels with noise levels similar to those likely to moor at the applicant's pier, and ranges to effects thresholds for fish.

Source	Acoustic Signature	Source Level	Threshold Range
85 foot Tourist Ferry	< 2 kHz Combination	187 dB_{peak}	206 @ N/A
Episodic periods measured in minutes to hours		177 dB_{SEL}	150 @ 63 m
Tugboat	< 2 kHz Combination	185 dB_{peak}	206 @ N/A
Episodic periods measured in minutes to hours		170 dB_{SEL}	150 @ 22 m
23 foot Boat w/ 2 4~ 100 HP Outboard Engines.	< 2 kHz Combination	175 dB_{peak}	206 @ N/A
Episodic brief periods measures in minutes		165 dB_{SEL}	150 @ 10 m

It is extremely unlikely that vessels would be run at anything close to full speed while near the pier. However, they may briefly use high power settings while maneuvering. To be protective of fish, this assessment assumes that pier-related in-water vessel noise levels above the 150 dB_{SEL} threshold could routinely extend 72 feet (22 m) around the pier, but may episodically extend to about 207 feet (63 m) when vessels close to 100 feet in length use the pier. Vessel noise levels would be non-injurious. However, juvenile Chinook salmon and steelhead that are within the 150 dB_{SEL} isopleth, are likely to experience behavioral disturbances, such as acoustic masking, startle responses, altered swimming patterns, avoidance, and increased risk of predation. Further, the intensity of these effects would increase with increased proximity to the source and/or duration of exposure. Response to this exposure would be non-lethal in most cases, but some individuals may experience stress and fitness effects that could reduce their long-term survival, and individuals that are eaten by predators would obviously be killed.

The annual numbers of juvenile PS Chinook salmon and PS steelhead that would be exposed to this stressor are unquantifiable with any degree of certainty and are likely to vary greatly over time. However, they would be very low. The typically episodic and short-duration of vessel operations at the pier combined with the juvenile salmonids typical migratory behavior in the Ship Canal, suggest that the probability and duration of exposure would be very low for any individual fish. Therefore, the PS Chinook salmon and PS steelhead that may be exposed to pier-relate elevated noise would represent extremely small subsets of their respective cohorts, and the annual numbers of individuals that would be meaningfully affected by this stressor would be too low to cause detectable population-level effects.

Marina-related Propeller Wash

Marina-related propeller wash would adversely affect juvenile PS Chinook salmon and juvenile PS steelhead, but cause only minor effects in adults of both species. The effects of propeller wash is described above for construction. Juvenile Chinook salmon and steelhead in the action area are likely to remain close to the surface where they may be exposed to spinning propellers and powerful propeller wash near the pier. Conversely, adults of both species would tend to swim offshore and below the surface, and they would be able to swim against most propeller wash they might be exposed to, without experiencing any measurable effect on their fitness or normal behaviors.

Although the likelihood of this interaction is very low for any individual fish or individual boat trip, it is very likely that over the extended lives of the pier, at least some juvenile PS Chinook salmon and juvenile PS steelhead would experience reduced fitness or mortality from exposure to spinning propellers and/or propeller wash at the pier.

The annual numbers of juveniles of either species that would be exposed to this stressor are unquantifiable with any degree of certainty and are likely to vary greatly over time. However, they would be very low. Based on the relatively small affected area, the juvenile Chinook salmon and steelhead that would annually come close to this pier is very low. Further, the typically episodic and short-duration of vessel operations at the pier makes the probability and duration of exposure would be very low for any individual fish. Therefore, the juvenile PS Chinook salmon and juvenile PS steelhead that would be exposed to pier-relate propeller wash would represent extremely small subsets of their respective cohorts, and the annual numbers of individuals that would be meaningfully affected by this stressor would be too low to cause detectable population-level effects.

Pier-related propeller scour is unlikely to cause any detectable effects on the fitness and normal behaviors of Chinook salmon and steelhead. The expectation that low power settings would be used when maneuvering at the pier, combined with the relatively deep water under most of the pier suggest that propeller scour would have negligible effects on benthic resources at the sites.

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, including full application of the planned conservation measures and BMPs, is likely to adversely affect designated critical habitat for PS Chinook salmon as described below.

1. Freshwater spawning sites – None in the action area.
2. Freshwater rearing sites – None in the action area.

3. Freshwater migration corridors free of obstruction and excessive predation:
   a. Obstruction and excessive predation – The proposed project would cause minor long-term adverse effects on this attribute. The altered light and in-water noise levels related to the continued presence of the pier's overwater structures and the moored vessels would maintain conditions at the sites that prevent normal migration behaviors, and increase the risk of predation for juvenile Chinook salmon and steelhead that approach the pier
   b. Water quantity – The proposed project would cause no effect on this attribute.
   c. Water quality – The proposed action would cause minor short- and long-term adverse and beneficial effects on this attribute. Demolition and construction would cause short-term adverse effects on water quality and would persist no more than a low number of hours after work stops. ACZA-treated timber and continued vessel operations at the pier would maintain persistent low level inputs of contaminants at the pier. Conversely, the permanent removal of creosote-treated timber piles would reduce ongoing PAH contamination at the sites. Detectable water quality impacts are expected to be limited to the areas within 300 feet around the project sites. The action would cause no measurable changes in water temperature or salinity.
   d. Natural Cover – The proposed action would cause minor long-term adverse effects on this attribute. Extending the useful life of the pier's overwater structure, albeit at a lesser degree because the project reduces the amount of overwater cover. The rebuilt bulkhead perpetuates the vertical-walled shoreline. Because this is an artificial channel with nearly 100 percent of the shoreline developed with vertical walled bulkheads, piers, and dense upland development, the perpetuation of the bulkhead contributes to the overall poor salmon habitat in the Ship Canal as a constructed waterway.
4. Estuarine areas free of obstruction and excessive predation – None in the action area.
5. Nearshore marine areas free of obstruction and excessive predation – 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 consultation (50 CFR 402.02 and 402.17(a)). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

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 2.4).

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

The NMFS is unaware of any specific future non-federal activities that are reasonably certain to affect the action area. However, the NMFS is reasonably certain that future non-federal actions such as the previously mentioned activities are all likely to continue and increase in the future as the human population continues to grow across the region. Continued habitat loss and degradation of water quality from development and chronic low-level inputs of non-point source pollutants will likely continue into the future. Recreational and commercial use of 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) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

As described in more detail above in 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 dissolved oxygen, as well as by causing more frequent and more intense flooding events.

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

2.7.1 ESA-listed Species

PS Chinook salmon and PS steelhead are 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, the effects on viability parameters of each species are also likely to be negative. In this context we consider how the proposed action's impacts on individuals would affect the listed species at the population and ESU/DPS scales.

PS Chinook salmon

The long-term abundance trend of the PS Chinook salmon ESU is slightly negative. 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 PS Chinook salmon most likely to occur in the action area would be fall-run Chinook salmon from the Cedar River and the North Lake Washington/Sammamish River populations, and part of the South Puget Sound MPG. Both populations are considered at high risk of extinction due to low abundance and productivity.

The project site is located along north bank of the Lake Washington Ship Canal, which serves as a freshwater migration route to and from marine waters for adult and juvenile PS Chinook salmon from both affected populations. The environmental baseline within the action area has been degraded by the effects of nearby intense bankside development and maritime activities, and by nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

The timing of the proposed work avoids the normal migration season for returning adult PS Chinook salmon, but work between December 31 and April 15 overlaps with the early part of emigration season for juveniles. Additionally, over the next several decades, low numbers of out-migrating juveniles that pass through the project sites would be exposed to low levels of contaminated forage and other altered habitat conditions, that both individually and collectively, would cause some combination of altered behaviors, reduced fitness, and mortality in some of the exposed individuals. The annual numbers of individuals that would be detectably affected by action-related stressors would be extremely 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 long-term abundance trend of the PS steelhead DPS is negative, especially for natural spawners. Growth rates are currently declining at 3 to 10 percent annually for all but a few DIPs. The extinction risk for most DIPs is estimated to be moderate to high, and the DPS is currently considered “not viable”. 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 PS steelhead most likely to occur in the action area would be winter-run fish from the Cedar River and North Lake Washington/Lake Sammamish DIPs. The abundance trends between 1984 and 2016 was strongly negative for both DIPs, and ten or fewer adult natural-spawners are estimated to return to the DIPs annually.

The Lake Washington Ship Canal which serves as a freshwater migration route to and from marine waters for adult and juvenile PS steelhead from both affected DIPs. The environmental baseline within the action area has been degraded by the effects of nearby intense bankside development and maritime activities, and by nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

It is likely that very small numbers, relative to the respective populations, of juvenile PS steelhead would be directly exposed to the proposed work. Over the next several decades, low numbers of out-migrating juveniles that pass through the project sites would be exposed to low levels of contaminated forage and other altered habitat conditions, that both individually and collectively, would cause some combination of altered behaviors, reduced fitness, and mortality in some of the exposed individuals. The annual numbers of individuals that would be detectably affected by action-related stressors would be extremely low.

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

2.7.2 Critical Habitat

Critical habitat was designated for PS Chinook salmon to ensure that specific areas with PBFs that are essential to the conservation of that listed species are appropriately managed or protected. The critical habitat for PS Chinook salmon will be affected over time by cumulative effects, some positive – as restoration efforts 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 trends are negative, the effects on the PBFs of critical habitat for PS Chinook salmon are also likely to be negative. In this context we consider how the proposed action's impacts on the attributes of the action area's PBFs would affect the designated critical habitat's ability to support the conservation of PS Chinook salmon as a whole.

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 obstruction and excessive predation, water quality, and natural cover. As described above, the project site is located along a heavily impacted, artificial waterway. The extended life of the pier, along with the continuation of pier-related vessel operations would cause minor long term adverse effects on the identified site attributes. The project also maintains the vertical wall bulkhead within the constructed waterway, which eliminates the possibly of natural shoreline processes that create and maintain shallow water habitat. On the positive side, the proposed work would also reduce ongoing PAH contamination by removing creosote piles and reduce the total amount of overwater coverage.

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 for its conservation role for PS Chinook salmon.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is the NMFS' biological 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).

2.9.1 Incidental Take Statement

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

Harm of PS Chinook salmon and PS steelhead from exposure to:

- Construction-related noise,
- Construction-related propeller wash,
- Construction-related contaminated forage,
- Pier-related altered lighting,
- Pier-related water and forage contamination,
- Pier-related noise, and
- Pier-related propeller wash.

The NMFS cannot predict with meaningful accuracy the number of PS Chinook salmon and PS steelhead that are reasonably certain to be injured or killed annually by exposure to any of these stressors. The distribution and abundance of the fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and spatial scales than are affected by the proposed action. Thus, the distribution and abundance of fish within the action area cannot be attributed entirely to habitat conditions, nor can the NMFS precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by the proposed action. Additionally, the NMFS knows of no device or practicable technique that would yield reliable counts of individuals that may experience these impacts. In such circumstances, the NMFS uses the causal link established between the activity and the likely extent and duration of changes in habitat conditions to describe the extent of take as a numerical level of habitat disturbance. The most appropriate surrogates for take are action-related parameters that are directly related to the magnitude of the expected take.

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

The timing and duration of work are the best available surrogates for the extent of take of juvenile PS Chinook salmon from exposure to construction-related noise and propeller wash because the planned work windows were selected to reduce the potential for juvenile fish presence at the project sites. Therefore, working outside of the planned work windows and/or working for longer than planned would increase the number of fish likely to be exposed to these construction-related impacts.

In addition to timing and duration, pile type, size, and method of installation are applicable for pile-installation noise because the intensity of effect is positively correlated with the loudness of the sound, which is determined by the type and size of the pile and the method of installation. Further, the number of fish that would be exposed to pile-installation noise is positively correlated with the size of the area of acoustic effect and the number of days that the area would be ensonified. In short, as the sound levels increase, the intensity of effect and the size of the ensonified area increases, and as the size of the ensonified area increases, and/or as the number of days the area is ensonified increases, the number of juvenile Chinook salmon that would be exposed to the sound would increase despite the low density and random distribution of individuals in the action area. Based on the best available information about the planned pile installation, as described in Section 2.5, the applicable ranges of effect for this project are driven by the type and size of the piles and the method of their installation, but not by the daily duration of vibratory work or the number of piles. Therefore, the daily number of piles and daily duration of vibratory pile installation are not considered measures of take for this action.

The pile removal method and the extent of the visible turbidity plumes around that work are the best available surrogates for the extent of take of juvenile PS Chinook salmon and juvenile PS steelhead from exposure to construction-related contaminated forage. The method of removal is appropriate because the intensity of surface sediment contamination would be positively correlated with the amount of contaminated subsurface sediments that would be brought to the surface, which is positively correlated with the extraction method. The piles will be slowly pulled up. As the amount of mobilized contaminated sediments increase, the amount of biologically available contaminants would increase, as would the intensity of prey contamination. The lateral extent of the visible turbidity plumes around pile extraction is appropriate because the size the affected areas would be positively correlated with the extent of the plume, and the numbers of contaminated prey organisms and/or exposed fish would be positively correlated with the size the affected area. Therefore, any increase in the amount of mobilized sediment would increase the intensity of contamination, and any increase in the size of the visible turbidity plumes would increase the number of contaminated prey organisms as well as the number of exposed listed fish, both of which would increase the intensity of the exposure and/or the number of exposed juvenile PS Chinook salmon and juvenile PS steelhead.

The location, size, and configuration of the repaired and/or replaced overwater structures are the best available surrogates for the extent of take of juvenile PS Chinook salmon and juvenile PS steelhead from exposure to pier-related altered lighting, water and forage contamination, noise, and propeller wash. Location is appropriate because installation of the overwater structures closer to shore would increase the likelihood of exposing juvenile PS Chinook salmon to altered lighting, vessel noise, and propeller wash, due to the increased proximity of those structures to preferred juvenile Chinook salmon habitat. Installation of the structures in shallower water would also increase propeller wash impacts on benthic resources, which would increase the likelihood that juvenile PS Chinook salmon and juvenile PS steelhead would be experience unanticipated take due to reduced availability of shelter and forage resources.

Size and configuration are appropriate for altered lighting because, salmonid avoidance and the distance required to swim around the structures would both increase as the size and opacity of a structures increase, and any increase in the artifical illumination would increase nightime phototaxis, which currently not expected to occur. Size and configuration are appropriate for pier-related water and forage contamination, noise, and propeller wash because those stressors are all positively correlated with the number of boats that moor at a structure, which is largely a function of the structure’s size. As the size of a mooring structure increases, the number of boats that can moor there increases. As the number of boats increase, boating activity increases. As boating activity increases, the potential for, and the intensity of exposure to the related pollutants, noise, and propeller wash would also increase for juvenile PS Chinook salmon and juvenile PS steelhead.

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

- About 1 month of in- water work each to be completed between October 1 and April 15;
- A total of about 21 days of vibratory installation of steel piles no larger than 32 inches in diameter and removal of existing piles;
- Pile removal by slowly pulling, with the visible turbidity plume not to exceed 300 feet from that work; and
- The post-construction location, size, and configuration of the applicant’s overwater structures 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 co-extensive with the proposed action, they nevertheless function as effective reinitiation triggers. If any of these take surrogates exceed the proposal, it could still meaningfully trigger reinitiation because the USACE 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 biological opinion, the NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.9.3 Reasonable and Prudent Measures

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

The USACE shall require the applicant to:

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

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary. The USACE or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The USACE or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:
    a. The USACE shall require the applicant to develop and implement plans to collect and report details about the take of listed fish. That plan shall:
        i. Require the applicant and/or their contractor to maintain and submit records to verify that all take indicators are monitored and reported. Minimally, the records should include:
            1. Documentation of the timing and duration of in- and over-water work to ensure that no more than about 1 month of vibratory pile driving is performed between October 1 and April 15;
            2. Documentation of the dates, method of pile installation, and pile type and size;
            3. Documentation of the dates and method of pile extraction;

4. Documentation of the lateral extent of the turbidity plumes, and measures taken to maintain them within 300 feet; and
5. Documentation of the location, size, and configuration of the repaired and/or replaced overwater structures to confirm that they do not exceed the locations and characteristics described in this opinion.

ii. Require the applicant to establish procedures for the submission of the construction records and other materials to the appropriate USACE office, and to submit an electronic post-construction report to the NMFS within six months of project completion. Send the report to: projectreports.wcr@noaa.gov. Be sure to include Attn: WCRO-2020-02417 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 USACE 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 the pier, with the intent to minimize propeller wash effects and mobilization of sediments at the sites.
2. The USACE should encourage the applicant to limit all in- *and overwater work* to the period between October 1 to April 15 to reduce the likelihood exposing juvenile Chinook salmon to the direct effects of construction;
3. The USACE should encourage the applicant to develop a plan to reduce the environmental impacts at their pier. Suggested measures include:
    a. Continue or establish a system to prevent and routinely remove litter, wastes, and floating pollutants from the waters within the pier;
    b. Continue or resume efforts at the pier to reduce the input of vessel-related pollutants;
    c. Continue or establish a system to require patrons to operate power boats at low speeds in the pier and in adjacent shallow shoreline areas; and
    d. Continue or establish a system to instruct patrons about the importance of the nearshore habitats at the sites to migrating juvenile salmon.
    e. The USACE should require the applicant to minimize artificial light use at the pier by installing automatic timers, aiming lights away from the water surface, using the minimum intensity necessary to allow for safe use of the pier at the night.

2.11 "Not Likely to Adversely Affect" Determinations

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

As described in Section 1.2 and below, the NMFS has concluded that the proposed action would be not likely to adversely affect southern resident (SR) killer whales and their designated critical habitat. Detailed information about the biology, habitat, and conservation status and trends of SR killer whales can be found in the listing regulations and critical habitat designations published in the Federal Register, as well as in the recovery plans and other sources at: https://www.fisheries.noaa.gov/species-directory/threatened-endangered, and are incorporated here by reference.

The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. The effects analysis in this section relies heavily on the descriptions of the proposed action and project site conditions discussed in Sections 1.3 and 2.4, and on the effects analyses presented in Section 2.5.

2.11.1 Effects on Listed Species

The proposed action will not have any direct effects on southern resident killer whales (SRKWs) or their critical habitat because all construction and associated short-term, direct impacts will take place in freshwater areas outside of SRKW designated critical habitat (which is limited to marine waters).

The project may, however, indirectly affect SRKW through the trophic web by affecting the quantity of prey available to SRKW. We therefore analyze that potential here but conclude that the effects to SRKW will be insignificant for at least two reasons. First, any effects to PS Chinook as described in Section 2.1, including short-term, adverse effects from construction on salmon and their habitat, as well as any long-term adverse impacts, will only affect the population of PS Chinook that migrate through the Lake Washington ship canal. The size of the two Lake Washington subpopulations populations are relatively small (2019 Cedar River and North Fork Lake Washington adult returns were 855 and 365, respectively, WDFW 2020c) and thus commensurately make up only a small portion of the SRKW diet. Second, these effects are only expected to impact juvenile PS Chinook during the brief, migratory portion of their freshwater lifestage.[1] As a result, relatively small numbers of individual juvenile fish in those two subpopulations would only be exposed to these effects, if at all, for brief spatial and/or temporal period(s). As described in Section 2.5, these temporally brief adverse effects will bear on far too few individual juvenile salmon to influence the VSP parameters or cause detectable effects to the Lake Washington returning adult population[2]. As a result, any project-related reduction in Chinook salmon availability for SR killer whales would be undetectable and thus insignificant. Therefore, the action is not likely to adversely affect SR killer whales.

[1] By comparison, in the Puget Sound nearshore juvenile PS Chinook are exposed to various effects during other life stages, such as rearing.

[2] Exact smolt to adult ratios are not known. Each individual juvenile fish already has a very high probability of not surviving to adulthood (Bradford 1995) under natural conditions. Salmonids produce very high numbers of offspring with very few surviving to adulthood and returning to spawn, but we also note that note that human-caused habitat degradation and other factors such as hatcheries and harvest exacerbate what would otherwise be natural causes of low survival such as natural variability in stream and ocean conditions, predator-prey interactions, and natural climate variability (Adams 1980, Quinones et al., 2014).

2.11.2 Effects on Critical Habitat

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

SR killer whale Critical Habitat: Designated critical habitat for SR killer whales includes marine waters of the Puget Sound that are at least 20 feet deep. The expected effects on SR killer whale critical habitat from completion of the proposed action, including full application of the conservation measures and BMP, would be limited to the impacts on the PBFs as described below.

1. Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth
   The proposed action would cause long-term undetectable effects on prey availability and quality. Action-related impacts would annually injure extremely low numbers of individual juvenile Chinook salmon during their brief freshwater migration through the Lake Washington ship canal. Consequently, the numbers of juvenile fish harmed would be too small to cause detectable effects on adult prey availability. Therefore, it would cause no detectable reduction in prey availability and quality. Any effects on the prey species PBF would be insignificant.

Therefore, the proposed action is not likely to adversely affect SR killer whale critical habitat.

2.12 Reinitiation of Consultation

This concludes consultation for the USACE's authorization of the Ballard Marine Pier project, King County, Washington.

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

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

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

This analysis is based, in part, on the EFH assessment provided by the USACE and descriptions of EFH contained in the fishery management plan for Pacific Coast salmon developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce (PFMC 2014).

3.1 Essential Fish Habitat Affected By the Project

The project is located on the north shore of the Lake Washington Ship Canal (Figure 1). The waters and substrate of the Ship Canal are designated as freshwater EFH for various life-history stages of Pacific Coast Salmon, which within the Lake Washington watershed include Chinook and coho salmon. Freshwater EFH for Pacific salmon is identified and described in Appendix A to the Pacific Coast salmon fishery management plan, and consists of four major components: (1) spawning and incubation; (2) juvenile rearing; (3) juvenile migration corridors; and (4) adult migration corridors and holding habitat.

Those components of freshwater EFH for Pacific Coast Salmon depend on habitat conditions for spawning, rearing, and migration that include: (1) water quality (e.g., dissolved oxygen, nutrients, temperature, etc.); (2) water quantity, depth, and velocity; (3) riparian-stream-marine energy exchanges; (4) channel gradient and stability; (5) prey availability; (6) cover and habitat complexity (e.g., large woody debris, pools, aquatic and terrestrial vegetation, etc.); (7) space; (8) habitat connectivity from headwaters to the ocean (e.g., dispersal corridors); (9) groundwater-stream interactions; and (10) substrate composition.

As part of Pacific Coast Salmon EFH, five Habitat Areas of Particular Concern (HAPCs) have been defined: 1) complex channels and floodplain habitats; 2) thermal refugia; 3) spawning habitat; 4) estuaries; and 5) marine and estuarine submerged aquatic vegetation. The action area provides no known HAPC habitat features.

3.2 Adverse Effects on Essential Fish Habitat

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

1. Water quality: – The proposed action would cause minor short- and long-term adverse and beneficial effects on this attribute. Demolition and construction would cause short-term adverse effects on water quality and would persist no more than a low number of hours after work stops. ACZA-treated timber and continued vessel operations at the pier would maintain persistent low level inputs of contaminants at the pier. Conversely, the permanent removal of creosote-treated timber piles would reduce ongoing PAH contamination at the sites. Detectable water quality impacts are expected to be limited to the areas within 300 feet around the project site. The action would cause no measurable changes in water temperature or salinity.

2. Water quantity, depth, and velocity: – No changes expected.

3. Riparian-stream-marine energy exchanges: – No changes expected.

4. Channel gradient and stability: – No changes expected.

5. Prey availability: – The proposed action would cause long-term minor adverse effects on this attribute. The replacement of the overwater structure and vertical walled bulkhead would reduce the density and diversity of the benthic and planktonic communities at the pier such as amphipods, copepods, and larvae of benthic species that are important prey resources for juvenile salmonids. Additionally, any contaminants that are mobilized during pile removal, combined with continued low-level input of contaminants from pier structures and related vessel operations would contaminate some of the available prey resources. Detectable effects would be limited to the area within about 300 feet around the pier.

6. Cover and habitat complexity: – The proposed action would cause long-term minor adverse effects on this attribute. The replacement of the overwater structures and vertical bulkhead maintains the degraded nature of the site, albeit to a lesser extent because the size of the pier is being reduced as well as the number of piles and solid overwater cover.

7. Water quantity: – No changes expected.

8. Space: – No changes expected.

9. Habitat connectivity from headwaters to the ocean: – No changes expected.

10. Groundwater-stream interactions: – No changes expected.

11. Connectivity with terrestrial ecosystems: – No changes expected.

12. Substrate composition: – No changes expected.

3.3 Essential Fish Habitat Conservation Recommendations

The proposed action includes design features, conservation measures, and BMPs that are expected to reduce and help offset action-related impacts on the quantity and quality of Pacific Coast salmon EFH. However, full implementation of the following EFH conservation recommendations would protect about 1/4 acre of designated EFH for Pacific Coast salmon by avoiding or minimizing the adverse effects described in Section 3.2, above.

To reduce adverse impacts on water quality and prey availability, the USACE should:

1. Require the applicant to limit all in- *and overwater work* to the period between October 1 to April 15 to reduce the likelihood exposing juvenile Chinook salmon to the direct effects of construction;
2. Encourage the applicant to require contracted tugboat operator(s) and client vessel operators to use the lowest safe maneuvering speeds and power settings when maneuvering near the pier, with the intent to minimize propeller wash effects and mobilization of sediments at the sites; and
3. Encourage the applicant to continue or develop a plan to reduce the environmental impacts at their pier. Suggested measures include:
    a. Continue or establish a system to prevent and routinely remove litter, wastes, and floating pollutants from the waters within the pier;
    b. Continue or resume efforts at the pier to reduce the input of vessel-related pollutants;
    c. Continue or establish a system to require patrons to operate power boats at low speeds in the pier and in adjacent shallow shoreline areas; and
    d. Continue or establish a system to instruct patrons about the importance of the nearshore habitats at the sites to migrating juvenile salmon.

The NMFS knows of no practical measures that are available to further reduce the action’s expected effects on cover and habitat complexity.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the USACE must provide a detailed response in writing to NMFS within 30 days after receiving 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 USACE must reinitiate EFH consultation with the NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this opinion is the USACE. Other interested users could include the applicant, 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 USACE. The document will be available within two weeks at the NOAA Library Institutional Repository (https://repository.library.noaa.gov/welcome). The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and 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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