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

Refer to NMFS No.:
WCRO-2019-00112

October 1, 2021

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

Re: Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Seattle Iron and Metal South Dock Rehabilitation, King County, Washington, COE Number: NWS-2017-1059, HUC: 171100130305 – Lower Duwamish Waterway.

Dear Ms. Printz:

Thank you for your letter of August 7, 2019, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for U.S Army Corps of Engineers (COE) authorization of the Seattle Iron and Metal south dock rehabilitation project. Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action.

The enclosed document contains the biological opinion (Opinion) prepared by NMFS pursuant to section 7(a)(2) of the ESA on the effects of the proposed action. In this Opinion, NMFS concludes that the proposed action is likely to adversely affect but not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon, PS steelhead, Bocaccio rockfish, or SRKW. NMFS also concludes that the proposed action is likely to adversely affect, but is not likely to result in the destruction or adverse modification of designated critical habitat for PS Chinook, nor SRKW. As required by section 7 of the ESA, NMFS has provided an incidental take statement with this Opinion. The incidental take statement describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action, and sets forth terms and conditions that the COE must comply with to meet those measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of listed species.

The document also includes our rationale for determining that two Distinct Population Segments of humpback whales are not likely to be adversely affected.

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

Please contact Bonnie Shorin of the Oregon/Washington Coastal Office by electronic mail at Bonnie.Shorin@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: Danette Guy, COE

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

Seattle Iron and Metal South Dock Rehabilitation
King County, Washington (COE Number: NWS-2019-1059)

NMFS Consultation Number: WCRO-2019-00112

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
Bocaccio rockfish *(Sebastes paucispinis)*	Endangered	Yes	No	Yes	No
Southern Resident Killer Whale (*Orcinus orca)*	Threatened	Yes	No	Yes	No
Humpback Whale *(Megaptera novaeangliae)* Central America and Mexico DPSs	Threatened (Mexico); Endangered (Central Am)	No	No	No	No

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

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
Highly migratory species	No	No
Pacific Coast groundfish	Yes	Yes

West Coast Region

Issued By:

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

Date: October 1, 2021

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LIST OF ACRONYMS

ACZA – Ammoniacal Copper Zinc Arsenate
BMP – Best Management Practices
CFR – Code of Federal Regulations
COE – Corps of Engineers, US Army
DIP – Demographically Independent Population
DO – Dissolved Oxygen
DPS – Distinct Population Segment
DQA – Data Quality Act
EF – Essential Feature
EFH – Essential Fish Habitat
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FR – Federal Register
HPA – Hydraulic Project Approval
HUC – Hydrologic Unit Code
Hz – Hertz (or cycles per second)
ITS – Incidental Take Statement
JARPA – Joint Aquatic Resource Permit Application Form
mg/l – Milligram per Liter
mg/kg – Milligram per Kilogram
MHHW – Mean Higher High Water
MPG – Major Population Group
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NMFS – National Marine Fisheries Service
NPDES – National Pollutant Discharge Elimination System
OWCO – Oregon Washington Coastal Office
PAH – Polycyclic Aromatic Hydrocarbons
PBF – Primary Biological Feature
PCB – Polychlorinated Biphenyl
PCE – Primary Constituent Element
PFMC – Pacific Fishery Management Council
PS – Puget Sound
PSSTRT – Puget Sound Steelhead Technical Recovery Team
PSTRT – Puget Sound Technical Recovery Team
PTS – Permanent Threshold Shift
RL – Received Level
RPM – Reasonable and Prudent Measure
SAV – Submerged Aquatic Vegetation
SL – Source Level
TTS – Temporary Threshold Shift
VSP – Viable Salmonid Population
WCR – Westcoast Region (NMFS)
WDFW – Washington State Department of Fish and Wildlife
WDOE – Washington State Department of Ecology

1. INTRODUCTION

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

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), 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 Lacey, Washington, Office.

1.2 Consultation History

On March 25th, 2019, NMFS received a letter from the US Army Corps of Engineers (COE) requesting informal consultation for the proposed action (COE 2017a). The request included the COE's Memorandum for the Services (MFS) for the proposed action (COE 2017b) and project drawings.

On May 17th, 2019, NMFS informed the COE that formal consultation was required for the proposed action, and requested additional information.

On August 2nd, 2019, the Corps provided a partial list of the requested information and requested formal consultation.

On October 4th, 2019, the COE provided further requested additional information. The applicant and the Corps continued to provide individual components of the requested information from then till February 21st, 2020.

On April 21st, 2020, formal consultation was initiated.

In October 2020, staffing transitions occurred at NMFS, leaving the consultation unstaffed.

In December 2020, a new consulting biologist was assigned to the consultation.

In March, 2021, staffing transitions occurred at the Corps of Engineers, and a new project manager was assigned. At NMFS, files were recovered and the consultation was resumed.

This Opinion is based on the review of the information and project drawings identified above; recovery plans, status reviews, and critical habitat designations for ESA-listed PS Chinook salmon and PS steelhead, bocaccio rockfish, humpback whales and SRKW; published and unpublished scientific information on the biology and ecology of those species; and relevant scientific and gray literature (see Literature Cited). A complete record of this consultation is on file at the Oregon Washington Coastal Office (OWCO) in Lacey, Washington.

1.3 Proposed Action

"Action" under the ESA 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). (50 CFR 402.02). Under 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 COE proposes to issue permits under Section 10 of the Rivers and Harbors Act, and Section 404 of the Clean Water Act, authorizing Seattle Iron and Metal (Seattle Iron) to repair and replace a degraded commercial pier, loading/unloading facility, and storage facility. Seattle Iron proposes to rehabilitate an aging and structurally deficient timber dock within the Lower Duwamish Waterway (LDW). The dock supports vessel shipping and receiving for an approximate 12-acre metals processing facility. Repairs and modifications to the dock and its facilities are in part intended to rectify a history of water quality violations at this site, including repeat exceedances of water quality criteria for:

- Solids (Residue) (Total suspended (TSS))
- Copper (Total)
- Ammonia (Total)
- pH (Hydrogen Ion)
- Petroleum Hydrocarbons (Total)
- Zinc (Total)
- Lead (Total)
- Mercury
- PCBs (polychlorinated biphenyls) (Total)

This project involves:

- Removal of 33 load-bearing piles (timber) between bents 1 and 21 of the existing dock and installation of a minimum of 28 load-bearing piles; up to 5 additional load bearing steel piles may be installed based upon filed determination during construction.
- Removal of 46 fender piles (timber) between bents 1 and 34 of the existing dock and installation of 30 steel fender piles.
- Installation of two piles to restore barge moorage previously provided by in-water dolphins. Piles would primarily be 16- to 18- inch diameter steel pipe piles, with the exception of the mooring piles, which would be 36-inch diameter piles.

- Replacement of the existing timber deck between bents 1 and 21 after the piles are replaced, and patching the existing timber deck (as needed) between bents 21 and 34.
- Addition of capture and filter to provide pre-treatment of stormwater from roof runoff and main dock yard stormwater. The area of impervious surface to be treated is the main yard drainage area (approximately 7.9 acres) and a paved area, east of the main yard (1.22 acres) which also goes to the treatment system. The drainage area is approximately 9.12 (including roofs, main yard, and docks).

Minimization Measures

- In water work will occur within the approved work window (October 1 to February 15).
- Over-water work may occur outside of the in-water work window, following approval from the regulatory agencies and implementation of BMPs to avoid dropping materials from the over-water construction area. For example, tarps will be installed beneath the south dock to prevent debris from overwater work from falling into the LDW.
- Construction staging will be established in a way that avoids contaminants or other construction materials from entering the LDW.
- A sorbent boom will be deployed around in-water activities.
- Barges and other vessels will be operated in a way that minimizes propeller-wash and prevents grounding.
- The soil from upland excavations that is not reused as backfill will be sent to a Subtitle-D permitted upland disposal facility. Temporary stockpiling of excavated materials will occur in bermed or otherwise contained areas only.
- Water generated during concrete saw cutting will be contained, treated as process water and to NPDES permit compliance limits prior to discharge.
- The BMPs for piling removal and placement in Washington State, issued by USEPA Region 10 (EPA 2016), will be implemented with particular attention to BMPs for projects located within areas of contaminated sediments.
- A vibratory hammer will be used to the extent feasible to minimize potential impacts to fish from underwater noise.
- A sound attenuating BMP (such as a bubble curtain or pile caps) will be implemented during pile driving to minimize potential impacts to fish from underwater noise.
- A sorbent boom will be deployed around the work area during removal of the creosote treated piles to capture wood debris, oil and other materials.
- The existing timber piles removed as part of the Project will be disposed of upland and will not enter the LDW after extraction. Piles will be cut 2- to 3-feet below mudline if they cannot be fully removed.
- If warranted, an impervious material will be placed over concrete or asphalt after pouring to avoid direct contact with stormwater as the pavement cures.

Remediation Measures

The proposed action is in part required by an enforcement action taken by Washington State Department of Ecology against the Seattle Iron to remedy violation of state water quality laws. Water quality impairment during Seattle Iron's operations at this facility is a detriment to features of critical habitat and the species that rely on that habitat, as well as to EFH. The following remediation activities are included as part of the proposed action:

1. Seattle Iron will conduct an underwater survey of the entire area underneath and around their docks to identify debris.
2. All debris larger than 6 inches in any dimension and protruding from the sediment will be removed by diver or dredge.
3. The debris removal area will extend 100 feet waterward of the north and south docks.
4. All survey, debris removal, and dredge activities will be documented and Seattle Iron will provide a report to each agency with authority within 1 year of completion of the activities.

1.4 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). Effects or consequences, therefore, are the physical, chemical, and biological changes that occur from the construction, presence, and operation of the proposed action, temporary and long term. The action area is identified by the furthest extent of these changes in the environment.

The project is located at River Mile 3 on the Lower Duwamish Waterway. At this location, the LDW is periodically part of the salt wedge estuary, which typically extends to river mile 2.2 but depending on tidal conditions can reach as high as river mile 8.7. We have identified the action area for this consultation to extend from the site of the facility downstream to Elliot Bay, and into Puget Sound. We base this extent of the action area on three factors: (1) vessel traffic associated with the operation of the facility, which transits to and from the dock via Elliot Bay transit through Puget Sound; (2) the fate and transport concepts for water quality pollutants and contaminated sediments, as it is likely that some of the inorganic compounds and heavy metals discharged from site will likely still be present in the water column as they are dispersed through Lower Duwamish Waterway and further out to Elliot Bay; and (3) the biotic effects on salmonids as a prey component of SRKW. Upon reaching the connection point to the greater Puget Sound there the further transmission of the contaminants, the traffic pattern of vessels and the density of and migration patterns of salmonids becomes diffuse; the Action Area is Puget Sound.

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 (pink, coho, and Chinook salmon) and Groundfish (e.g., English Sole, Starry Flounder, Rock Sole, and rockfish).

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

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

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

Species	Status	Listing	Listing Date	Critical Habitat Designation	Designation Date
Puget Sound Chinook	Threatened	64 FR 14308	3/24/1999	50 FR 52630	9/2/2005
Puget Sound Steelhead	Threatened	72 FR 26722	6/11/2007	81 FR 9252	2/24/2016
Bocaccio Rockfish	Endangered	75 FR 22276	4/28/2010	79 FR 68042	11/13/2014
Southern Resident Killer Whales	Endangered	70 FR 69903 (updated with 79 FR 20802)	11/18/2005	71 FR 69054	11/19/2006

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

2.1 Analytical Approach

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

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214).

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

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

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

2.2 Range-wide Status of the Species and Critical Habitat

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

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

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

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014, Mote 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013, Mote et al. 2014).

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014; Kunkel et al. 2013). Recent temperatures in all but two years since 1998 ranked above the 20th century average (Mote et al. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014).

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

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

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

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

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7ºC by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011, Reeder et al. 2013).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. A 38 percent to 109 percent increase in acidity is projected by the end of this century in all but the most stringent CO_2 mitigation scenarios and is essentially irreversible over a time scale of centuries (IPCC 2014). Regional factors appear to be amplifying acidification in Northwest ocean waters, which is occurring earlier and more acutely than in other regions and is already impacting important local marine species (Barton et al. 2012, Feely et al. 2012). Acidification also affects sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012, Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011, Reeder et al. 2013). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel *et al.* 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor Coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Tillmann and Siemann 2011, Reeder et al. 2013).

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

2.2.1 Status of the Species

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

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

"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation in single genes to complex life history traits (McElhany et al. 2000).

"Abundance" generally refers to the number of naturally-produced adults (i.e., the progeny of naturally-spawning parents) in the natural environment (e.g., on spawning grounds).

"Productivity," as applied to viability factors, refers to the entire life cycle (i.e., the number of naturally-spawning adults produced per parent). When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany et al. (2000) use the terms "population growth rate" and "productivity" interchangeably when referring to production over the entire life cycle. They also refer to "trend in abundance," which is the manifestation of the long-term population growth rate.

For species with multiple populations, once the biological status of a species' populations has been determined, we assess the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany, 2000). Additional information is available at NMFS's West Coast Region website; http://www.westcoast.fisheries.noaa.gov/).

Puget Sound Chinook salmon.

The Puget Sound Chinook salmon evolutionarily significant unit (ESU) was listed as threatened on June 28, 2005 (70 FR 37160). The status was reviewed by the Northwest Fisheries Science Center in 2010 (Ford et al. 2010) and in 2015 (NWFSC 2015) and remained unchanged after both reviews. A subsequent status review completed in 2017 (NMFS 2017) confirmed that the status should remain as threatened.

We adopted the recovery plan for this ESU in January 2007. The recovery plan consists of two documents: the Puget Sound salmon recovery plan (Shared Strategy for Puget Sound 2007) and a supplement by NMFS (2006). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus *et al.* 2002). The PSTRT's biological recovery criteria will be met when all of the following conditions are achieved:

- The viability status of all populations in the ESU is improved from current conditions, and when considered in the aggregate, persistence of the ESU is assured;
- Two to four Chinook salmon populations in each of the five biogeographical regions of the ESU (Table 6) achieve viability, depending on the historical biological characteristics and acceptable risk levels for populations within each region;
- At least one population from each major genetic and life history group historically present within each of the five biogeographical regions is viable;
- Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-wide recovery scenario; Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with ESU recovery; and
- Populations that do not meet the viability criteria for all VSP parameters are sustained to provide ecological functions and preserve options for ESU recovery.

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

Between 1990 and 2014, the proportion of natural-origin spawners has trended downward across the ESU, with the Whidbey Basin the only MPG with consistently high fractions of natural-origin spawner abundance. All other MPG have either variable or declining spawning populations with high proportions of hatchery-origin spawners (NWFSC 2015). Overall, the new information on abundance, productivity, spatial structure and diversity since the 2010 status review supports no change in the biological risk category (NWFSC 2015).

Table 2. Extant PS Chinook salmon populations in each biogeographic region (PSTRT 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 Rivers
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

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

Washington Dept. of Fish and Wildlife maintain annual abundance observances indexing for individual runs of Puget Sound Chinook salmon stock inventory (SaSI). These counts and estimates are made on the bases of fish in system at post-harvest levels. The most recent estimates for abundance 2015-2017 put natural spawner abundance at 26,904 returners and hatchery produced spawners at 26,617 individuals (SaSI 2017).

Limiting Factors. Limiting factors for this species include:

- Degraded floodplain and in-river channel structure
- Degraded estuarine conditions and loss of estuarine habitat
- Riparian area degradation and loss of in-river large woody debris
- Excessive fine-grained sediment in spawning gravel
- Degraded water quality and temperature
- Degraded nearshore conditions
- Impaired passage for migrating fish
- Altered flow regime

Even though different life history forms have to date been studied most extensively in Skagit River Chinook salmon, Beamer et al. (2005) assume that they naturally occur in other populations, too. Further, Beamer et al. (2005) assume that the distribution within a population will depend upon environmental conditions. For example, the large number of fry migrants in the Skagit can be interpreted as a response to limited delta habitat. In the action area, salmonid fork lengths generally increased for each species' cohort, as a consequence of seasonal growth after outmigration from local watersheds, from January through September. In 2016, outmigrating chinook fork length averaged between 80 and 250 millimeters (Figure 1). Chum average fork length averaged between 35 and 125 millimeters (Frierson et al. 2017).

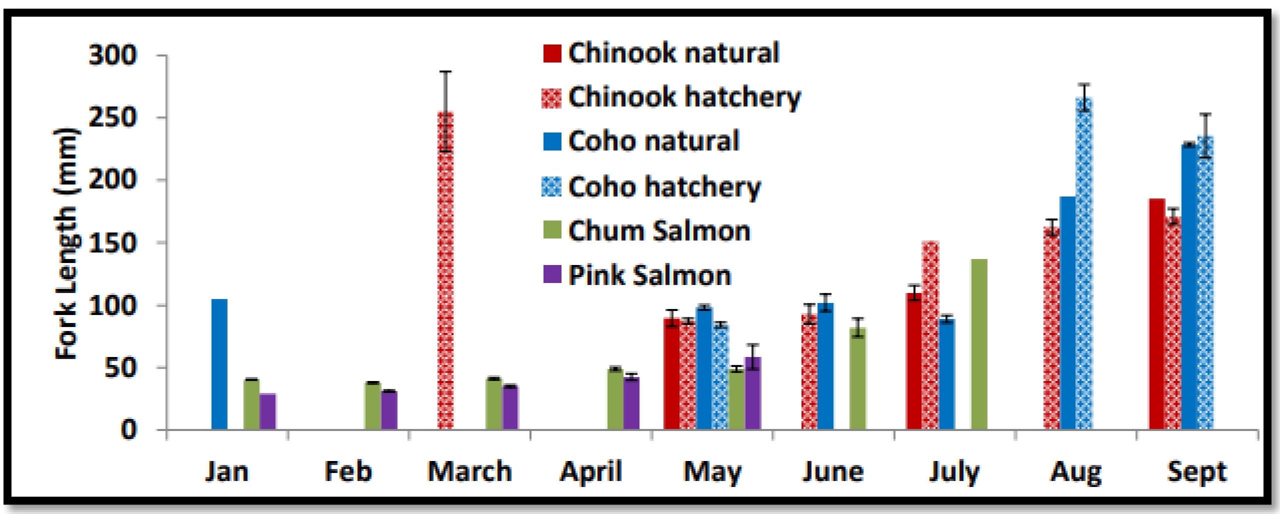


Figure 1. Image of Table Showing Mean for Length for Juvenile Salmonid Species in the Action Area, 2016

Puget Sound Steelhead.

Puget Sound Steelhead was listed as threatened in 2007 (72 FR 26722; 5/11/07). The status was reviewed by the Northwest Fisheries Science Center in 2010 (Ford et al. 2010), updated in 2014 (79 FR 20802) reviewed in 2015 (NWFSC 2015) and remained unchanged after in each instance. A subsequent status review completed in 2017 (NMFS 2017) confirmed that the status should remain as threatened.

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

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

<u>Spatial Structure and Diversity</u>**.** The PS steelhead DPS is the anadromous form of *O. mykiss* that occur in rivers, below natural barriers to migration, in northwestern Washington State that drain to Puget Sound, Hood Canal, and the Strait of Juan de Fuca between the U.S./Canada border and the Elwha River, inclusive. The DPS also includes six hatchery stocks that are considered no more than moderately diverged from their associated natural-origin counterparts: Green River natural winter-run; Hamma Hamma winter-run; White River winter-run; Dewatto River winter-run; Duckabush River winter-run; and Elwha River native winter-run. Steelhead are the anadromous form of *Oncorhynchus mykiss* that occur in rivers, below natural barriers to migration, in northwestern Washington State (Ford 2011). Non-anadromous ''resident'' *O. mykiss* occur within the range of PS steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (Hard *et al.* 2007).

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

<u>Abundance and Productivity</u>. Abundance of adult steelhead returning to nearly all Puget Sound rivers has fallen substantially since estimates began for many populations in the late 1970s and

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

There are some signs of modest improvement in steelhead productivity since the 2011 review, at least for some populations, especially in the Hood Canal & Strait of Juan de Fuca MPG. However, these modest changes must be sustained for a longer period (at least two generations) to lend sufficient confidence to any conclusion that productivity is improving over larger scales across the DPS. Moreover, several populations are still showing dismal productivity, especially those in the Central & South Puget Sound MPG (NWFSC 2015).

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

<u>Limiting factors.</u> In our 2013 proposed rule designating critical habitat for this species (USDC 2013b), we noted that the following factors for decline for PS steelhead persist as limiting factors:

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

Bocaccio Rockfish

There are no estimates of historic or present-day abundance of PS/GB bocaccio across the full DPSs area. In 2013, the Washington State Department of Fish and Wildlife (WDFW) published abundance estimates from a remotely operated vehicle survey conducted in 2008 in the San Juan Island area (Pacunski et al. 2013). This survey was conducted exclusively within rocky habitats and represents the best available abundance estimates to date for one basin of the DPS. The survey produced estimates of 47,407 (25 percent variance) yelloweye rockfish, and 4,606 (100 percent variance) PS/GB bocaccio in the San Juan area (Tonnes et al., 2016).

Further, data suggest that total rockfish declined at a rate of 3.1 to 3.8 percent per year from 1977 to 2014 or a 69 to 76 percent total decline over that period. The three listed species declined over-proportional compared to the total rockfish assemblage. Therefore, long-term population growth rate for the listed species was likely even lower (more negative) than that for total rockfish. Finally, there is little to no evidence of recent recovery of total rockfish abundance to recent protective measures.

The PS/GB bocaccio distinct population segment (DPS) was listed as endangered on April 28, 2010 (75 FR 22276). In April 2016, we completed a 5-year status review that recommended the DPS retain its endangered classification (Tonnes *et al*. 2016), and we released a recovery plan in October 2017 (NMFS 2017b). Extinction risk factors identified in the plan include loss of nearshore habitat. Larval rockfish rely on nearshore habitat. A study of rockfish in Puget Sound found that larval rockfish appeared to occur in two peaks (early spring, late summer) that coincide with the main primary production peaks in Puget Sound. Both measures indicated that rockfish ichthyoplankton essentially disappeared from the surface waters by the beginning of November. Densities also tended to be lower in the more northerly basins (Whidbey and Rosario), compared to Central and South Sound (Greene and Godersky 2012).

The nearshore is generally defined as habitats contiguous with the shoreline from extreme high water out to a depth no greater than 98 feet (30 m) relative to mean lower low water. This area generally coincides with the maximum depth of the photic zone and can contain physical or biological features essential to the conservation of many fish and invertebrate species, including PS/GB bocaccio. Approximately 27 percent of Puget Sound's shoreline has been modified by armoring (Simenstad et al. 2011). Nearshore habitats throughout the greater Puget Sound region have been affected by a variety of human activities, including agriculture, heavy industry, timber harvest, and the development of sea ports and residential property (Drake et al. 2010).

Though PS/GB bocaccio were never a predominant segment of the multi-species rockfish population within the Puget Sound/Georgia Basin, their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Most PS/GB bocaccio within the DPS may have been historically spatially limited to several basins within the DPS. They were apparently historically most abundant in the Central and South Sound with no documented occurrences in the San Juan Basin until 2008. The apparent reduction of populations of PS/GB bocaccio in the

Main Basin[1] and South Sound represents a further reduction in the historically spatially limited distribution of PS/GB bocaccio, and adds significant risk to the viability of the DPS.

The VSP criteria described by McElhaney et al. (2000), and summarized at the beginning of Section 2.2, identified spatial structure, diversity, abundance, and productivity as criteria to assess the viability of salmonid species because these criteria encompass a species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. These viability criteria reflect concepts that are well founded in conservation biology and are generally applicable to a wide variety of species because they describe demographic factors that individually and collectively provide strong indicators of extinction risk for a given species (Drake et al. 2010), and are therefore applied here for PS/GB bocaccio.

General Life History: The life history of PS/GB bocaccio includes a larval/pelagic juvenile stage that is followed by a juvenile stage, and subadult and adult stages. As with other rockfish, PS/GB bocaccio fertilize their eggs internally and the young are extruded as larvae that are about 4 to 5 mm in length. Females produce from several thousand to over a million offspring per spawning (Love et al. 2002). The timing of larval parturition in PS/GB bocaccio is uncertain, but likely occurs within a five- to six-month window that is centered near March (Greene and Godersky 2012; NMFS 2017b; Palsson et al. 2009). Larvae are distributed by prevailing currents until they are large enough to actively swim toward preferred habitats, but they can pursue food within short distances immediately after birth (Tagal et al. 2002). Larvae are distributed throughout the water column (Weis 2004), but are also observed under free-floating algae, seagrass, and detached kelp (Love et al. 2002; Shaffer et al. 1995). Unique oceanographic conditions within Puget Sound likely result in most larvae staying within the basin where they are released rather than being broadly dispersed (Drake et al. 2010).

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

Spatial Structure and Diversity: The PS/GB PS/GB bocaccio DPS includes all PS/GB bocaccio from inland marine waters east of the central Strait of Juan de Fuca and south of the northern Strait of Georgia. The waters of Puget Sound and Straits of Georgia can be divided into five

[1] The U.S. portion of the Puget Sound/Georgia Basin that is occupied by yelloweye rockfish and PS/GB bocaccio can be divided into five areas, or Basins, based on the distribution of each species, geographic conditions, and habitat features. These five interconnected Basins are: (1) The San Juan/Strait of Juan de Fuca Basin, (2) Main Basin, (3) Whidbey Basin, (4) South Puget Sound, and (5) Hood Canal. 79 FR 68041: 11/13/2014.

interconnected basins that are largely hydrologically isolated from each other by relatively shallow sills (Burns 1985; Drake et al. 2010). The basins within US waters are: (1) San Juan, (2) Main, (4) South Sound, and (4) Hood Canal. The fifth basin consists of Canadian waters east and north of the San Juan Basin into the Straights of Georgia (Tonnes et al. 2016). Although most individuals of the PS/GB PS/GB bocaccio DPS are believed to remain within the basin of their origin, including larvae and pelagic juveniles, some movement between basins occurs, and the DPS is currently considered a single population.

Abundance and Productivity: The PS/GB PS/GB bocaccio DPS exists at very low abundance and observations are relatively rare. No reliable range-wide historical or contemporary population estimates are available for the PS/GB bocaccio DPS. It is believed that prior to contemporary fishery removals, each of the major PS/GB basins likely hosted relatively large, though unevenly distributed, populations of PS/GB bocaccio. They were likely most common within the South Sound and Main Basin, but were never a predominant segment of the total rockfish abundance within the region (Drake et al. 2010). The best available information indicates that between 1965 and 2007, total rockfish populations have declined by about 70 percent in the Puget Sound region, and that PS/GB bocaccio have declined by an even greater extent (Drake et al. 2010; Tonnes et al. 2016; NMFS 2017b).

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

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

Southern Resident Killer Whales.

The Southern Resident killer whale Distinct Population Segment (DPS), composed of J, K and L pods, was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). A 5-year review under the ESA completed in 2016 concluded that Southern Residents should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2016).

The limiting factors described in the final recovery plan included reduced prey availability and quality, high levels of contaminants from pollution, and disturbances from vessels and sound (NMFS 2008). This section summarizes the status of Southern Resident killer whales throughout their range. This section summarizes information taken largely from the recovery plan (NMFS 2008), recent 5-year review (NMFS 2016), as well as new data that became available more recently.

Abundance, Productivity, and Trends

Southern Resident killer whales are a long-lived species, with late onset of sexual maturity (review in NMFS 2008). Females produce a low number of surviving calves over the course of their reproductive life span (Bain 1990, Olesiuk et al. 1990). Compared to Northern Resident killer whales (a resident killer whale population with a sympatric geographic distribution ranging from coastal waters of Washington State and British Columbia north to Southeast Alaska) Southern Resident females appear to have reduced fecundity (Ward et al. 2013, Vélez-Espino et al. 2014); the average inter-birth interval for reproductive Southern Resident females is 6.1 years, which is longer than the 4.88 years estimated for Northern Resident killer whales (Olesiuk et al. 2005). Recent evidence has indicated pregnancy hormones (progesterone and testosterone) can be detected in Southern Resident killer whale feces and have indicated several miscarriages, particularly in late pregnancy (Wasser et al. 2017). The authors suggest this reduced fecundity is largely due to nutritional limitation. Mothers and offspring maintain highly stable social bonds throughout their lives, which is the basis for the matrilineal social structure in the Southern Resident population (Baird 2000, Bigg et al. 1990, Ford 2000). Groups of related matrilines form pods. Three pods – J, K, and L – make up the Southern Resident community. Clans are composed of pods with similar vocal dialects and all three pods of the Southern Residents are part of J clan.

At present, the Southern Resident population has declined to historically low levels. Since censuses began in 1974, J and K pods have steadily increased their sizes. However, the population suffered an almost 20 percent decline from 1996-2001 (from 97 whales in 1996 to 81 whales in 2001), largely driven by lower survival rates in L pod. The overall population had increased slightly from 2002 to 2010 (from 83 whales to 86 whales). During the international science panel review of the effects of salmon fisheries (Hilborn et al. 2012), the Panel stated that during 1974 to 2011, the population experienced a realized growth rate of 0.71 percent, from 67 individuals to 87 individuals. Since then, the population has decreased to only 74 whales, a historical low in the last 30 years with a current realized growth rate (from 1974 to 2017) at half of the previous estimate described in the Panel report, 0.29 percent.

There is representation in all three pods, with 24 whales in J pod, 17 whales in K pod and 33 whales in L pod. There are currently 4 reproductively mature males in J pod, 8 in K pod, and 10 mature males in L pod between the ages of 10 and 42 years. Although the age and sex distribution is generally similar to that of Northern Residents that are a stable and increasing population (Olesiuk et al. 2005), there are several demographic factors of the Southern Resident population that are cause for concern, namely reduced fecundity, sub-adult survivorship in L pod, and the total number of individuals in the population (review in NMFS 2008). Based on an updated pedigree from new genetic data, most of the offspring in recent years were sired by two fathers, meaning that less than 30 individuals make up the effective reproducing portion of the population. Because a small number of males were identified as the fathers of many offspring, a smaller number may be sufficient to support population growth than was previously thought (Ford et al. 2011, NWFSC unpublished data). Some offspring were the result of matings within the same pod raising questions and concerns about inbreeding effects. Research into the relationship between genetic diversity, effective breeding population size, and health is currently underway to determine how this metric can inform us about extinction risk and inform recovery (NWFSC unpublished data). The historical abundance of Southern Resident killer whales is estimated from 140 to an unknown upper bound. The minimum estimate (~140) is the number of whales killed or removed for public display in the 1960s and 1970s added to the remaining population at the time the captures ended. Several lines of evidence (i.e., known kills and removals [Olesiuk et al. 1990], salmon declines (Krahn et al. 2002) and genetics (Krahn et al.

2002, Ford et al. 2011) all indicate that the population used to be larger than it is now and likely experienced a recent reduction in size, but there is currently no reliable estimate of the upper bound of the historical population size.

Seasonal mortality rates among Southern and Northern Resident whales may be highest during the winter and early spring, based on the numbers of animals missing from pods returning to inland waters each spring. Olesiuk et al. (2005) identified high neonate mortality that occurred outside of the summer season. At least 12 newborn calves (9 in the southern community and 3 in the northern community) were seen outside the summer field season and disappeared by the next field season. Additionally, stranding rates are higher in winter and spring for all killer whale forms in Washington and Oregon (Norman et al. 2004). Data collected from three Southern Resident killer whale strandings in the last five years have contributed to our knowledge of the health of the population and the impact of the threats to which they are exposed. Transboundary partnerships have supported thorough necropsies of L112 in 2012, J32 in 2014, and L95 in 2016, which included testing for contaminant load, disease and pathogens, organ condition, and diet composition14. A final necropsy report for J34, who was found dead near Sechelt, British Columbia on December 20, 2016 is still pending.

The NWFSC continues to evaluate changes in fecundity and mortality rates, and has updated the work on population viability analyses conducted for the 2004 Status Review for Southern Resident Killer Whales and the science panel review of the effects of salmon fisheries (Krahn et al. 2004; Hilborn et al. 2012; Ward et al. 2013). Following from that work, the data now suggests a downward trend in population growth projected over the next 50 years. As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates, however, if all of the parameters in the model remain the same the overall trend shows a decline in later years. This downward trend is in part due to the changing age and sex structure of the population, but also related to the relatively low fecundity rate observed over the period from 2011 to 2016 (NMFS 2016f). To explore potential demographic projections, Lacy et al. (2017) constructed a population viability assessment that considered sub-lethal effects and the cumulative impacts of threats (contaminants, acoustic disturbance, and prey abundance). They found that over the range of scenarios tested, the effects of prey abundance on fecundity and survival had the largest impact on the population growth rate. Furthermore, they suggested in order for the population to reach the recovery target of 2.3 percent growth rate, the acoustic disturbance would need to be reduced in half and the Chinook abundance would need to be increased by 15 percent (Lacy et al. 2017).

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

Southern Resident killer whale DPS is an average growth rate of 2.3 percent for 28 years (NMFS 2008e). In light of the current average growth rate of 0.29 percent (from 1974 to present), this recovery criterion reinforces the need to allow the population to grow quickly.

Population growth is also important because of the influence of demographic and individual heterogeneity on a population's long-term viability. Population-wide distribution of lifetime reproductive success can be highly variable, such that some individuals produce more offspring than others to subsequent generations, and male variance in reproductive success can be greater than that of females (i.e., Clutton-Brock 1988, Hochachka 2006). For long-lived vertebrates such as killer whales, some females in the population might contribute less than the number of offspring required to maintain a constant population size (n = 2), while others might produce more offspring. The smaller the population, the more weight an individual's reproductive success has on the population's growth or decline (i.e., Coulson et al. 2006). For example, although there are currently 26 reproductive aged females (ages 11-42) in the Southern Resident killer whale population, only 14 have successfully reproduced in the last 10 years (CWR unpubl. data). This further illustrates the risk of demographic stochasticity for a small population like Southern Resident killer whales – the smaller a population, the greater the chance that random variation will result in too few successful individuals to maintain the population.

Geographic Range and Distribution

Southern Residents occur throughout the coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (NMFS 2008, Hanson et al. 2013,) Southern Residents are highly mobile and can travel up to 86 miles (160 km) in a single day (Baird 2000, Erickson 1978), with seasonal movements likely tied to the migration of their primary prey, salmon.

During the spring, summer, and fall months, the whales spend a substantial amount of time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Bigg 1982; Ford 2000; Krahn et al. 2002; Hauser et al. 2007). In general, the three pods are increasingly more present in May and June and spend a considerable amount of time in inland waters through September. Late summer and early fall movements of Southern Residents in the Georgia Basin are consistent, with strong site fidelity shown to the region as a whole and high occurrence in the San Juan Island area (Hanson and Emmons 2010, Hauser et al. 2007). All three pods generally remain in the Georgia Basin through October and make frequent trips to the outer coasts of Washington and southern Vancouver Island and are occasionally sighted as far west as Tofino and Barkley Sound (Ford 2000; Hanson and Emmons 2010, Whale Museum unpubl. data). Sightings in late fall decline as the whales shift to the outer coasts of Vancouver Island and Washington.

Although seasonal movements are generally predictable, there can be large inter-annual variability in arrival time and days present in inland waters from spring through fall, with late arrivals and fewer days present in recent years (Hanson and Emmons 2010; The Whale Museum unpubl. data). For example, K pod has had variable occurrence in June ranging from 0 days of occurrence in inland waters to over 25 days. Fewer observed days in inland waters likely indicates changes in their prey availability (i.e., abundance, distribution and accessibility).

During fall and early winter, Southern Resident pods, and J pod in particular, expand their routine movements into Puget Sound, likely to take advantage of chum and Chinook salmon runs (Hanson et al. 2010, Osborne 1999).

In recent years, several sightings and acoustic detections of Southern Residents have been obtained off the Washington and Oregon coasts in the winter and spring (Hanson et al. 2010, Hanson et al. 2013, NWFSC unpubl. data). Satellite-linked tag deployments have also provided more data on the Southern Resident killer whale movements in the winter indicating that K and L pods use the coastal waters along Washington, Oregon, and California during non-summer months. Detection rates of K and L pods on the passive acoustic recorders indicate Southern Residents occur with greater frequency off the Columbia River and Westport and are most common in March (Hanson et al. 2013). J pod has also only been detected on one of seven passive acoustic recorders positioned along the outer coast (Hanson et al. 2013). The limited range of the sightings/ acoustic detections of J pod in coastal waters, the lack of coincident occurrence during the K and L pod sightings, and the results from satellite tagging in 2012–2016 (NWFSC unpubl. data) indicate J pod's limited occurrence along the outer coast and extensive occurrence in inland waters, particularly in the northern Georgia Strait.

Limiting Factors and Threats

Several factors identified in the final recovery plan for Southern Residents may be limiting recovery. These are quantity and quality of prey, toxic chemicals that accumulate in top predators, and disturbance from sound and vessels. Oil spills are also a risk factor. It is likely that multiple threats are acting together to impact the whales. Modeling exercises have attempted to identify which threats are most significant to survival and recovery (Lacy et al. 2017) and available data suggests that all of the threats are potential limiting factors (NMFS 2008).

Quantity and Quality of Prey

Southern Resident killer whales consume a variety of fish species (22 species) and one species of squid (Ford et al. 1998; Ford 2000; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016), but salmon are identified as their primary prey. Southern Residents are the subject of ongoing research, including direct observation, scale and tissue sampling of prey remains, and fecal sampling. The diet data indicate that the whales are consuming mostly larger (i.e., older) Chinook salmon. Chinook salmon is their primary prey despite the much lower abundance in some areas and during certain time periods in comparison to other salmonids, for mechanisms that remain unknown but factors of potential importance include the species' large size, high fat and energy content, and year-round occurrence in the whales' geographic range. Chinook salmon have the highest value of total energy content compared to other salmonids because of their larger body size and higher energy density (kcal/kg) (O'Neill et al. 2014). For example, in order for a killer whale to obtain the total energy value of one Chinook salmon, they would need to consume approximately 2.7 coho, 3.1 chum, 3.1 sockeye, or 6.4 pink salmon (O'Neill et al. 2014). Recent research suggests that killer whales are capable of detecting, localizing and recognizing Chinook salmon through their ability to distinguish Chinook echo structure as different from other salmon (Au et al. 2010).

Scale and tissue sampling from May to September in inland waters of WA and B.C. indicate that their diet consists of a high percentage of Chinook salmon (monthly proportions as high as >90 percent) (Hanson et al. 2010; Ford et al. 2016). Genetic analysis of the Hanson et al. (2010) samples indicate that when Southern Residents are in inland waters from May to September, they consume Chinook stocks that originate from regions including the Fraser River (including Upper Fraser, Mid Fraser, Lower Fraser, North Thompson, South Thompson and Lower Thompson), Puget Sound (North and South Puget Sound), the Central British Columbia Coast and West and East Vancouver Island.

DNA quantification methods are used to estimate the proportion of different prey species in the diet from fecal samples (Deagle et al. 2005). Recently, Ford et al. (2016) confirmed the importance of Chinook salmon to the Southern Residents in the summer months using DNA sequencing from whale feces. Salmon and steelhead made up to 98 percent of the inferred diet, of which almost 80 percent were Chinook salmon. Coho salmon and steelhead are also found in the diet in spring and fall months when Chinook salmon are less abundant. Specifically, coho salmon contribute to over 40 percent of the diet in late summer, which is evidence of prey shifting at the end of summer towards coho salmon (Ford et al. 1998; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016). Less than 3 percent each of chum salmon, sockeye salmon, and steelhead were observed in fecal DNA samples collected in the summer months (May through September). Prey remains and fecal samples collected in inland waters during October through December indicate Chinook and chum salmon are primary contributors of the whale's diet (NWFSC unpubl. data).

Observations of whales overlapping with salmon runs (Wiles 2004; Zamon et al. 2007; Krahn et al. 2009) and collection of prey and fecal samples have also occurred in coastal waters in the winter months. Preliminary analysis of prey remains and fecal samples sampled during the winter and spring in coastal waters indicated the majority of prey samples were Chinook salmon, with a smaller number of steelhead, chum salmon, and halibut (NWFSC unpubl. data). The occurrence of K and L pods off the Columbia River in March suggests the importance of Columbia River spring runs of Chinook salmon in their diet (Hanson et al. 2013). Chinook genetic stock identification from samples collected in winter and spring in coastal waters included 12 U.S. west coast stocks, and over half the Chinook salmon consumed originated in the Columbia River (NWFSC unpubl. data). Columbia River, Central Valley, Puget Sound, and Fraser River Chinook salmon comprise over 90 percent of the whales' coastal Chinook salmon diet (NWFSC unpubl. data).

Over the past decade, some Chinook salmon stocks within the range of the whales have had relatively high abundance (e.g. WA/OR coastal stocks, some Columbia River stocks), whereas other stocks originating in the more northern and southern ends of the whales' range (e.g. most Fraser stocks, Northern and Central B.C. stocks, Georgia Strait, Puget Sound, and Central Valley) have declined. Changing ocean conditions driven by climate change may influence ocean survival of Chinook and other Pacific salmon, further affecting the prey available to Southern Residents.

Currently, hatchery production is a significant component of the salmon prey base returning to watersheds within the range of Southern Resident killer whales (Barnett-Johnson et al. 2007;

NMFS 2008e). Although hatchery production has contributed some offset of the historical declines in the abundance of natural-origin salmon within the range of the whales, hatcheries also pose risks to natural-origin salmon populations (Nickelson et al. 1986; Ford 2002; Levin and Williams 2002; Naish et al. 2007). Healthy natural-origin salmon populations are important to the long-term maintenance of prey populations available to Southern Residents because it is uncertain whether a hatchery dominated mix of stocks is sustainable indefinitely and because hatchery fish can differ, relative to natural-origin Chinook salmon, for example, in size and hence caloric value and in availability/migration location and timing. However, the release of hatchery fish has not been identified as a threat to the survival or persistence of Southern Residents. It is possible that hatchery produced fish may benefit this endangered population of whales by enhancing prey availability as scarcity of prey is a primary threat to Southern Resident killer whale survival and hatchery fish often contribute to the salmon stocks consumed (Hanson et al. 2010).

Nutritional Limitation and Body Condition

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

Since 2008, NOAA’s SWFSC has used aerial photogrammetry to assess the body condition and health of Southern Resident killer whales, initially in collaboration with the Center for Whale Research and, more recently, with the Vancouver Aquarium and SR3. Aerial photogrammetry studies have provided finer resolution for detecting poor condition, even before it manifests in “peanut heads” that are observable from boats. Annual aerial surveys of the population from 2013-2017 (with exception of 2014) have detected declines in condition before the death of seven Southern Residents (L52 and J8 as reported in Fearnbach et al. 2018; J14, J2, J28, J54, and J52 as reported in Durban et al. 2017), including five of the six most recent mortalities (Trites and Rosen 2018). These data have provided evidence of a general decline in Southern Resident killer whale body condition since 2008, and documented members of J pod being in poorer body condition in May compared to September (at least in 2016 and 2017) (Trites and Rosen 2018).

Although body condition in whales can be influenced by a number of factors, including prey availability, disease, physiological or life history status, and may vary by season and across years, prey limitation is the most likely cause of observed changes in body condition in wild mammalian populations (Matkin et al. 2017). It is possible that poor nutrition could contribute to mortality through a variety of mechanisms. To demonstrate how this is possible, we reference studies that have demonstrated the effects of energetic stress (caused by incremental increases in energy expenditures or incremental reductions in available energy) on adult females and juveniles, which have been studied extensively (e.g., adult females: Schaefer et al. 1996, Daan et al. 1996, juveniles: Noren et al. 2009, Trites and Donnelly 2003). Small, incremental increases in energy demands should have the same effect on an animal's energy budget as small, incremental reductions in available energy, such as one would expect from reductions in prey. Ford and Ellis (2006) report that resident killer whales engage in prey sharing about 76 percent of the time. Prey sharing presumably would distribute more evenly the effects of prey limitation across individuals of the population than would otherwise be the case (i.e., if the most successful foragers did not share with other individuals). Therefore, although cause of death for most individuals that disappear from the population is unknown, poor nutrition could occur in multiple individuals as opposed to only unsuccessful foragers, contributing to additional mortality in this population.

Toxic Chemicals

Various adverse health effects in humans, laboratory animals, and wildlife have been associated with exposures to persistent pollutants. These pollutants have the ability to cause endocrine disruption, reproductive disruption or failure, immunotoxicity, neurotoxicity, neurobehavioral disruption, and cancer (Reijnders 1986, de Swart et al. 1996, Subramanian et al. 1987, de Boer et al. 2000; Reddy et al. 2001, Schwacke et al. 2002; Darnerud 2003; Legler and Brouwer 2003; Viberg et al. 2003; Ylitalo et al. 2005; Fonnum et al. 2006; Viberg et al. 2006; Darnerud 2008; Legler 2008; Bonefeld-Jørgensen et al. 2011). Southern Residents are exposed to a mixture of pollutants, some of which may interact synergistically and enhance toxicity, influencing their health. High levels of these pollutants have been measured in blubber biopsy samples from Southern Residents (Ross et al. 2000; Krahn et al. 2007; Krahn et al. 2009), and more recently, these pollutants were measured in fecal samples collected from Southern Residents providing another potential opportunity to evaluate exposure to these pollutants (Lundin et al. 2015; Lundin et al. 2016).

Killer whales are exposed to persistent pollutants primarily through their diet. For example, Chinook salmon contain higher levels of some persistent pollutants than other salmon species, but only limited information is available for pollutant levels in Chinook salmon (Krahn et al. 2007; O'Neill and West 2011; Veldhoen et al. 2010; Mongillo et al. 2016). These harmful pollutants, through consumption of prey species that contain these pollutants, are stored in the killer whale's blubber and can later be released; when the pollutants are released, they are redistributed to other tissues when the whales metabolize the blubber in response to food shortages or reduced acquisition of food energy that could occur for a variety of other reasons. The release of pollutants can also occur during gestation or lactation. Once the pollutants mobilize in to circulation, they have the potential to cause a toxic response. Therefore, nutritional stress from reduced Chinook salmon populations may act synergistically with high pollutant levels in Southern Residents and result in adverse health effects.

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

Disturbance from Vessels and Sound

Vessels have the potential to affect killer whales through the physical presence and activity of the vessel, increased underwater sound levels generated by boat engines, or a combination of these factors. Vessel strikes are rare, but do occur and can result in injury or mortality (Gaydos and Raverty 2007). In addition to vessels, underwater sound can be generated by a variety of other human activities, such as dredging, drilling, construction, seismic testing, and sonar (Richardson et al. 1995; Gordon and Moscrop 1996; National Research Council 2003). Impacts from these sources can range from serious injury and mortality to changes in behavior. In other cetaceans, hormonal changes indicative of stress have been recorded in response to intense sound exposure (Romano et al. 2003). Chronic stress is known to induce harmful physiological conditions including lowered immune function, in terrestrial mammals and likely does so in cetaceans (Gordon and Moscrop 1996).

Killer whales rely on their highly developed acoustic sensory system for navigating, locating prey, and communicating with other individuals. While in inland waters of Washington and British Columbia, Southern Resident killer whales are the principal target species for the commercial whale watch industry (Hoyt 2001; O’Connor et al. 2009) and encounter a variety of other vessels in their urban environment (e.g., recreational, fishing, ferries, military, shipping). Several main threats from vessels include direct vessel strikes, the masking of echolocation and communication signals by anthropogenic sound, and behavioral changes (NMFS 2008). There is a growing body of evidence documenting effects from vessels on small cetaceans and other marine mammals (NMFS 2010c; NMFS 2016f; NMFS in press). Research has shown that the whales spend more time traveling and performing surface active behaviors and less time foraging in the presence of all vessel types, including kayaks, and that noise from motoring vessels up to 400 meters away has the potential to affect the echolocation abilities of foraging whales (Holt 2008; Lusseau et al. 2009; Noren et al. 2009; Williams et al. 2010b). Individual energy balance may be impacted when vessels are present because of the combined increase in energetic costs resulting from changes in whale activity with the decrease in prey consumption resulting from reduced foraging opportunities (Williams et al. 2006; Lusseau et al. 2009; Noren et al. 2009a; Noren et al. 2012).

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

In the final rule, NMFS committed to reviewing the vessel regulations to evaluate effectiveness, and also to study the impact of the regulations on the viability of the local whale watch industry. In March 2013, NMFS held a killer whale protection workshop16 to review the current vessel regulations, guidelines, and associated analyses; review monitoring, boater education, and enforcement efforts; review available industry and economic information and identify data gaps; and provide a forum for stakeholder input to explore next steps for addressing vessel effects on killer whales.

In December 2017, NOAA Fisheries completed a technical memorandum evaluating the effectiveness of regulations adopted in 2011 to help protect endangered Southern Resident killer whales from the impacts of vessel traffic and noise (Ferrara et al. 2017). In the assessment, Ferrara et al. (2017) used five measures: education and outreach efforts, enforcement, vessel compliance, biological effectiveness, and economic impacts. For each measure, the trends and observations in the 5 years leading up to the regulations (2006-2010) were compared to the trends and observations in the 5 years following the regulations (2011-2015). The memo finds that the regulations have benefited the whales by reducing impacts without causing economic harm to the commercial whale-watching industry or local communities. The authors also find room for improvement in terms of increasing awareness and enforcement of the regulations, which would help improve compliance and further reduce biological impacts to the whales.

Oil Spills

In the Northwest, Southern Resident killer whales are the most vulnerable marine mammal population to the risks imposed by an oil spill due to their small population size, strong site fidelity to areas with high oil spill risk, large group size, late reproductive maturity, low reproductive rate, and specialized diet, among other attributes (Jarvela-Rosenberger et al. 2017). Oil spills have occurred in the range of Southern Residents in the past, and there is potential for spills in the future. Oil can be discharged into the marine environment in any number of ways, including shipping accidents, refineries and associated production facilities, and pipelines.

Despite many improvements in spill prevention since the late 1980s, much of the region inhabited by Southern Residents remains at risk from serious spills because of the heavy volume of shipping traffic and proximity to petroleum refining centers in inland waters. Numerous oil tankers transit through the inland waters range of Southern Residents throughout the year. The magnitude of risk posed by oil discharges in the action area is difficult to precisely quantify. The total volume of oil spills declined from 2007 to 2013, but then increased from 2013 to 2017 (WDOE 2017). The percent of potential high-risk vessels that were boarded and inspected between 2009 and 2017 also declined (from 26 percent inspected in 2009 to 12.2 percent by 2017) (WDOE 2017).

Repeated ingestion of petroleum hydrocarbons by killer whales likely causes adverse effects; however, long-term consequences are poorly understood. In marine mammals, acute exposure to petroleum products can cause changes in behavior and reduced activity, inflammation of the mucous membranes, lung congestion and disease, pneumonia, liver disorders, neurological damage, adrenal toxicity, reduced reproductive rates, and changes in immune function (Geraci and St. Aubin 1990; Schwacke et al. 2013; Venn-Watson et al. 2015; de Guise et al. 2017; Kellar et al. 2017), potentially death and long-term effects on population viability (Matkin et al. 2008; Ziccardi et al. 2015). For example, 122 cetaceans stranded or were reported dead within 5 months following the Deepwater Horizon spill in the Gulf of Mexico (Ziccardi et al. 2015). An additional 785 cetaceans were found stranded from November 2010 to June 2013, which was declared an Unusual Mortality Event (Ziccardi et al. 2015). In addition, oil spills have the potential to adversely impact habitat and prey populations, and, therefore, may adversely affect Southern Residents by reducing food availability.

2.2.2 Status of Critical Habitat

This section describes the status of designated critical habitat relevant to the proposed action by examining the condition and trends of the essential physical and biological features of that habitat throughout the designated areas. These features are essential to the conservation of the ESA-listed species because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration and foraging).

For salmon, NMFS's critical habitat analytical review teams (CHARTs) ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each ESA-listed species that they support (NOAA Fisheries 2005). The conservation rankings were high, medium, or low. To determine the conservation value of each watershed to species viability, the CHARTs evaluated the quantity and quality of habitat features, the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area. Even if a location had poor habitat quality, it could be ranked with a high conservation value if it were essential due to factors such as limited availability, a unique contribution of the population it served, or serving another important role. No critical habitat in marine areas has been designated for PS steelhead, and so the action area does not include critical habitat for this DPS.

In designating critical habitat (CH) for PS Chinook and HCSR chum salmon in estuarine and nearshore marine areas[5], NMFS determined that the area from extreme high water extending out to the maximum depth of the photic zone (no greater than 30 meters relative to MLLW) contain essential features that require special protection. For nearshore marine areas, NMFS designated the area inundated by extreme high tide because it encompasses habitat areas typically inundated and regularly occupied during the spring and summer when juvenile salmon are migrating in the nearshore zone and relying heavily on forage, cover, and refuge qualities provided by these occupied habitats.

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

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

During the listing process for SRKW, NMFS requested specific information on critical habitat to assist in gathering and analyzing the best available scientific data to support critical habitat designations, and met with co-managers and other stakeholders to review the information and the overall designation process (NMFS 2006). Since then, significant work has been done to continue to understand the threats to SRKW habitat, including in the Recovery Plan process, status reviews, and a proposed rule in 2019 to revise SRKW critical habitat, significantly expanding areas understood to be critical to this species survival and recovery.

Table 3 provides a summary of critical habitat information for the species addressed in this opinion. More information relevant to critical habitat status can be found in the Federal Register notices, recovery plans, status reports and other documents available at NMFS' West Coast Region website (http://www.westcoast.fisheries.noaa.gov/) and is incorporated here by reference.

Table 3. Current Status of Designated Critical Habitat

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Puget Sound Chinook salmon	9/02/05 70 FR 52630	Critical habitat for Puget Sound Chinook salmon includes 1,683 miles of streams, 41 square mile of lakes, and 2,182 miles of nearshore marine habitat in Puget Sounds. The Puget Sound Chinook salmon ESU has 61 freshwater and 19 marine areas within its range. Of the freshwater watersheds, 41 are rated high conservation value, 12 low conservation value, and eight received a medium rating. Of the marine areas, all 19 are ranked with high conservation value.
Puget Sound Steelhead	2/24/16 81 FR 9252	Critical habitat for Puget Sound steelhead includes 2,031 stream miles. Nearshore and offshore marine waters were not designated for this species. There are 66 watersheds within the range of this DPS. Nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS.
Puget Sound/Georgia Basin DPS of bocaccio	11/13/2014 79 FR68042	Critical habitat for bocaccio includes 590.4 square miles of nearshore habitat and 414.1 square miles of deepwater habitat. Critical habitat is not designated in areas outside of United States jurisdiction; therefore, although waters in Canada are part of the DPSs' ranges for all three species, critical habitat was not designated in that area. Based on the natural history of bocaccio and their habitat needs, NMFS identified two physical or biological features, essential for their conservation: 1) Deepwater sites (>30 meters) that support growth, survival, reproduction, and feeding opportunities; 2) Nearshore juvenile rearing sites with sand, rock and/or cobbles to support forage and refuge. Habitat threats include degradation of rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality as specific threats to rockfish habitat in the Georgia Basin.
Southern resident killer whale	11/29/06 71 FR 69054	Critical habitat consists of three specific marine areas of inland waters of Washington: 1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; 2) Puget Sound; and 3) the Strait of Juan de Fuca. These areas comprise approximately 2,560 square miles of marine habitat. Based on the natural history of the Southern Residents and their habitat needs, NMFS identified three PCEs, or physical or biological features, essential for the conservation of Southern Residents: 1) Water quality to support growth and development; 2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and 3) passage conditions to allow for migration, resting, and foraging. Water quality in Puget Sound, in general, is degraded. Some pollutants in Puget Sound persist and build up in marine organisms including Southern Residents and their prey resources, despite bans in the 1970s of some harmful substances and cleanup efforts. The primary concern for direct effects on whales from water quality is oil spills, although oil spills can also have long-lasting impacts on other habitat features In regards to passage, human activities can interfere with movements of the whales and impact their passage. In particular, vessels may present obstacles to whales' passage, causing the whales to swim further and change direction more often, which can increase energy expenditure for whales and impacts foraging behavior. Reduced prey abundance, particularly Chinook salmon, is also a concern for critical habitat. Additional areas are proposed to expand SRKW critical habitat per 84 FR 55530, published 10/19/19.

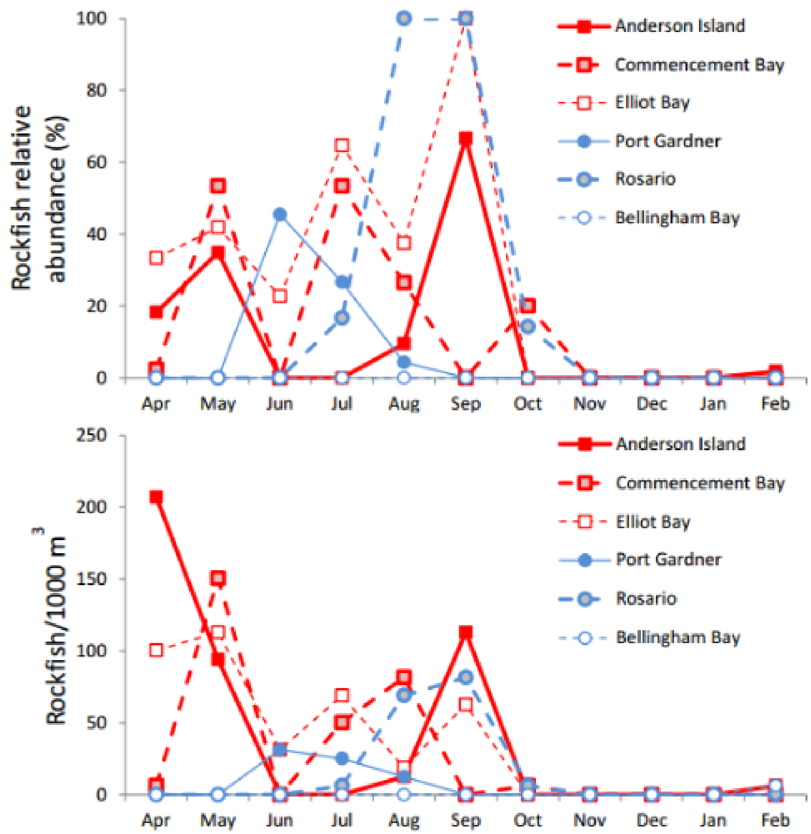
2.4 Environmental Baseline

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). As described in section 1.4, the action area is established by the downstream influence of water pollution associated with the subject project, vessel traffic to and from the subject project, and the biotic effects on salmonids as prey species of SRKW.

The Lower Duwamish Waterway is a transitional are between freshwater and the estuary of Elliot Bay, and the action area extends into Elliot Bay, and beyond into greater Puget Sound. These areas are heavily modified by anthropogenic changes. Water quality, sediments, riparian vegetation, and natural formation of banks and depths are degraded from their natural condition. For example, between the mouth of the Duwamish River (RM 0.0) and RM 6.0, approximately 56 percent has riprap; 7 percent is bulkheaded with concrete, pilings, or steel; 1 percent has concrete boat ramps; and only 11 percent has no shoreline armoring (TerraLogic and Landau 2004). This is a slight increase in shoreline armoring from the early 1990's when a total of 85 percent of the shoreline was armored (Tanner 1991). In addition to commercial and industrial discharge, stormwater drainage has also contributed to pollutant loading in the Duwamish, Elliot Bay, and Puget Sound generally. Despite improved water quality standards and permitting requirements in subsequent decades, water quality remains degraded. Water quality and sediment conditions are impaired in Elliot Bay to the degree that health advisories limit consumption of fish harvested in this waterway. Shoreline development and shipping traffic are well-established uses that impair restoration to good habitat conditions for ESA-listed salmonids or other species.

The LDW provides migratory habitat for adult and juvenile PS Chinook salmon and PS steelhead from the Central/South Puget Sound MPG for each species. The Duwamish Waterway is the name for the lower 12 miles of the Green River, therefore, PS Chinook and steelhead from the Green River populations fish must pass through 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 action area also supports unlisted salmonids, such as coho, chum, pink salmon, and blackmouth. A King County health advisory recommends that crab, perch, flounder, sole, rockfish fished from the Duwamish not be consumed because of high levels of mercury and PCBs, that blackmouth salmon and herring be consumed no more than twice per month, and that Chinook be consumed no more than once per week to limit human exposure and health effects of PCBs and Mercury. Chum, pink, coho, and sockeye from the Duwamish River are noted as safe to consume up to 3 times per week.

Elliot Bay is within the migration corridor for both salmonid species and presence of larval, and possibly juvenile, bocaccio rockfish is expected (in Elliot Bay, rockfish (*Sebastes* spp.) have been collected near Harbor Island, but presence of rockfish in LDW is unlikely (WDOH 2003). Miller and Borton (1980) mapped brown rockfish (*S. auriculatus*), yellowtail rockfish (*S. flavidus*), Quillback rockfish (*S. maliger*), and copper rockfish (*S. caurinus*) adjacent to, or near, Piers 90 and 91 at the north end of Elliott Bay. While no ESA-listed rockfish have been collected in the LDW, they could be present incidentally as larvae). Bocaccio in the Puget Sound are a single population, listed as endangered. As of the 2016 5-year status review, rockfish populations declined at over 3 percent annually from 1977 to 2014. Bocaccio presence in Elliot Bay waxes and wanes over the calendar year, with presence likely peaking in May and again in July, the nadir occurring in April, June, September.



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. Humpback whales have been sighted in Elliott Bay from 1982 to 2016, with 2 to 5 sightings annually since 2013 compared to 0 to 2 sightings annually from 1982 to 2010. Killer whales have also been sighted regularly in Elliott Bay (Olson 2018).

Within greater Puget Sound, bank armoring, overwater structure, and water quality are chronic, widely present conditions that reduce quantity and quality of habitat conditions for listed fishes.

Other habitat conditions specific to SRKW include poor prey base (both quality and quantity), with ongoing risks from vessels via either noise, or ship strikes.

Figure 3. South dock to be replaced with material holding area (red) landward of the dock into which stormwater will be drained.

2.5 Effects of the Action on Species and Designated Critical Habitat

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).

Effects of the proposed action and its consequences include:

Temporary effects associated with construction: Sound associated with pile removal and pile driving; water quality reductions during pile removal and replacement; disrupted benthic communities near removed and replaced piles.

Long term effects associated with the presence of structures in and over aquatic habitat: Shade from overwater decking, which impairs biotic conditions in the shaded area, and is a migratory obstruction; Pilings, which provide predation points for piscivorous fish, and are a migratory obstruction.

Effects associated with the operations at the structure: The dock supports vessel shipping and receiving for an approximate 12-acre metals processing facility, thus episodes of vessel noise, water quality reductions from vessel operations, and accidental discharge of handled material into the aquatic environment are likely to occur over the life of the structure.

We evaluated the applicability of the Nearshore Calculator to evaluate the project's effects to nearshore habitat in terms of conservation "debits." The Nearshore Calculator is designed for estuarine habitat, including the salt wedge. The salt wedge in the LDW, while occasionally reaching as far upstream as river mile 8 on extreme high tides, is generally identified as ending at river mile 2.2. The proposed action of repairing an upgrading the dock, pilings, stormwater treatment facilities, and discharge point are located at river mile 3. Because the effects of the structure itself are primarily located upstream of the salt-wedge, and because certain effects associated with the operation and maintenance of the structure are not within the calculator framework, the effects on ESA listed species, designated critical habitat (and EFH) are determined and evaluated independently of the Nearshore Calculator.

2.5.1 Effects on Critical Habitat

This assessment considers the intensity of expected effects in terms of the change they would cause in 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.

The PBFs of PS Chinook salmon and PS steelhead critical habitat in the action area are estuarine areas free of obstruction, with;

(1) water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh-and saltwater,
(2) natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders,
(3) juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The PBFs of Bocaccio rockfish in the action area are:

(1) quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities,
(2) water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities,
(3) substrates such as sand, rock and/or cobble compositions that also support kelp are essential for conservation because these features enable forage opportunities and refuge from predators and enable behavioral

and physiological changes needed for juveniles to occupy deeper adult habitats.

The PBF essential to SRKW conservation and recovery in the action area are:

(1) water quality to support growth and development, and

(2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth.

Features of critical habitat common to all ESA listed species considered in this opinion are [good] water quality, [sufficient] prey, and [safety of] migration corridors. Passage conditions to allow for migration, resting, and foraging are physical features necessary to support both PS Chinook and PS steelhead. We will present our analysis to features of habitat, and then consider the effect with regard to their designation status.

Sound from Pile Removal and Installation (temporary)

The Project will require the use of both vibratory and impact pile-driving hammers, creating elevated underwater noise levels during their operation. Impact pile driving is only anticipated for proofing of the load-bearing piles. A vibratory hammer will be used to the extent feasible and a sound attenuating BMP (such as a bubble curtain or pile caps) will be implemented during:

- Removal of 33 load-bearing piles (timber) between bents 1 and 21 of the existing dock and installation of a minimum of 28 load-bearing piles; up to 5 additional load bearing piles may be installed based upon filed determination during construction.
- Removal of 46 fender piles (timber) between bents 1 and 34 of the existing dock and installation of 30 fender piles.
- Installation of two piles to restore barge moorage previously provided by in-water dolphins. Piles would primarily be 16- to 18- inch diameter steel pipe piles, with the exception of the mooring piles, which would be 36-inch diameter piles.
- Replacement of the existing timber deck between bents 1 and 21 after the piles are replaced, and patching the existing timber deck (as needed) between bents 21 and 34.

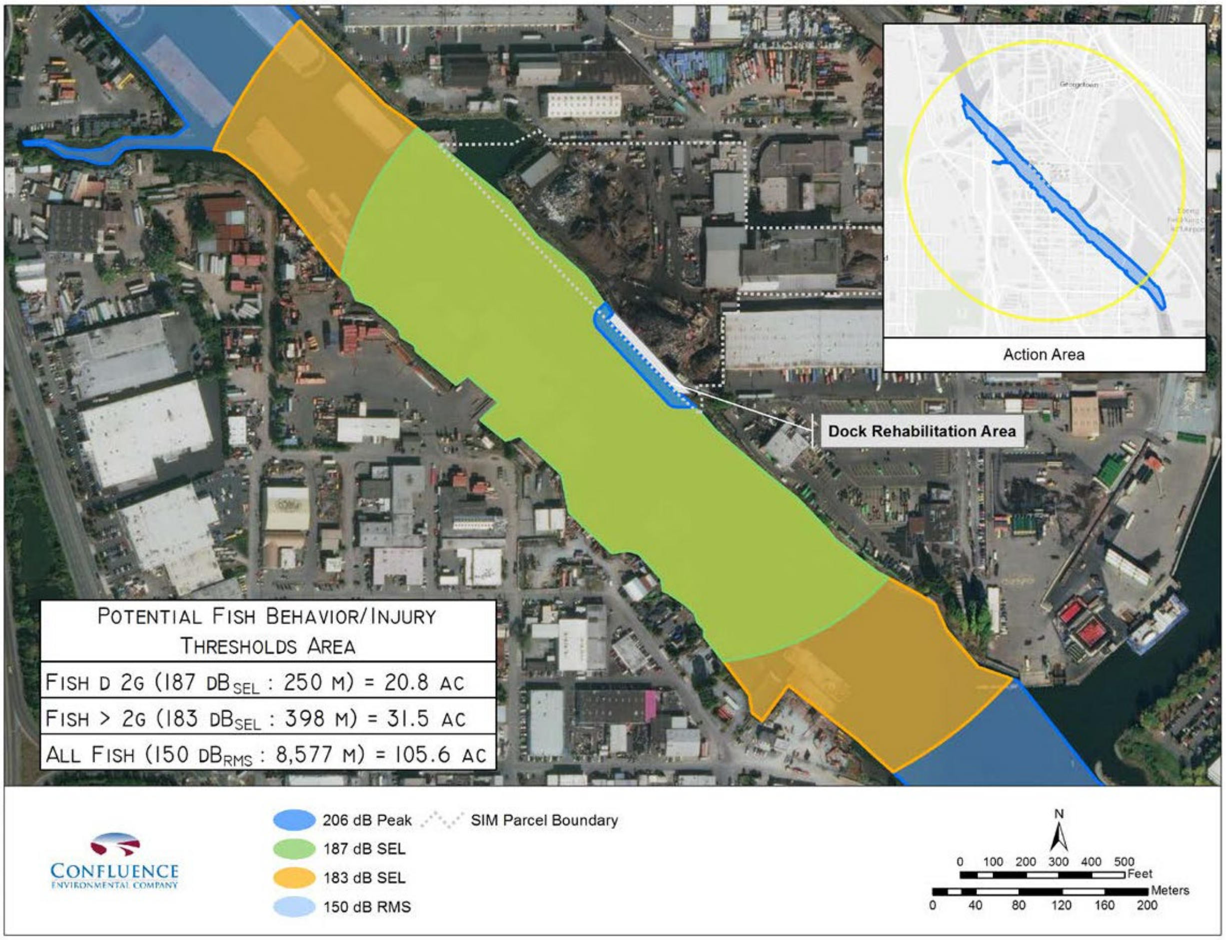


Figure 4. Extent of in-water noise, and threshold areas.

Vibratory Driving Sound. The sound profile of vibratory pile driving is distinct from that of impact driving. As described by Popper and Hawkins (2018), underwater sound is generated by the movement or vibration of objects immersed in water, or any other compressible medium, and results from the inherent elasticity of the medium. As the source moves, kinetic energy (KE) is imparted to the medium and in turn is passed on, traveling as a propagated elastic wave within which particles of the medium are moved back and forth. The term “particle” denotes the smallest element of the medium that represents the medium’s mean density. The particles of the medium do not travel with the propagating sound wave, but instead move back and forth over the same location. At the same time, particles transmit their oscillatory motion to their neighbors. The particles oscillate along the line of transmission, and are accompanied by waves of compression (increase in pressure) and rarefaction (reduction in pressure)—referred to as the sound pressure.

There are intimate links between the benthic infauna and the sediment, with some species playing a major role in structuring the sediments (Gray and Elliott, 2009), as cited in Popper and Hawkins). There may be indirect effects on the benthos in terms of habitat destruction and sediment re-sorting, as a result of sound transmission through and on the substrate, and it is clear that human activities may add considerably to substrate transmission through activities including dredging, pile-driving, et cetera. However, to date no studies distinguish particle motion from pressure to evaluate detrimental effects (Popper and Hawkins 2018).

In the absence of specific information on adverse effects from vibratory driving, we note noise of this type in the aquatic environment is a disruption of ambient conditions, which persists with the operation of the equipment. Conditions in water (pressure, particle motion) revert to baseline levels when vibratory pile driving ceases. While this perturbation persists, migration and forage values of the habitat may be diminished.

Impact Driving Sound. Sound associated with impact driving is likely have more negative effects on the value of habitat for migration and rearing values. The practical spreading loss model indicates that noise associated with pile driving in the Project area would attenuate to less than the 150 dBRMS sound level behavioral threshold for fish disturbance at a distance of about 8,577 meters (28,132 feet). The cumulative SEL will exceed the injury threshold at a distance of about 251 meters (824 feet) for an 18-inch pile. This represents a total area surrounding the proposed dock of approximately 106 acres and 21 acres, respectively. Within this zone, habitat values for rearing, foraging, and migration are diminished while sound pressure waves occur.

<u>Water Quality Reduction/Suspended sediment (temporary)</u>
Sediment is likely to become suspended when piles are removed or installed. This resuspension will cause a turbidity pulse at each location where a pile is extracted and at each location a pile is installed. The amount of material being re-suspended is likely to low, and turbidity will be constrained to a small area (measured in feet) immediately around the pile. Finer materials will drift before settling, and the spatial extent of suspended sediments effects is expected to be confined to the point of compliance for state water quality standards for turbidity (Washington Administrative Code 173-201A-200), which would be 300 feet downstream of the construction activity. Heavier materials will settle out more rapidly, and closer to the pile-work location.

These small pulses temporarily diminish water quality within the 300-foot mixing zone. The increased suspended sediment would occur episodically throughout the time frame of the construction activities, potentially over the entire 4.5-month in-water construction period, but is more likely to be a shorter duration of in-water work.

A total of 81 creosote treated timber piles are proposed for removal for the dock rehabilitation. The potential for PAH introduction into the water column would occur episodically throughout the time frame of the pile removal activities, which is expected to occur in the first (approximately) 30 days of in-water construction period. The removal of the creosote-treated piles can mobilize PAHs into the surrounding water and sediments (Smith et al. 2008; Parametrix 2011). The concentration of PAHs released into the surface water rapidly dilutes.

Smith et al. (2008) reported concentrations of total PAHs of 101.8 μg/l up to 30 seconds after the removal of creosote piles and 22.7 μg/l up to 60 seconds after their removal. Romberg (2005) found a major reduction in sediment PAH levels 3 years after pile removal contaminated an adjacent sediment cap. The probability of exposure to PAHs by aquatic organisms in the water column is expected to be strongly correlated with suspended sediment as PAHs become adsorbed to the particulates in the sediment (Perkins 2010). However, the removal of creosote pilings does create a long-term reduction in this source of contamination, after the initial spike of introduced contamination.

<u>Water Quality Reduction/Stormwater Contaminants (long term)</u>
Because of a previous history of water quality violations at the site, including excessive discharges of zinc, copper, lead, and other pollutants, in 2014, 2017, and 2018, the new pier is being designed in such a way as to direct storm water back onto land and into a large scrape and metal holding area prior to discharge. Despite capture and treatment intended to reduce the contaminant load in effluent, discharge will still contain several contaminants which impair water quality as a feature of critical habitat. Stormwater from this site discharges to the LDW, where it mingles with and dilutes into the receiving water, and is transported downstream into Puget Sound.

To evaluate likely contaminants within the stormwater to discharge from this site, we reviewed an evaluation of surface water at a metals scrap yard, which focused on five heavy metals, Nickel (Ni), Zinc (Zn), Copper (Cu), Cadmium (Cd), Lead (Pb) (Ojekunle et a. 2016). In that study, the amount of contaminants present varied, and were present in the following relationship: Cd > Pb > Zn > Cu > Ni. Cadmium presented the highest ecological risk, with lead, zinc, copper and nickel all presenting with "light levels of contamination" of surface water. We anticipate that a similar suite of contaminants is likely to occur in effluent discharging from this site and confirmed with information provided by the Washington State Department of Ecology that contaminants associated with the Seattle Iron Dock include copper, lead, zinc, mercury, silver, ammonia, petroleum hydrocarbons, and PCBs, as well as suspended solids and associated oxygen demand.

In addition to diminishments from discharged stormwater, water quality is also likely affected by material (oils, greases) introduced by vessel motor operation and exhaust (PAHs).

Effects of the presence of these water quality degrading pollutants is presented in more detail in sections on prey exposure, and on species responses to exposure, below.

Effluent Limits: Outfall # 001		
Parameter	**Average monthly limits**	**Maximum daily** [a]
Flow [b]	Report Gal/Day	576,000 Gal/Day
Total Suspended Solids (TSS)	Report mg/L	10 mg/L
Total Petroleum Hydrocarbon (TPH)	Report mg/L	5 mg/L (technology-based)
Copper	13.2 ug/L	26.5 ug/L
Lead	52 ug/L	119 ug/L
Mercury	0.73 ug/L	1.5 ug/l
Silver	5.9 ug/l	11.9 ug/L
Zinc	245 ug/L	491 ug/L
COD	Report mg/L	Report mg/L
Ammonia (as N)	21 mg/L	42 mg/L
Total PCBs [c]	5.1 ng/L	8.9 ng/L
Chemicals of Concern: • 1,2-Dichlorobenzene. • 1,4-Dichlorobenzene; 1,2,4-Trichlorobenzene. • Butylbenzyl phthalate; Fluoranthene; Hexachlorobenzene. • Hexachlorobutadiene; N-nitrosodiphenylamine; Phenol.	Report Only (μg/L)	
	Daily minimum	**Daily maximum**
pH	6 standard units	9 standard units
[a] Maximum daily effluent limit is the highest allowable daily discharge. The daily discharge is the average discharge of a pollutant measured during a calendar day. For pollutants with limits expressed in units of mass, calculate the daily discharge as the total mass of the pollutant discharged over the day. This does not apply to pH or temperature.		

Figure 5. Image of Ecology Effluent Limits for Contaminants in Stormwater Discharge at Seattle Iron Dock

Prey Base Impairment (long term)
Long term benthic disturbance will occur as a result of pile replacement, shade from the overwater structure, and stormwater runoff released into the LDW as discharge. Prey communities of all three ESA-listed fishes will also be affected by contaminants in stormwater. Juvenile Chinook salmon from the Lower Columbia and Willamette Rivers, which have similar urban sources of pollution, were noted to have PCBs and PAHs in the stomach contents of all fish evaluated, indicating that prey is a source of exposure contributing to body burden in salmonids (Johnson et al 2007). Similar consumption/stomach content would be expected at this site. Salmonids that consume those prey will also carry those contaminants themselves as prey species of SRKW.

The substrate along the Seattle Iron and Metal waterfront provides conditions for invertebrates, such as copepods, amphipods, and snails, which might otherwise not be found on soft sediments (Mumford 2007). Copepods and other zooplankton represent the major food base for the food chain in Puget Sound and the LDW, specifically for small and juvenile fish including Pacific herring, sand lance, surf smelt, and salmonids. The intertidal area provides important habitat for a variety of marine invertebrates and fishes, including salmonid species.

The existing piles occupy approximately 69 to 108 square feet of benthic habitat, based on the range of 12- to 15-inch sizes. The proposed piles will occupy a range of 103 square feet to 125 square feet of benthic habitat, based on the 16- to 18-inch pile size (respectively) and the inclusion of all the contingency piles. The net change in benthic disturbance would range from a 5-square foot reduction to a maximum increase of 56 square feet These structures, if they create in increase in the footprint will incrementally reduce the abundance of prey organisms for juvenile salmonids habitat complexity. These anticipated effects will persist as long as the structure remains in place, thus lowering the quantity and quality of the forage PCE of marine habitat in the action area over several decades.

The long-term discharge of copper, lead, zinc and other heavy chemicals and biological contaminants will reduce water quality throughout the entire action area, diminishing the water quality PCE. These anticipated effects will persist as long as the structure remains in place, thus lowering the quantity and quality of the forage PCE of marine habitat in the action area over several decades. While sediments are usually considered as a sink for metals because the metals can bind to the minerals, they can also become a source under certain conditions. Then, trace metals are able to move towards the water column or accumulate in plants and consequently contaminate the food chain (Segura et al., 2006). Transport of metals, concentration of metals, and bioavailability are each influenced by the mineral components of the sediments, the grain size, pH, river volume and velocity, and the presence of organic matter. For example, a study of lead copper and zinc in a Canadian river, showed that in fluvial environments, metals concentrations increase with decreasing grain size (Stone and Droppo, 1996), thus, during transport, sediment with highest stays in suspension and transports further downstream, with longer periods potential biotic exposure.

Benthic organisms may also be exposed to PAHs through their diet and through direct contact with contaminated water and sediments. PAHs may bioaccumulate in aquatic invertebrates within these benthic communities (Varanasi et al. 1989, Meador et al. 2006).

Structure-related Prey Reduction

There is likely to be a long-term reduction in prey base resulting from the existence of the pier and piles. The substrate along the Seattle Iron and Metal waterfront provide substrate for invertebrates, such as copepods, amphipods, and snails, which might otherwise not be found on soft sediments (Mumford 2007). Copepods and other zooplankton represent the major food base for the food chain in Puget Sound and the LDW, specifically for small and juvenile fish including Pacific herring, sand lance, surf smelt, and salmonids. The intertidal provide important habitat for a variety of marine invertebrates and fishes, including salmonid species.

To the degree that PS Chinook salmon are impaired in abundance or quality (size, fat store, biocaccumulated contaminants) which is presented in more detail in effects on species, below, these effects are detrimental to the prey base of SRKW, and a negative influence on this PBF of SRKW designated critical habitat.

Operations-related Contaminated Forage

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

Migratory Obstruction (long term)
Safe migration conditions of PS Chinook and PS Steelhead are diminished by the presence of structures in and over water. The structures increase the likely presence and success of piscivorous fish, and shade from the structures interfere with juvenile salmonid migration.

The existing and proposed pier and associated piling represent an artificial habitat structure that constitute an alteration of undisturbed habitat conditions. There is concern that these structures can present conditions that are disruptive to normal feeding and migration behaviors, as well as posing elevated risks of predation by creating preferred habitat for ambush predators. Several studies have reported that overwater structures in nearshore marine and freshwater environments can affect light regime, wave energy, substrates, predator-prey relationships, and behavior (Simenstad et al. 1999, Carrasquero 2001, Nightingale and Simenstad 2001).

Fish that would normally swim closer to shore will swim into deeper waters to avoid the pier. OWS create a sharp-edged shadow and Ono (2010) reports that juveniles salmonids tended to stay on the bright side of the shadow edge, 2 to 5 meters away from the dock, even when the shadow line moved underneath the dock. These findings suggest that OWS can disrupt juvenile salmonid migration in marine and riverine shorelines, degrading the role of this habitat for migration and foraging purposes.

Effects on values of critical habitat
Based on temporary and long-term effects of the proposed structure and its use over time on water quality, prey abundance, and prey quality we find the reductions in the PBFs have the following influence on the role of the habitat in the action area:

Conditions of critical habitat for juvenile salmonids – values of habitat to promote growth and maturation values, and safe passage are incrementally diminished and that this effect is chronic.

Conditions for critical habitat for juvenile bocaccio – values to habitat to promote individual growth and survival are incrementally diminished and this effect is chronic.

Conditions for critical habitat of SRKW – values to promote growth and development are incrementally diminished and this effect is chronic.

2.5.2 Effects on Species

Effects on species are a function of exposure and response. Exposure requires presence of the species. Work timing can influence the numbers of individuals likely to be exposed, and lifestage exposed, to construction related effects. Long term effects from the presence or operation of a project means many individuals will be exposed over time, and may influence which lifestages are exposed.

Sound during pile driving (salmonids only)
Vibratory Driving. The sound profile of vibratory pile driving is distinct from that of impact driving, which is known to have injurious sound pressure levels. Assessments of the potential impact of sound on fishes and invertebrates have often overlooked key factors, including the sensitivity of many of these animals to the particle motion that accompanies the transmission of

the sound, rather than the sound pressure (Popper and Hawkins 2018). Early modeling suggested that the basic sense organs used to detect sounds (the otolith organs in the ears of fishes, and the various organs used by invertebrates) are actually sensitive to particle motion. The body of a fish is very similar in average density and elasticity to water and, as a consequence, the tissues move back and forth with the acoustic particle motion. The otoliths (or otoconial masses) within the ears of fishes function like accelerometers to detect this motion.

There is also growing evidence that invertebrates and fishes may be capable of detecting sounds traveling through and on the substrate.

It is reasonably likely that individuals exposed to elevated underwater noise levels could exhibit an avoidance response or temporary displacement from foraging activities, resulting in reduced foraging success or undue energy expenditure. The duration of such a response is expected to be only short-term and intermittent, correlating with instances of pile driving.

Impact Driving. All ESA-listed fish present within the area in which pile driving noise occurs may be affected by elevated underwater noise levels. Sound from driving is not expected to transmit as far as the mouth of the LDW where it joins Elliot Bay.

Impact pile driving is known to injure and/or kill fish, as well as cause temporary stunning and alterations in behavior. High underwater SPLs are known to injure and/or kill fish by causing barotraumas (injuries caused by pressure waves, such as hemorrhage and rupture of internal organs), as well as causing temporary stunning and alterations in behavior (Turnpenny et al. 1994, Turnpenny and Nedwell 1994, Popper 2003, Hastings and Popper 2005). Fish with swim bladders, including salmonids, are more susceptible to barotraumas from impulsive sounds than fish without swim bladders. Any gas-filled structure within an animal is particularly susceptible to the effects of underwater sound (Gisiner et al. 1998).

Physical injury to fish from elevated SPLs may not result in immediate mortality; death may occur several hours or days later, or injuries may be sublethal. Death from barotrauma can be instantaneous or delayed by up to several days after exposure (Carlson 2012). Abbott et al. (2002) reported that Sacramento blackfish (*Othodon microlepidotus*) exposed to high SPLs were still capable of swimming for several hours before death with extensive internal bleeding. Sublethal injuries have been reported to produce a range of effects, including increased energy expenditure, disrupted equilibrium, and compromised ability to carry out essential life functions such as feeding and predator avoidance (Gaspin et al 1976, Govoni et al. 2008; Hastings et al. 1996; Popper 2003).

<u>Vessels Noise (SRKW only)</u>
Vessels will transit to and from the iron dock transiting through Puget Sound. Vessels sounds interfere with SRKW behaviors. Killer whales rely on their highly developed acoustic sensory system for navigating, locating prey, and communicating with other individuals. While in inland waters of Washington and British Columbia, SRKWs are the principal target species for the commercial whale watch industry (Hoyt 2001; O'Connor et al. 2009) and encounter a variety of other vessels in their urban environment (e.g., recreational, fishing, ferries, military, shipping). Several main threats from vessels include direct vessel strikes (which can result in injury or

mortality (Gaydos and Raverty 2007)), the masking of echolocation and communication signals by anthropogenic sound, and behavioral changes (NMFS 2008a). There is a growing body of evidence documenting effects from vessels on small cetaceans and other marine mammals. Research has shown that SRKWs spend more time traveling and performing surface active behaviors and less time foraging in the presence of all vessel types, including kayaks, and that noise from motoring vessels up to 400 meters away has the potential to affect the echolocation abilities of foraging whales (Holt 2008; Lusseau et al. 2009; Noren et al. 2009; Williams et al. 2010). Individual energy balance may be impacted when vessels are present because of the combined increase in energetic costs resulting from changes in whale activity with the decrease in prey consumption resulting from reduced foraging opportunities (Williams et al. 2006; Lusseau et al. 2009; Noren et al. 2009; Noren et al. 2012). Impacts from the panoply of sound in the marine environment can range from serious injury and mortality to changes in behavior. In other cetaceans, hormonal changes indicative of stress have been recorded in response to intense sound exposure (Romano et al. 2003). Chronic stress is known to induce harmful physiological conditions including lowered immune function, in terrestrial mammals and likely does so in cetaceans (Gordon and Moscrop. 1996).

Water Quality – Exposure to Suspended Sediment (salmonids only)

The severity of effect of suspended sediment increases as a function of the sediment concentration and exposure time (Newcombe and Jensen 1996; Bash et al. 2001). Timing of work will reduce the number of fish exposed, but not avoid exposure. Any exposure durations are likely to be limited due to the ephemeral nature of the turbidity plume, and adherence to the in-water construction period to minimize likelihood of salmonid presence. In most cases of exposure, it is expected that increased turbidity will elicit an avoidance response. Any physical trauma caused by turbidity will occur only to fish exposed within a few feet of the activity for an extended period of time, which response we do not expect, instead, we anticipate that fish will detect and avoid areas with high sediment concentration, and any physiological effects are expected to increase the avoidance response.

Chronic exposure to lower levels of suspended solids and turbidity may cause sublethal effects such as loss or reduction of foraging capability, reduced growth, resistance to disease, increased stress and maintenance energy, and interference with cues necessary for orientation in homing and migration (Lloyd et al. 1987, Servizi and Martens 1991).

Suspended sediments have been reported to negatively affect migratory and social behavior and foraging opportunities (Bisson and Bilby 1982, Berg and Northcote 1985). Short-term pulses of suspended sediment have been suggested to influence territorial, gill flaring, and feeding behavior of salmon under laboratory conditions (Berg and Northcote 1985). As visual feeders, research indicates that foraging effectiveness of salmonids can be reduced by turbidity at levels as low as 20 nephelometric turbidity units (NTUs) (Berg 1982).

Water Quality – Chemical and Metals Exposures (salmonids, bocaccio)

Stormwater will discharge episodically into the LDWD year-round. Exposure of PS Chinook and PS steelhead will occur in all locations from the point of discharge to Elliot Bay. In Elliot Bay Bocaccio rockfish may be exposed at two different lifestages – as larvae and as juveniles. All ESA-listed fish species discussed in this Opinion are likely to be exposed to copper, lead, mercury, silver, zinc, ammonia, PCBs, and PAHs in stormwater as well as creosote and its associated contaminants (i.e., PAHs) when old pilings are removed.

PAHs - The intensities and concentrations of potential PAH introduction cannot be predicted, although it would be limited to periods of pile removal. The temporal and spatial extent of PAH introduction is most likely correlated with suspended sediment effects, as discussed above. Exposure of fish to PAHs is generally associated with narcosis, resulting in a general depression of biological and physiological activities (Van Brummelen et al. 1998). These effects may be linked to reduced immune function, increased mortality after disease challenge, and reduced growth (Karrow et al. (1999), Varanasi et al. 1993, Arkoosh et al. 1991, Arkoosh et al. 1998).

Impacts of PAHs on the reproduction and development of wild Puget Sound salmon have not been well characterized, although some laboratory studies have shown abnormal behavioral effects during early development of coho salmon exposed to PAHs (Ostrander et al., 1988, 1989). Casillas et al. (1995, 1998) reported that exposure to PAHs may suppress growth in juvenile Chinook salmon from the Duwamish and Hylebos Waterways.

We acknowledge here that after the spike of contamination that occurs with the removal of creosote piles, a long-term benefit to water quality will occur as that source of contamination will no longer be present.

PCBs - Aside from PAHs (discussed above), the primary contaminants of concern in the LDW include PCBs and other persistent organic pollutants (POPs). However, the most notable pathway of exposure is not via water/suspension of contaminated sediments, but through bioaccumulation, as Kelley et al. (2011) reported no PCBs in fish tissue sampled over a 4-year period of *in situ* caged contaminant exposure studies in the LDW, in which there was an absence of feeding during the caged exposure. Many biological responses have been reported for PCBs, including mortality, impaired growth and reproduction, immune dysfunction, hormonal alterations, enzyme induction, neurotoxicity, behavioral responses, disease susceptibility and mutagenicity reducing fitness of individuals and populations (Meador et al 2002).

Metals – Juvenile fish rearing and migration through the LDW will have the greatest exposure to the suite of contaminants, including metals, with exposure become less intense with distance from the point of discharge.

NMFS has identified has identified the chronic sublethal and acute lethal levels for salmon from three major constituents (see Table 4).

Table 4. Thresholds for biological effects in salmonids from metals in stormwater.

Constituent	Persistent Exposure	Acute Exposure
Copper	*4.8 µg/L*	*3.1 µg/L*
Lead	*210 µg/L*	*8.1 µg/L*
Zinc	*90 µg/L*	*81 µg/L*

Exposure, regardless of location, will be to a mixture of metals and chemicals. Fish response ranges from behavioral changes such as in hierarchical behavior and competition, (Sloman 2007) or avoidance, to olfactory impairment (Svecevicius, 1999; Hecht et al 2007) to sublethal responses and long-term health effects associated with bioaccumulation. Svecevicius et al. (2014) evaluated the bioaccumulation of metals in Atlantic salmon, comparing mixture exposure to single metal exposure, and found that accumulation of zinc, nickel, lead and chromium was significantly higher in most body tissues when exposed to mixtures than to single metals. Metals concentrate in the liver, kidneys, and muscle tissues, as well as gills and spines.

<u>Exposure to Diminished Prey Base (salmonids, bocaccio, SRKW)</u>
In general, early marine juvenile growth is dependent on ample food supply and has been shown to be linked to overall salmonid survival and production (Beamish et al., 2004) (Tomaro et al., 2012). Rapid growth of PS Chinook salmon during the early marine period is critical for improved marine survival (Beamish et al. 2003; Duffy and Beauchamp, 2011).

Limited prey availability due to shade and modified substrate (piles and concrete pad) and diminished in quantity and quality of prey from exposure to contaminated sediments are likely. Juvenile salmonids may experience more competition for limited prey, which diminishes growth and overall fitness for survival in the marine environment. Smaller size also increases their vulnerability to predation by larger fish. ESA-listed fish may also be indirectly exposed to contamination through the food web, which has an array of sublethal and latent effects. Many biological responses in fish and other biota have been reported for PCBs, including mortality, impaired growth and reproduction, immune dysfunction, hormonal alterations, enzyme induction, neurotoxicity, behavioral responses, disease susceptibility, and mutagenicity (Tierney et al. 2014). The range of potential effects of combined POP contaminant exposure include mortality, growth inhibition, and reproductive impairment, all of which could reduce population fitness.

Chinook salmon have been shown to bioaccumulate PCBs and presumably are similarly affected by other organic contaminants in estuarine sediments that accumulate in salmonid prey species and are consumed by fish that rear in the estuary (Meador et al. 2010). Meador et al. (2010) reported that all observed outmigrating juvenile Chinook salmon increased their PCB load in the LDW, and that they accumulated three to five times more PCBs on the east side of the LDW than fish on the west side, which was supported by an almost identical difference in mean sediment concentrations. PCBs are primarily bioavailable through ingestion (Gobas et al. 1999). Amphipods and copepods uptake PAHs from contaminated sediments (Landrum and Scavia 1983; Landrum et al. 1984; Neff 1982), and pass them to juvenile Chinook salmon and other fish through the food web. Varanasi et al. (1993) found high levels of PAHs in the stomach contents of juvenile Chinook salmon in a contaminated waterway (Duwamish). They also reported reduced growth, suppressed immune competence, as well as increased mortality in juvenile Chinook salmon that was likely caused by the dietary exposure to PAHs. Meador et al. (2006) demonstrated that dietary exposure to PAHs caused “toxicant-induced starvation” with reduced growth and reduced lipid stores in juvenile Chinook salmon. The authors surmised that these impacts could severely impact the odds of survival in affected juvenile Chinook salmon. Juvenile PS steelhead were not specifically addressed in the available literature, but it is reasonable to expect that they may be similarly affected by dietary uptake of contaminants.

The annual number of juvenile PS Chinook salmon and PS steelhead that may be exposed to contaminated forage that would be attributable to this action is unquantifiable with any degree of certainty, as is the amount of contaminated prey that any individual fish may consume, or the intensity of any effects that an exposed individual may experience. However, the small affected area suggests that the probability of trophic connectivity to the contamination would be very low for any individual fish. The duration of fish presence in the affected area suggests that the probability of trophic connectivity to the contamination increases for rearing fish. Therefore, for both species, annually, all fish migrating through the may be exposed to contaminated prey but this low in the riverine system, this exposure/consumption of contaminated prey would be more pronounced among the cohorts of juvenile Chinook because of their smaller size and longer duration of presence in the action area. However, because the effects are likely to be latent or sublethal, it would be difficult to identify detectable cohort level or population-level effects because any harm or injury is likely to manifest at later life stages where it cannot be observed as causal. SRKW in turn will have reduced quality of prey, as the salmonids they consume may have sublethal health effects from their exposure contaminants or reduced prey abundance as some exposed salmonids experience reduced survival or reduced fecundity as a consequence of exposure.

Prioritized List of Contaminants of Concern to Southern Resident Killer Whales and Chinook salmon

Level of concern to SRKW Health	**Contaminants of Concern to Southern Resident Killer Whales**	**Contaminants of Concern to Chinook Salmon**
Tier 1 – Major concern	PCBs[1] , DDT[1] , PFOS[1] , PFOA[1]	PCBs, DDT, PFOS, PFOA, Copper, phthalates (DEHP), bisphenol family (BPA), Current-Use Pesticides
Tier 2 – Medium concern	PBDEs[1] , HBCD[1] , mercury and organic mercury	PBDEs, HBCD, mercury and organic mercury, Pharmaceuticals and Personal Care Products
Tier 3 – Minor concern	chlorinated alkanes, 4-nonylphenol, dieldrin, tributyltin, dibutyltin, triclosan, current use pesticides, biological contaminants	PAHs[1] , hydrocarbons, volatile organic compounds, cadmium, lead, microplastics, biological contaminants

[1] PCBs - polychlorinated biphenyls; DDT – dichlorodiphenyltrichloroethane; PFOS – perfluorooctanesulfoic acid; PFOA – perfluorooctanoic acid; PBDEs – polybrominated diphenyl ethers; HBCD – Hexabromocyclododecane; PAHs – polycyclic aromatic hydrocarbons

Figure 6. Prioritized List of SRKW and Chinook Salmon Contaminants of Concern - Canada SRKW Contaminants Working Group

Exposure to Structures in and over aquatic habitat (salmonids only)

Fish migration along the shoreline in marine waters and freshwater shows behavioral responses upon encountering docks and piers (Nightingale and Simenstad 2001). Migrating salmonid responses to overwater cover include migration delays, school dispersal, and migration directional changes (Nightingale and Simenstad 2001, Celedonia et al. 2008a, 2008b). Celedonia et al. (2008) and Williams et al. (2003) both report that juvenile salmon have been shown to migrate along the edges of the shadows of overwater structures rather than penetrate them.

These changes in migration behavior may lead to increased energetic demands to the juveniles or increased risk of predation (Kemp et al. 2005).

King County documents on Elliot Bay and the Duwamish Estuary (King County, 2001) cite Werthamp and Farley (1976) as observing juvenile salmon along open shorelines and under piers in the lower Duwamish River. They noted that more Chinook salmon were seen along shorelines than under piers. Simenstad et al. (1999) and Williams et al. (2003) reported on the potential for increased predation of juvenile salmon around ferry terminals due to predator abundance. Both studies suggested that increased predation rates around these terminals may occur, but are more likely due to over-water structure (or other factors) than in-water vertical structural elements. However, other studies have not documented any increase in predation associated with overwater structures in the marine environment (Ratte and Salo 1985, Shreffler and Moursund 1999, Nightingale and Simenstad 2001). In freshwater, as is the present case, predation has been observed near overwater structures (Carrasquero 2001). In Lake Washington and the Ship Canal, salmonid predators such as smallmouth and largemouth bass can be found directly under piers (Tabor et al. 2004, 2006; Celedonia et al. 2008a, 2008b).

The continued overwater cover may influence juvenile salmonid behavior during their outmigration. However, key fish predators (smallmouth and largemouth bass, northern pikeminnow) found in freshwater systems such as Lake Washington are not present in the LDW, and behavioral responses such as delay of migration and increased bioenergetics expenditure to migrate around the structure are the most likely responses to this structure.

<u>Summary of species effects</u>
Aside from vessel traffic in Puget Sound associated with the movement of metals to and from the Iron Dock, the effect with the largest “reach” in the environment is chemical contamination introduced via stormwater, because of its chronic nature, persisting in water, sediments, and in exposed species that themselves travel into and throughout Puget Sound. Relevant environmental cycles influencing exposure include the probabilistic time necessary for existing pollutants to flush from the basin by river discharge as measured in a half-life estimated to last for days for dissolved pollutants, but will require decades for pollutants adsorbed or absorbed onto sediment.

Of the species exposed directly to these water quality changes (PS Chinook, PS steelhead, and bocaccio), those that are likely to have the greatest level of exposure and response are likely to be steelhead, whose vulnerable juvenile life stage is known to pass through the action area, and spring Chinook, which can rear for a year before their migration to salt water.

SRKW are likely to be exposed to contaminants indirectly through the juvenile and adult consumption of prey (salmon) that have been exposed to the contaminants discharged from the Seattle Iron and Metal facility.

At the site of the Iron Dock itself, species will experience episodic perturbations of their aquatic habitat such as vessel noise, suspended sediment as vessel engines churn water and sediment on docking and departure, as well as chronic conditions associated with the structure, such as shade which interferes with salmonid migration behavior, predator detection, and prey availability.

2.6 Cumulative Effects

Cumulative effects are those effects of future state or private activities, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to the consultation (50 CFR 402.02). Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

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

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

NMFS is unaware of any specific future non-federal activities that are reasonably certain to affect the action area. However, NMFS is reasonably certain that future non-federal actions such as the previously mentioned shoreline and upstream activities are all likely to continue and increase in the future as the human population continues to grow across the region. Continued habitat loss and degradation of water quality from development and chronic low-level inputs of non-point source pollutants will likely continue into the future as population projections suggest that human numbers in the greater Puget Sound region will increase by two million in the next 30 years (Levin 2020; PSRC 2018). Recreational and commercial use of the waters within the action area are also likely to increase as the human population grows. The effects of climate change may also intensify the consequences of water quality effects associated with human population growth, as shifting acidity, salinity, and water temperatures modify food both bioaccumulation and food webs (Alava et al 2018).

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

2.7 Integration and Synthesis

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

2.7.1 Effects on Critical Habitat Conservation Value

The baseline condition of critical habitat in the action area is degraded by decades of anthropogenic changes, many of which function as limiting factors. Among these degrading baseline conditions is poor water quality, frequent vessel traffic, poor prey abundance and prey quality, contaminated sediments, and in/overwater anthropogenic structures that support the human uses which are the source of these degrading conditions. Despite these impairments, the action area has high value for salmonids as a migration area, and also serves as a location for foraging and growth and migration for each of the four species. To this baseline, we add the effects of the proposed action.

As noted in the effects on critical habitat section multiple PBFs are affected by the proposed action, and the extensive effects are from stormwater due to its reach downstream into Elliot Bay, vessel traffic through Puget Sound, intensifying in Elliot Bay and the Lower Duwamish, and prey degradation. At the project site in particular, the structure itself continues to add shade and perturbations that suppress aquatic vegetation and prey, and interrupt migration pathways for salmonids. The effects are chronic, and diminish multiple features of critical habitat. These incremental but chronic effects slightly impair the role or value that the critical habitat serves for each of the species for growth and fitness of individuals and populations. However, as the increment of water quality degradation will be impossible to distinguish from baseline water quality conditions. The proposed action poses a chronic, and additive risk to listed species considered in this opinion, but at a scale and intensity which cannot be distinguished from existing conditions or habitat trends. The conservation value of the critical habitat is therefore unlikely to be reduced by the proposed action in a manner that can be measured.

When cumulative effects are considered, including climate change, it is difficult to evaluate these added effects. The exact effects of climate change are both uncertain, and unlikely to be spatially homogeneous. However, climate change is reasonably likely to modify freshwater/instream conditions by causing more frequent and more intense flooding events, increasing low flow events, and increasing stream temperatures. 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. As human population increase in the Puget Sound Region, it is reasonable to assume that the level of demand on waterways, and the level of upstream influence on waters in the action area will increase, putting negative pressure on all features of habitat to a degree that cannot be forecasted with detail or precision.

2.7.2 Effects on Species at the Population Scale

As identified in Section 2.2, the proposed action is likely adversely affect individuals from 3 ESA-listed species considered in the opinion. Of the many populations comprising these species that have had a viability analysis completed, few rate as "viable." The overall risk of extinction varies among the component populations from low (1 to 5 percent chance of extinction in 100 years) to very high (greater than 60 percent chance of extinction in 100 years. Effects to salmonids are most likely to occur at the greatest level (intensity and duration of exposure, numbers exposed) among the specific populations of salmon and steelhead that must migrate through the LDW, but we expect other salmonid populations within Puget Sound will also likely be affected by stormwater runoff that is a consequence of this action at lower, less acute levels.

The specific populations of listed salmonids that travel through the LDW are the Green River fall Chinook (from the Central/South Puget Sound MPG) and the Green River winter steelhead (from the Central/South Puget Sound MPG), as the Green River enters Elliot Bay through the Duwamish Waterway.

The Green River Steelhead is a priority population for recovery (NMFS 2019); the population appears to be stable in the most recent five years (neither increasing nor decreasing in abundance) although the long-term trend shows declining abundance since 1985 and current viability estimates show that abundance is less than one third of the lower threshold recovery target (NWFSC 2021, in draft).

The Green/Duwamish Chinook population is an integrated wild-hatchery population with a major role played by hatchery fish (NMFS 2007). King County reported in the early 2000s that both 1- and 2-year old Chinook fry have been found in the Duwamish as early as January and exiting in August, with wild Chinook peaking February through March and hatchery fingerlings peaking in May. Both wild and hatchery fish consume benthic, epibenthic, and pelagic invertebrates, most commonly consuming chironomids (freshwater midge larvae), corophium (estuaring amphipods) and daphnia (freshwater planktonic). The Green/Duwamish juvenile Chinook total PCB concentration is highest among juveniles collected in the Lower Duwamish in May (King Co. 2005). The extended residence time indicates high likelihood for significant duration of exposure to contaminants from the project effluent.

Individual level exposure and response to pollutants which occurs repeatedly among successive cohorts is likely to result in population level outcomes (Spromberg and Meador, 2006). "In individual organisms, stormwater can alter physiology, resulting in such phenomena as pericardial oedema and sensory deprivation in juvenile fishes. In turn, the physiological alteration can reduce survival or reproductive output or shift behaviour, and this can have long-term, multi-generational consequences" (Levin et al. 2020). For example, Meador (2013) found that juvenile Chinook that pass through estuaries impacted by stormwater pollution exhibit a 45% reduction in survival during their ocean residence relative to fish that migrate through uncontaminated habitats, which indicates population level abundance declines are likely as a result of successive juvenile cohort exposure to stormwater loads. Green River fall Chinook show a general decline in abundance over the last 15 years (NWFSC 2021 in draft).

The DPS of Puget Sound Bocaccio are not identified with component populations. Effects among individuals are aggregated over space and time to determine effects at the species scale.

The SRKW are listed as an endangered species. Low abundance and productivity are concerns for these listed mammals, and the population estimate at the time of this biological opinion was 74 individuals. SRKW are composed of three “pods,” J, with 24 members, K with 17 members, and L, with 33 members. None of the pods is documented as occurring in Elliot Bay, and we anticipate exposure to reduced prey abundance and prey quality will occur among all pod members, while sound from vessels will have a more pronounced effect on female members of each pod.

As described at section 2.4 the baseline conditions in the action area includes a variety of NMFS identified factors identified as limiting the recovery of these fish species, most notably degraded habitat, including degraded water quality. Other baseline factors affecting fish are hatchery and harvest-related effects, and adverse effects related to hydropower development. Many of the baseline conditions are considered limiting. Poor prey base (both quality and quantity) are concerns for the marine mammals, with ongoing risks from vessels via either noise, or ship strikes. To this baseline, understanding the status of the species/populations, we evaluate the effects of the action.

The project upgrades structural components of in- and overwater structure, ensuring that conditions that depress forage and safe migration conditions will persist for an additional period of years, and all members of future salmonid cohorts in that period will be exposed to these degraded conditions. The suppressed prey availability and impaired rearing conditions - caused by shade, and the impaired migration condition - from predatory species that use the structure as an ambush site result in habitat conditions that support fewer juvenile salmonids that must rely on this habitat for rearing or migration. The degraded habitat expose the individuals to conditions that diminish their fitness - both as juveniles and adults.

The increment of water quality degradation this project will add to the baseline condition is small but chronic. Post-construction stormwater runoff is expected to be less contaminated than the previous discharge due Seattle Iron and Metal’s expected adherence to the requirements of state and federal water quality. However, compliance with these criteria does not address the full array of contaminants, nor remove all regulated contaminants. The salmonids with individuals most likely to be exposed at juvenile lifestages are Green River winter steelhead and Green River fall Chinook. Juvenile bocaccio are not likely to be exposed in high numbers, though it is likely that many larvae will be exposed episodically, when spawn and stormwater pulses coincide. These effects are most likely to be sublethal, and unlikely to increase the level of death or injury among species in a manner that can be measured in any way. Overall, because responses are expected to be sublethal health effects, the abundance of the populations may be diminished over time but because of the nature of the declines are from delayed health effects in multiple cohorts over many years, it is likely to be reduced in a manner that observation identifies as diminishing adult returns that cannot be specifically attributable to the project.

Relative to marine mammals, the species most at risk of exposure is SRKW, based on their extended presence in Puget Sound where they consume contaminated prey. But, similar to fish species, the nature of this exposure among SRKW is both low level and chronic. The response of SRKW to the quality and quantity of their preferred prey being reduced over time is expected to be impossible to discern at either an individual or population scale because on the incremental nature of project effects on the prey is likely to be evenly distributed among all members of the SRKW ESU that consume the prey.

In summary, given the rangewide status of the species likely to be adversely affected by the proposed action, the environmental baseline in the extensive action area, the effects of the proposed action on species, and cumulative effects in the action area. The proposed action poses a chronic risk from the structure and its operations, and temporary additive risk from the construction effects, to listed species considered in this opinion, but at a scale and intensity which cannot be distinguished from surrounding conditions or population trends. When climate change is considered, pressure on all listed species is likely to be negative, and the adaptive ability of listed-species is uncertain. Climate change is likely to produce, over time, reductions in population size, spatial structure, 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, prey, and the biological environment are expected to be of such a small scale that no measurable effects on ESA-listed species abundance or productivity are discernible even when synergistic interactions with the impacts of global climate change are expected.

2.8 Conclusion

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

2.9 Incidental Take Statement

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

2.9.1 Amount or Extent of Take

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

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

- Construction noise
- Suspended sediment
- Contaminated stormwater discharges and vessel pollution
- Reduction of forage base from pollution, construction, and presence of structure

Harm of larval and juvenile bocaccio from exposure to:

- Contaminated stormwater discharges and vessel pollution
- Reduction of forage base from pollution

Harm of SRKW from exposure to:

- Reduction in forage quality from pollution and quantity from pollution and in/overwater structure
- Vessel noise

Injury or Death of juvenile PS Chinook salmon and PS steelhead from exposure to impact driving when proofing the installation of piles.

NMFS cannot predict with meaningful accuracy the number of fishes that are reasonably certain to be injured or killed by exposure to any of these stressors. The distribution and abundance of the fish that occur within an action area are affected by spawning success in upstream areas, habitat quality, competition, predation, and the interaction of processes that influence 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. Not only is presence (exposure) over time highly variable, but because the effects are largely chronic and sublethal, we cannot estimate how many fish are injured directly, or killed indirectly. NMFS knows of no device or practicable technique that would yield reliable counts of individuals that may experience these impacts.

In such circumstances, NMFS uses the causal link established between the activity and the likely extent and duration of changes in habitat conditions to describe the extent of take as a numerical level of habitat disturbance. The most appropriate surrogates for take are action-related parameters that are directly related to the magnitude of the expected take.

- The extent of take of juvenile salmonids from in and overwater structures is the 0.49 acre footprint of the dock. This footprint is equal to the shaded area where migration and prey are impaired for salmonids.

  The extent of take of juvenile salmonids from pile driving noise that is associated with driving of up to 33 piles, with 25 minutes of impact driving per each. Vibratory driving sound above background levels interrupting normal behaviors such as feeding and predator detection is a source of harm; Sound pressure levels associated with impact driving cause injury or death. If the number of piles increases or the duration of driving increases, then duration and intensity of exposure would also increase.

- The extent of take of juvenile salmonids from turbidity is the authorized mixing zone for turbidity, 300 feet downstream of the point of discharge in the Lower Duwamish Waterway. This is the area within which sediment and contaminated sediment will cause immediate physical response and incur latent sublethal health effects. If the presence of visible elevated suspended sediment levels is apparent beyond 300-foot buffer this would indicate exceedance of take.
- The extent of take of juvenile salmonids, and juvenile and larval bocaccio, and SRKW from water quality reductions and consumption of contaminated prey and total reductions prey reductions associated with prey exposure to contaminated water that is produced from runoff from the amount of impervious surface at the project site, 9.12 acres. If the footprint of impervious surfaces increases at the site, or if the capture of stormwater is from less than this area, then load of contaminants will increase and the extent of harm will be exceeded.

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

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

2.9.2 Effect of the Take

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

2.9.3 Reasonable and Prudent Measures

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

The COE shall minimize take from the proposed action by:

1. Ensuring that the applicant conduct monitoring and reporting to confirm that the exempted take for the proposed action is not exceeded.
2. Ensuring the applicant meets state stormwater management protocols and ensures discharges at the site meet state requirements.

2.9.4 Terms and Conditions

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

1. To implement RPM Numbers 1 and 2, the applicant shall confirm that the take exemption for the proposed action is not exceeded through the following monitoring and reporting:
    a. Demonstrate compliance/noncompliance with the NPDES permit/state water quality criteria by:
        i. Providing a copy of stormwater and other monitoring data as required by the facility's NPDES permit and produced to WA Department of Ecology in an annual report to NOAA for 3 years post-construction.
    b. Observe at hourly intervals during work, from the shore or from a vessel, the downstream extent of the visible turbidity plume created during in-water work. If the visible plume exceeds 300 feet, suspend work until the plume has dissipated to a level constrained by the mixing zone before recommencing work. Contact the NMFS consulting biologist at 360 995 2750 if the visible plume exceeds the mixing zone two or more times in order to identify available measures to further reduce turbidity during work and ensure the extent of take is not exceeded.
    c. Observe from shore or from a vessel, during impact driving, to detect any dead or injured fish floating to the surface, or unusually high levels of avian predation that would indicate sound injury among salmonids. If such conditions are observed, cease work and contact NMFS the NMFS biologist at 360 995 to identify available measures to further reduce sound pressure levels, and ensure the extent of take is not exceeded

2. To implement RPM Number 1, the COE or the proponent shall provide a post construction report within 6 months of project completion, including;
    a. As-built dimensions of the dock.
    b. Describe the general character of recyclables removed from substrate near the dock (e.g., how many pieces, size of pieces)

Send reports by electronic copy to: projectreports.wcr@noaa.gov. Be sure to include Attn: WCRO-2019-00112 in the subject line.

The ESA authorized NOAA to exempt non-jeopardizing take that is incidental to otherwise lawful actions. The applicant must adhere and comply with all state and federal laws and permits. Water quality exceedances in violation of state standard may result in unauthorized take.

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 applicant should implement water treatment protocols and build infrastructure to reduce contaminant levels below detectable levels.
2. The applicant should work to reduce contaminants in the discharged stormwater to levels below effect levels for ESA listed species.
3. The COE should encourage the applicant to develop a long-term plan to reduce the environmental impacts Suggested measures include:
   a. Replant native vegetation along the shoreline in the riparian belt;
4. Ensuring mitigation of impacts to aquatic resources under 33 CFR parts 325 and 332. The applicant should provide biologically relevant mitigation that would offset the specific impacts to listed species and habitat totally at least 0.21 DSAYs within 1 year of the completion dock improvements.
   a. The mitigation must be in kind and within the action area as described above.
   b. Submit an electronic post-construction report to NMFS within six months of project completion.

Send the report to: projectreports.wcr@noaa.gov. Be sure to include Attn: WCRO-2019-11342 in the subject line.

2.11 Species and Critical Habitats Not Likely to be Adversely Affected

Humpback whales were listed as endangered under the Endangered Species Conservation Act in June, 1970 (35 FR 18319), and remained listed after the passage of the ESA in 1973 (35 FR 8491). Humpbacks are divided globally by the NMFS into 14 DPSs and place four DPSs (Western North Pacific, Arabian Sea, Cape Verde/Northwest Africa, and Central America) as endangered and one (Mexico DPS) as threatened (81 FR 62259). Photo-identification and modeling efforts indicate that a large proportion of humpback whales feeding along the coasts of northern Washington and southern British Columbia are from the Hawaii DPS (63.5 percent), with fewer animals from the Mexico (27.9 percent) and Central America (8.7 percent) DPSs (Wade 2017).

Critical habitat was designated for humpback whale DPSs in April, 2021 (86 FR 21082). Critical habitat for the Central America DPS and Mexico DPS of the humpback whale extends from the Pacific Ocean into the Strait of Juan de Fuca, to Angeles Point, just west of Port Angeles. Critical habitat encompasses off shore areas up to 1200 meters with the shoreward boundary at 50 meters. The proposed project would not be located within designated critical habitat, and unlike SRKW, humpback whales do not prey upon salmonids, thus we do not anticipate effects of the action to occur among prey communities that would be a feature of critical habitat at any location. Effects to features of humpback whale critical habitat are discountable.

Data has not been collected on the proportion of DPSs within the Salish Sea, but is likely to be similar to presence at coastal Washington areas. For our analysis, we consider humpback whales migrating or foraging off the coast or in inland waters of Washington to primarily originate from the listed Mexico or non-listed Hawaii DPSs, with a smaller proportion being Central America humpback whales, following Wade (2017). However, because of limited data availability for the inner Salish Sea, we have presented our humpback whale text outside of the scope of DPS. With current limited data, any individual humpback in the inner Salish Sea should be assumed to be part of a listed population, unless proven otherwise.

Numbers of humpback whales have been growing annually at a rate of 6-7.5% off the U.S. west coast (Carretta et al. 2020; Calambokidis and Barlow 2020). Humpback whale sightings in the Salish Sea have also been increasing since the early 2000s (Calambokidis et al. 2018). Humpbacks whales have been documented occasionally in Elliot Bay, including a fatal strike by a ferry in 2019. However, vessels associated with the Iron Dock are barges, which have a top speed of about 8 knots, a vessel speed considered by NMFS to be suitable for increasing safety of endangered Right whales by enabling them to avoid moving vessels. We assume here that because of the barge's low speed, the likelihood of vessel strike of humpback whales from barges is discountable.

While humpback whales can bioaccumulate lipophilic compounds (e.g., halogenated hydrocarbons) and pesticides (e.g., DDT) in their blubber, by feeding on contaminated prey (bioaccumulation) or inhalation in areas of high contaminant concentrations (Barrie et al. 1992; Wania and Mackay 1993) no detectable effect from contaminants has been identified in baleen whales. In the 2015 NMFS status review of humpback whales, contaminants were currently not considered an important threat to the Central America, Mexico, and Hawaii DPSs (Bettridge et al. 2015). Because no detectable effects of contaminants have been identified in humpback whales, response of humpback whales to any direct (via water quality) or indirect (via contaminated prey) exposure to contaminants is considered insignificant.

Based on data available in 2015, the threat of anthropogenic noise received a "low" rating for all DPSs of humpback whales in the recent NMFS Status Review (out of possible ratings of unknown, low, medium, high, and very high; Bettridge et al. 2015). Noise from pile driving is not expected to reach Elliot Bay due to bends in the river constraining sound transmission to the riverine environment. This source of sound is discountable for humpback whales.

The proposed actions are not intended to increase the number of barges to and from the Iron Dock, through Puget Sound. Barge traffic is expected to continue to and from the Iron Dock at current levels for the foreseeable life of the project. While noise from vessel traffic has been shown to cause variation in humpback whale behavior from changes in surface, foraging, and vocal behavior, displacing animals from occupied areas we do not expect such results as a consequence of the proposed action. Humpback whales have been found to move away from noise sources (Dunlop et al. 2016), reduce male singing activity (Sousa-Lima and Clark 2008, Risch et al. 2012), reduce feeding activity (Siyle et al. 2016), and alter their migration path and speed (Dunlop et al. 2015, 2016). Williams et al. (2014) found coastal marine noise levels high enough to potentially cause significant communication problems for humpback whales at several locations in British Columbia, including Haro Strait in the Salish Sea adjacent to Washington.

However, Schuler et al. (2019) found that feeding and traveling humpback whales were likely to maintain their behavioral state regardless of vessel presence, while surface active humpback whales were likely to transition to traveling in the presence of vessels, and Dunlop (2016) found that vessel noise did not appear to alter humpback communication behavior.

Large vessels, including the cruise ships and tour vessels, generate low frequency noise (Arveson & Vendittis 2000), and a recommendation by Sprogis et al., in 2020 is that whale watch vessels slow to 10 knots to reduce sound levels that humpback whales would experience, as low frequency sound was observed to have fewer responses among mother/calf pairs of humpback whales. Because the vessels associated with the Iron Dock are barges, which travel at a low rate of speed and with larger motors, noise is expected to elicit insignificant response among exposed humpback whales.

Because the proposed action would extends the functional life of the structure, it would also maintain existing commercial vessel traffic, thus we would expect the relative risk of ship strike as a consequence of the proposed action to be the same as it is now. Humpback whales have been observed in Elliot Bay, and a Washington State Ferry did fatally strike a young humpback whale in Elliot bay in 2019. At the time, it was believed to be the first ferry/whale collision in roughly 30 years. At the time, John Clambokidis of Cascadia Research was quoted in print media as saying that at least 90% of all whales hit by large vessels die, and most sink.[2] However, vessels to and from the Iron Dock are typically slow-moving barges, and none have been recorded as having struck any humpback whales.

Coastal studies of vessel strikes by large ships show that humpback whales are particularly vulnerable due to their feeding methods near the surface and mother/calf pairs that stay near the surface. Of 292 recorded strikes contained in the Jensen and Silber (2003) west coast database, 44 were of humpback whales, second only to fin whales. According to a NMFS West Coast Region whale collision database, there have been 31 documented humpback whale strikes by vessels in the state of Washington since 1995. In the past several years, documented humpback whale strikes have occurred in association with large vessels, such as the Bainbridge Island ferry in May 2019 (NWPB 2019), and the Whidbey Island ferry in July 2020 (Cascadia Research Collective, 2020). These collisions have resulted in the assumed fatality of the individual.

Areas with high boat traffic pose a higher collision risk for humpback whales. These include the mouths of the Strait of Juan de Fuca and Columbia River, the north-south shipping lane leading to California, and the Strait of Juan de Fuca and other parts of the Salish Sea (Williams and O'Hara 2010, Nichol et al. 2017, Rockwood et al. 2017). However, vessel traffic associated with the Iron dock are barges, which move at only about 8 knots or lower, making them avoidable by whales. For example, NOAA has published rules regarding vessel speed to reduce strikes between vessels and Right whales, limiting speed to 10 knots or less.

Because the vessels to and from the Iron Dock will be slow moving barges, and as no documentation of vessel strikes to humpback whales are associated with barge traffic to or from

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[2] https://www.thedailyworld.com/northwest/whale-ferry-collision-in-seattles-elliott-bay-a-byproduct-of-humpback-revival/ May 31, 2019; accessed June 23, 2021.

the Iron Dock, likelihood of exposure to vessel strikes as a consequence of this proposed action is considered discountable.

2.12 Reinitiation of Consultation

This concludes formal consultation for the U.S. Army Corps of Engineers' authorization of the Seattle Iron and Metal South Dock Rehabilitation, King County, Washington. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitats in a manner or to an extent not considered in this Opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitats that was not considered in this Opinion, or (4) a new species is listed or critical habitat is designated that may be affected by the action.

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

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect essential fish habitat (EFH). The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."

Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810).

Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. This analysis is based, in part, on the description of EFH for Pacific Coast salmon contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC 2014) and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

Designated EFH for salmonids and groundfish occur within the action area Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other waterbodies currently or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable human-made barriers (as identified by the PFMC 1999), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years) (PFMC 1999).

In estuarine and marine areas, designated salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone offshore of Washington, Oregon, and California, north of Point Conception to the Canadian border (PFMC 1999).

The proposed action and action area for this consultation are described in section 1 of this document and include freshwater areas for salmonids. The waters and substrate of Elliot Bay waterway are designated as EFH for several Groundfish (e.g., English sole [*Parophrys vetulus*], and starry flounder, [*Platichthys stellatus*]), as well as for various life-history stages of Pacific Coast Salmon. EFH for Pacific salmon is identified and described in Appendix A in the Pacific Coast salmon fishery management plan (PFMC 2014).

3.2 Adverse Effects on Essential Fish Habitat

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

3.3 Essential Fish Habitat Conservation Recommendations

The proposed action includes design features that are expected to reduce impacts on the quantity and quality of for Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species EFH. It also includes a conservation measure and BMP to minimize construction-related effects. While these conservation measures and BMPs are commendable, they are not sufficient to completely avoid or offset all effects to the listed EFH. Therefore, additional conservation recommendations pursuant to MSA (§305(b)(4)(A)) are necessary. The following conservation recommendations are prescribed:

1. The applicant should implement water treatment protocols and build infrastructure to reduce contaminant levels below current standards.
2. The applicant should work to reduce contaminants in the discharged stormwater to levels below effect levels for ESA listed species.
3. The COE should encourage the applicant to develop a long-term plan to reduce the environmental impacts. Suggested measures include:
    b. Replant natural plantings along the shoreline in the riparian belt;
4. The applicant should provide biologically relevant mitigation that would offset the specific impacts to listed species and habitat totally at least 0.21 DSAYs within 1 year of the completion of the construction of the dock modifications.
    a. The mitigation must be in kind and within the action area as described above.
    b. Submit an electronic post-construction report to NMFS within six months of project completion. Send the report to:
        projectreports.wcr@noaa.gov.
        Be sure to include Attn: WCRO-2019-00112 in the subject line.

3.4 Statutory Response Requirement

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

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

3.5 Supplemental Consultation

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this Opinion is the COE and the applicant. Other users could include WDFW, the governments and citizens of King County and the City of Seattle, and Native American tribes. Individual copies of this Opinion were provided to the COE. The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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