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

Refer to NMFS Consultation No:
WCRO-2018-00067
(Previous NMFS No.: WCR-2018-10257)

August 14, 2019

Michelle Walker
Chief, Regulatory Branch
Seattle District, Corps of Engineers
PO Box 3755
Seattle, Washington 98124-3755

Re: Endangered Species Act Section 7(a)(2) Biological Opinion Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Columbia River Carbonates Woodland Marine Terminal Project, Cowlitz County, Washington (HUC_{12}-170800030900-Cathlamet Channel-Columbia River) (NWS-2013-834)

Dear Ms. Walker:

Thank you for your letter of July 6, 2018, requesting initiation of formal consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Columbia River Carbonates Woodland Marine Terminal project.

As required by section 7 of the ESA, NMFS is providing an incidental take statement with the enclosed biological opinion (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. The take statement sets forth nondiscretionary terms and conditions, including reporting requirements, that the Federal action agency must comply with to carry out the reasonable and prudent 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.

In this opinion, NMFS concludes that the proposed action is not likely to jeopardize the continued existence of Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*), Upper Columbia River (UCR) spring-run Chinook salmon, Snake River (SR) spring/summer run Chinook salmon, SR fall-run Chinook salmon, Upper Willamette River (UWR) Chinook salmon, Columbia River (CR) chum salmon (*O. keta*), LCR coho salmon (*O. kisutch*), SR sockeye salmon (*O. nerka*), LCR steelhead (*O. mykiss*), Middle Columbia River (MCR) steelhead, UCR steelhead, Snake River Basin (SRB) steelhead, UWR steelhead, or result in the destruction or adverse modification of designated critical habitats.

The NMFS also concludes that the proposed action is not likely to adversely affect the southern designated population segment (sDPS) of eulachon (*Thaleichthys pacificus*), the sDPS of green sturgeon (*Acipenser medirostris*), or their designated critical habitats.

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. We have included the results of that review in Section 3 of this document. This section includes four conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects on the EFH of Pacific Coast salmon management plan. The conservation recommendations includes a subset of the ESA take statement's terms and conditions. Section 305(b) (4) (B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving these recommendations.

If the response is inconsistent with the EFH conservation recommendations, the Federal action agency must explain why the recommendation will not be followed, including the scientific justification for any disagreements over the effects of the action and recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we request that in your statutory reply to the EFH portion of this consultation, you clearly identify if the conservation recommendations are accepted.

As stated in 50 CFR 402.14(g)(5) the NMFS will consider comments or concerns regarding this consultation transmitted in writing. Please submit comments via email to Scott Sebring (scott.sebring@noaa.gov) of the Oregon-Washington Coastal Office in Lacey, Washington.

Sincerely,

istrator
Oregon Washington Coastal Office

cc: Danette Guy, USACE
Juliana Houghton, USACE

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

Columbia River Carbonates Woodland Marine Terminal Project, Cowlitz County, Washington (HUC$_{12}$-170800030900-Cathlamet Channel-Columbia River) (NWS-2013-834)

NMFS Consultation Number: WCRO-2018-00067
Previous NMFS No.: WCR-2018-10257

Action Agency: U.S. Army Corps of Engineers

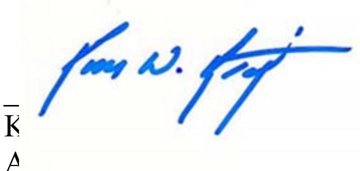
Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tschawtscha*)	Threatened	Yes	No	Yes	No
Upper Columbia River (UCR) spring-run Chinook salmon	Endangered	Yes	No	Yes	No
Upper Willamette River (UWR) Spring-run Chinook salmon	Threatened	Yes	No	Yes	No
Snake River (SR) spring/summer run Chinook salmon	Threatened	Yes	No	Yes	No
SR fall-run Chinook salmon	Threatened	Yes	No	Yes	No
Columbia River (CR) chum salmon (*O. keta*)	Threatened	Yes	No	Yes	No
LCR coho salmon (*O. kisutch*)	Threatened	Yes	No	Yes	No
SR sockeye salmon (*O. nerka*)	Endangered	Yes	No	Yes	No
LCR steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
Middle Columbia River steelhead	Threatened	Yes	No	Yes	No
UCR steelhead	Threatened	Yes	No	Yes	No
UWR steelhead	Threatened	Yes	No	Yes	No
Snake River Basin (SRB) steelhead	Threatened	Yes	No	Yes	No
Southern DPS (sDPS) of green sturgeon (*Acipenser medirostris*)	Threatened	No	No	No	No
sDPS of Pacific eulachon (*Thaleichthys pacificus*)	Threatened	No	No	No	No

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

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:



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Oregon Washington Coastal Office

Date: August 14, 2019

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1. INTRODUCTION

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

1.1. Background

The National Marine Fisheries Service (NMFS) prepared the opinion and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 and implementing regulations at 50 CFR 402. We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file at the Oregon and Washington Coastal Office.

1.2. Consultation History

On November 15, 2017 the COE sent a letter to NMFS requesting early ESA consultation for the construction of a marine terminal in Woodland, Washington.

- On March 27, 2018 the NMFS attended a site visit to the proposed location with other state and federal entities. The NMFS provided feedback on CRC's proposal on April 11, 2018.
- On April 2, 2018 the NMFS received notification that the COE was withdrawing their request for early consultation and would provide updated information to a forthcoming formal consultation package.
- On July 9, 2018, NMFS received a letter from the COE proposing to grant a permit to CRC for construction of a marine terminal under the Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. In this letter the COE requested formal consultation under the ESA with the NMFS. The COE provided an application package that included a biological assessment, mitigation plan, and supplemental information provided by the applicant's agent, Ecological Land Services (ELS), LLC.
- On August 22, 2018, the NMFS contacted the COE and requested information about moorage and transport route of marine barges. The COE responded the following day acknowledging the request.
- On October 23, 2018, the NMFS sent a letter to the COE and CRC requesting an additional 60 days to complete the draft biological opinion. CRC general counsel responded later that day accepting the 60-day extension request.
- On November 26, 2018, the COE sent a letter to the NMFS requesting an update on the status of delivering a draft biological opinion. The NMFS responded to the request on December 6, 2018.

- On February 5, 2019, the NMFS sent a second letter to the COE and CRC requesting an additional 60 days to complete the draft biological opinion. The NMFS requested this extension as a result of the 35-day lapse in government appropriations from December 22, 2018 to January 27, 2019. CRC general counsel responded later that day accepting the 60-day extension request.
- On February 7, 2019, the COE responded to the NMFS agreeing to the additional 60-day extension request.
- On May 16, 2019 the NMFS requested the COE include four conservation measures regarding herbicide use into the proposed action. On May 21, 2019 the COE responded to the inquiry and requested to include all four conservation measures to the proposed action.
- On July 1, 2019 the NMFS provided the COE with a draft version of the biological opinion.
- Only July 31, 2019 the COE responded with comments to the draft version of the biological opinion.

In its initial request the COE determined that the proposed action is likely to adversely affect (LAA) all thirteen species of salmon and steelhead and their designated critical habitats. The, COE determined that the proposed action is not likely to adversely affect (NLAA) the sDPS of eulachon, the sDPS of green sturgeon, and designated critical habitats of these species. Analysis supporting the NLAA determination is found in section 2.11 of this document.

1.3. Proposed Federal Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02).

The COE seeks to permit within its authority under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act, the proposed construction of a marine terminal and management of a 9.4-acre parcel for by Columbia River Carbonates (CRC). CRC proposes to import high-grade, high-bright calcium carbonate (i.e., limestone rock) sourced from its marine-based mine located in southeast Alaska. CRC proposes to receive and temporarily store this material onsite prior to final processing at its production facility in Woodland, Washington.

CRC proposes to construct the new marine terminal exclusively for the purposes of importing limestone with the stated aim of ensuring that sources of potential windblown contamination (e.g., dirt, dust, and leaves) are minimized prior to final processing. CRC proposes to temporarily berth marine transport barges at the terminal and use a large front-loader to unload limestone from the surface of the barge deck onto an enclosed conveyor belt that will transport limestone to the shore-based temporary upland storage area. The enclosed conveyor is designed to minimize potential contamination as well as particulate loss. CRC proposes to maintain limestone delivery quantities at the current level.

CRC's proposed marine terminal design consists of numerous overwater support structures, including: berthing and mooring dolphins, grated steel walkways, and a large hoist and transfer towers to support moorage of marine transport barges and material offloading capabilities

(Figure 1). The proposed design for moorage of marine transport barges will be stabilized by berthing dolphins and mooring dolphins. CRC proposes to install 26-foot by 15-foot (390 square foot) berthing dolphins to support the loading dock, and smaller 16-foot by 12-foot (192 square foot) mooring dolphins. CRC proposes to commence construction in upland areas during the dry season late spring, early summer period after seasonal peak flows have receded and inundation of floodplain habitat will not occur. CRC proposes to complete construction in areas below ordinary high water from October through December 15.

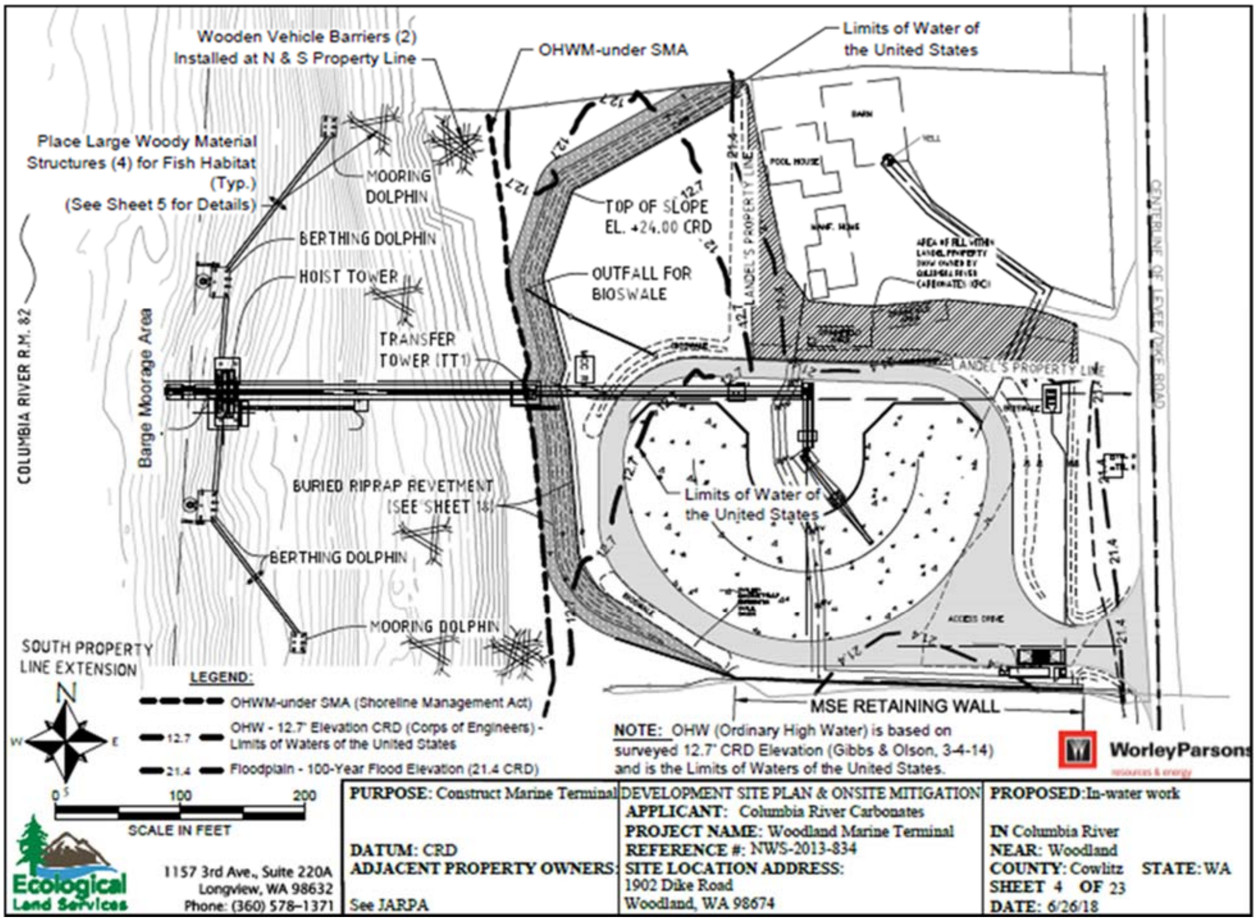

Figure 1. Proposed marine terminal construction.

Each dolphin will consist of six to seven 24-inch diameter steel piles supporting a 48-inch thick concrete pad connected by 4-foot wide grated steel walkways (Figure 2). All walkway surfaces will consist of grated steel allowing 60 percent light penetration. Large, cylindrical-shaped 'donut' fenders measuring 95 square feet will be placed waterward of the berthing dolphins to provide protection when barges are moored at the terminal. The concrete dolphins and walkways are designed to be elevated about 10 feet above the ordinary high water (OHW) level (i.e., 12.7 feet Columbia River Datum [CRD]). Two 14-inch steel piles will support elevated walkways between the concrete pads.

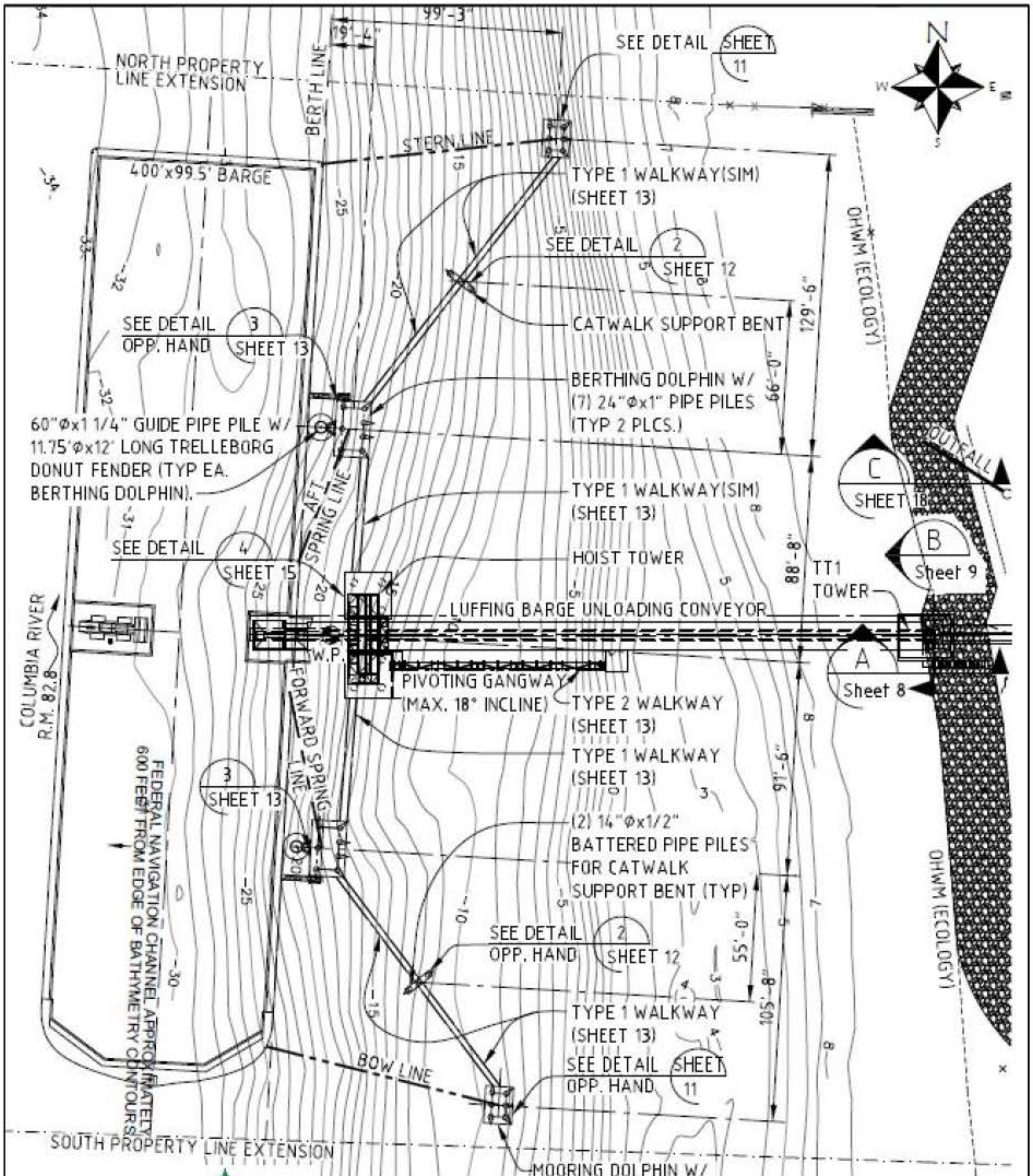

Figure 2. *Overwater view of the proposed marine terminal (ELS 2018).*

The two large towers supporting the material conveyor system will have a 42-inch thick concrete pad supported by 24-inch steel piles. The hoist tower is located approximately 240 feet from the shoreline and consists of two similarly-sized concrete pads between which the material conveyor system is positioned. The two concrete pads that form the hoist tower will each be supported by four 36-inch steel piles. The 26-foot by 30-foot transfer tower pad located adjacent to the shoreline will be supported by nine 24-inch steel piles.

CRC proposes to begin installing steel piles by using a vibratory hammer until the pile strikes bedrock substrate or until refusal. To achieve the proper load bearing capacity specifications the contracting engineer will use an impact hammer to place each pile to an elevation of 50 to 60 feet below the mudline. CRC estimates 500 to 1,000 strikes per day, requiring 14 days of construction that is spaced over approximately 3 weeks. When using an impact hammer contractors will surround all vertically-oriented piles with a high density polyethylene pipe and use a bubble curtain to attenuate sound pressure. A total of 26 piles, most used to support mooring dolphins will be installed at an acute angle and placed through a large template to ensure precise installation is achieved. CRC will not use a bubble curtain or other sound attenuation method because the polyethylene pipe used to confine air bubbles will not fit within the template. CRC proposes to install rock anchors inside 26 of the 24-inch steel piles, which will require about 25 days of construction after pile installation. The rock anchors will then be sealed with grout and tested to ensure the proper tension specifications are achieved.

Contractors will use a ‘soft-start’ procedure to initiate vibratory and impact pile driving. The procedure consists of operating the vibratory hammer for 15 seconds at 40 to 60 percent power, followed by a 1 minute waiting period prior to operating the equipment at 100 percent power. The contractor will repeat this procedure two additional times before operating the vibratory hammer at full power. Contractors will use the ‘soft-start’ procedure each time pile driving is delayed by 30 minutes. Contractors will also use a ‘soft-start’ procedure prior to operating the impacting hammer at full power. The procedure consists of three pile strikes at 40 percent, separated by a 1 minute waiting period, and repeated three times prior to operating the equipment at full power.

The marine terminal includes construction in a 3.75-acre upland area where CRC proposes rock will be offloaded, stockpiled, and loaded onto trucks (Figure 3). CRC proposes to fill a total of 0.9 acres at elevations less than 12.7 feet Columbia River Datum (CRD) that defines ordinary high water (OHW) and the limits of the waters of the United States in this area of the Columbia River. Elevations below OHW are considered floodplain habitat. CRC proposes to remove surrounding vegetation and locate the stockpile area at the highest possible elevation to decrease sources of fine sediment and leaf litter that may contaminate limestone rock from riverine or airborne sources.

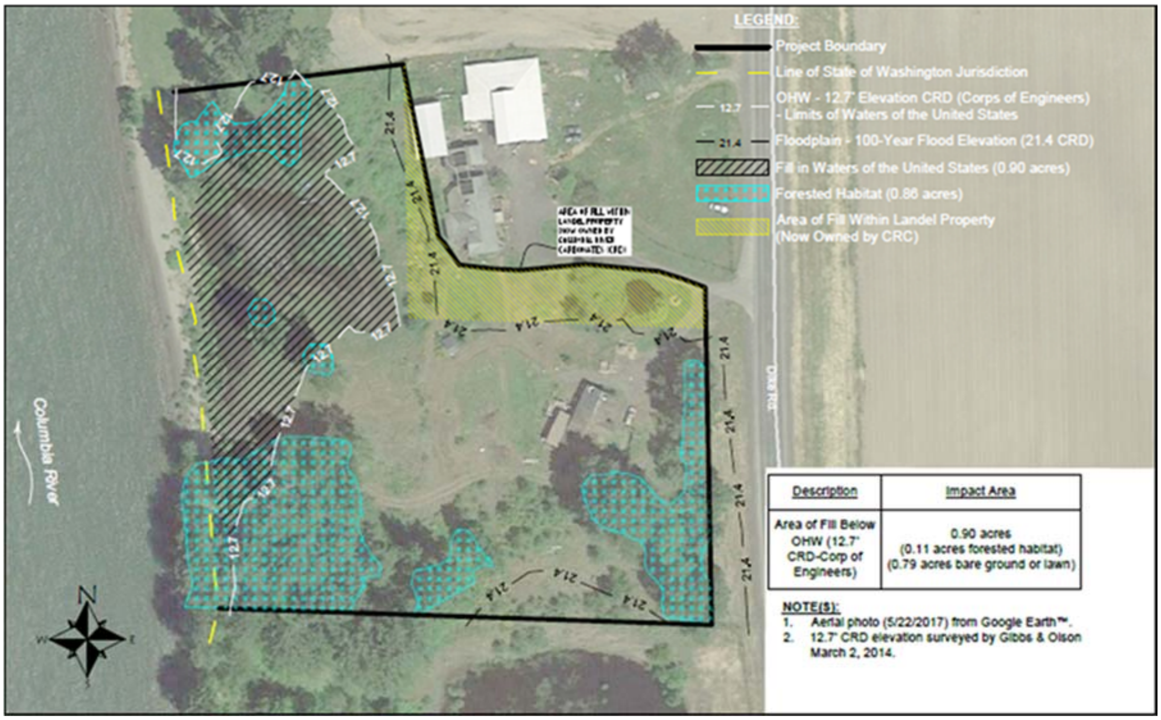

***Figure 3**. Proposed upland development site (ELS 2018).*

CRC proposes to complete on-site mitigation at the development site that includes placement of large woody debris (LWD) jams and riparian plantings. A total of six LWD structures are proposed for installation adjacent to the shoreline (Figure 4). CRC proposes to install four structures, each composed of 3-6 logs with attached rootwads, near the low water line at approximately 0 feet CRD. Two larger structures each measuring 40 feet by 50 feet will be installed on each end of the property line at higher elevations on the shoreline to reduce vehicular traffic. The larger structures are not intended to provide the same potential benefits for juvenile fish rearing and refugia habitat. Contractors will use an excavator to install and anchor logs into the substrate and will link pieces within each structure with wire rope, threaded rod, and metal fasteners. Some wood pieces will be embedded several feet into the sediment to provide sheer strength the necessary to hold the entire structure in place. Each structure may take a day to install, yielding a total of 6 days of shoreline construction.

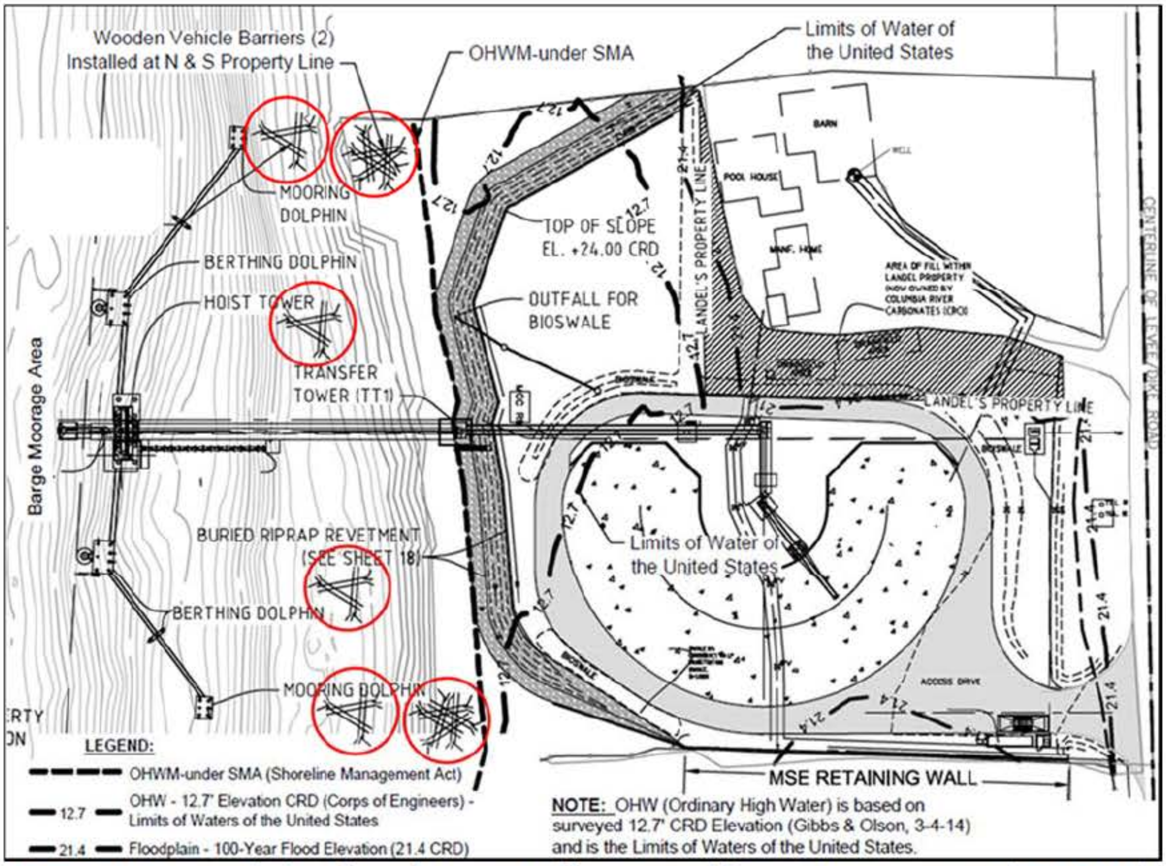

***Figure 4**. Proposed shoreline placement of large wood for on-site mitigation (ELS 2018).*

CRC will construct barrier walls and install vegetation atop an earthen berm to provide a buffer to the neighboring recreational vehicle park on the north side of the property. CRC proposes to install rock revetment along 440 feet of the shoreline to prevent erosion of the upland storage area. CRC proposes to complete construction in upland areas using excavators, front-loaders, and other standard heavy construction equipment. Additional volumes denoted in cubic yards (cy) of material for excavation and fill are provided below in Table 1.

***Table 1**. Proposed fill and excavation quantities at the CRC development site.*

Purpose	Material	Below OHW (cy)	Above OHW (cy)	Total (cy)
Removal	native soils	-2,189	-1,505	-3,313
Fill	Topsoil (3-foot depth)	2,643	1,265	2,809
Fill	Crushed rock (6-inch)	654	293	943
Fill	Sand fill	1,656	403	2,059
Fill	Dredged sand	9,032	21,312	41,204

CRC proposes by to stabilize the river bank by raising the existing elevation by about 14 feet with the addition of 41,204 cy of 6-inch-minus crushed rock bedding material, concrete, masonry, and Class II riprap (Figure 5). The sloped section of the armored streambank will be covered by a 3-foot thick layer of topsoil. The post-construction elevation of the site will be 24.0 feet CRD, which is above the 100-year floodplain of 21.4 feet CRD. CRC will install native plant species interspersed with woody debris to provide additional anchorage of the soil.

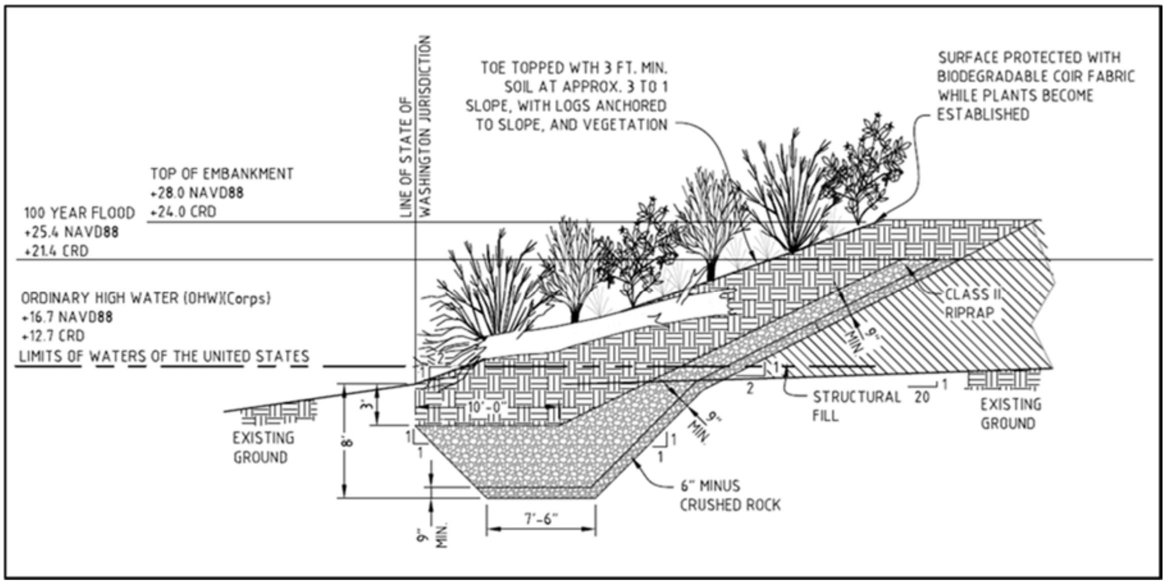

Figure 5. Riparian plantings on regraded streambank (ELS 2018).

The proposed action will modify stormwater conveyance as a result of the altered contours and fill. CRC will implement a stormwater pollution and prevention plan (SWPPP) during the construction phase that will include and temporary and permanent stormwater treatment facilities. The total area receiving drainage is limited to 3.1 acres. CRC will treat all stormwater from this area by constructing bioswales, vegetated filter strips, or other vegetated areas. All treated water will be delivered to a single outfall which will drain into the Columbia River. CRC has designed site drainage to comply with the Stormwater Manual for Western Washington (DOE 2012). In addition, CRC proposes to obtain an industrial stormwater national pollution discharge elimination system (NPDES) permit and comply with all requirements for materials handling, storage, and conveyance during operation of the terminal.

CRC proposes a maximum of 24 barges per year, with unloading procedures restricted from 7:00AM to 10:00 PM. Employees will activate task lights on the waterward end of the marine terminal designed to illuminate the barge, berthing and mooring dolphins, and associated walkways when barges are being unloaded. Overwater lights will be shielded to focus illumination near work areas. Automatic shut-off timers installed on all overwater task lights are designed to facilitate safe operation and ensure that the site is not artificially illuminated when unloading operations are not ongoing.

CRC uses marine transport barges that measure 400-foot long by 100-feet wide (0.91-acres), draw 21 feet deep when fully loaded. CRC anticipates barges will require 1 to 4 days to unload. After unloading, CRC staff will undock the barge for transport to the material loading point in Alaska. Once limestone is transported via the enclosed conveyor belt to the upland storage location it will be loaded onto trucks and transported 2.25 miles to the manufacturing facility in Woodland. CRC intends to store enough limestone onsite to provide 25 daily truck transport trips to the processing facility.

Mitigation site

CRC proposes to mitigate for floodplain fill and decreased habitat functions in shoreline and aquatic habitats by restoring an undeveloped 9.4-acre parcel located 2.5 miles upstream of the marine terminal (Appendix A, Figure 6). CRC proposes to establish and record a permanent and irrevocable deed restriction, conservation covenant, or similar legal document with Cowlitz County to protect the mitigation site from development in perpetuity (ELS 2018). CRC's agent, Ecological Land Services (ELS), completed a habitat equivalency analysis (HEA) to determine the number of discount service acre years (DSAYs) associated with the proposed development and mitigation sites. The HEA methodology provides a quantitative comparison of value between habitat types between the mitigation site and the development site. A summary of DSAYs calculated by ELS for specific habitat types in both the development site and mitigation site is included below in Table 2. In this case, because deep water and upland habitats do not occur on the mitigation site, the applicant proposes that degradation occurring in these habitats at development site will be offset by functions provided by 1) shallow water (10.222 DSAYs), 2) active channel margin (13.993 DSAYs), and 3) 100-year floodplain (7.333 DSAYs) habitats. Under the HEA analysis the proposed mitigation generates 5.138 DSAYs in habitat function more than the DSAY loss associated with the development site.

***Table 2**. Habitat types, elevations, and discount service acre years associated with the development and mitigation sites.*

Habitat type	Elevation	Development site	Mitigation site (after restoration)	Total
Deep water	Less than -20 feet	-0.321	-	-0.321
Shallow water	20 feet to MLLW	-3.145	10.222	7.077
Active channel margin	MLLW to OHWM	-12.556	13.993	1.437
100-year floodplain	OHWM to 21.4 feet	-10.090	7.333	-2.757
Upland	+21.4 feet	-0.297		-0.297
Total		**-26.410**	**31.548**	**5.138**

At the mitigation site, CRC proposes to improve habitat conditions for aquatic species by installing LWD structures near the shoreline and removing invasive vegetation and about 50 cy of trash. CRC intends to remove invasive plant species such as false indigo bush, Himalayan blackberry, and reed canary grass by manual shredding, and/or applying herbicides foliar application, basal cut painting, and mechanical trimming. The total acreage covered by invasive plant species is about 1.26 acres. The anticipated timeframe to complete trash removal and invasive vegetation treatment is 2 to 4 weeks.

Access to the mitigation site will be limited to a 900-square foot gravel parking area adjacent to Dike Road. CRC proposes to maintain a single point for the public to access the shoreline via two 3-foot wide foot trails. CRC will limit future access to foot traffic by installing a locked gate and by placing large boulders at the trailhead and adjacent to the road on the south end of the property.

Previous use of the property included off-road vehicle use, which created approximately 0.77 acres of eroded trails and several small depressions totaling about 0.2 acres where juvenile fish could potentially occur during periods of high flow. CRC proposes to restore the eroded trails by installing native vegetation and grading depressions to allow water drainage and fish egress to prevent stranding. CRC also intends to remove 17 mature cottonwoods from the development site and place them at the mitigation site as LWD habitat features.

CRC proposes to use best management practices (BMPs) that are intended to avoid and minimize effects to ESA-listed species:

- Grading and construction work along the shoreline will be completed during dry conditions when the river level is below the work area.
- Conditions in local, state, and federal permits will be met.
- Straw bales and silt fencing will be installed between the work area and the river to limit potential for sediment or other material to enter the Columbia River.
- Controlling dust control and soil erosion during construction by using any of the following materials: grass seed, sod, mulching, plastic covering, applying polyacrylamide, and gravel.
- No pollutants, such as green concrete, contaminated water, silt, welding slag, sandblasting abrasive, or grout cured less than 24 hours will contact any waterbody.
- Post-project vegetation survival assessments will be conducted at intervals of 1, 2, 5, 7, and 10 years.
- Marine barges will not contact the sediment at any time during moorage.
- A fugitive dust control plan will be prepared, and a wheel-wash station to will be maintained on site to reduce dust dispersal during vehicular transport to the processing facility.
- Herbicides will not be applied in areas below OHW.
- Mechanical removal will be used first and chemical treatments will occur afterwards, only if needed.
- Herbicides will not be applied when precipitation as forecasted by the NOAA National Weather Service will occur within 48 hours of treatment.
- Herbicides will only be applied with a backpack sprayer with wand in areas near waterbodies.

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). NMFS identified vessel moorage at the proposed terminal, unloading of limestone rock, and vehicle traffic at the development site as interrelated or interdependent actions.

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 habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

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).

The designations of critical habitat for the salmonid species use the term “primary constituent element” (PCE) or “essential features.” The new critical habitat regulations (81 FR 7414) replace these terms with “physical or biological features” (PBFs). The shift in terminology does not change the approach used in conducting a ‘‘destruction or adverse modification’’ analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

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

- Identify the rangewide 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 RPA to the proposed action.

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' 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). 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% 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). 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).

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen 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 and Weitkamp 2013; Raymondi et al. 2013).

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

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest 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. Acidification also impacts sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012; Sunda and Cai 2012).

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

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

2.2.1 Status of the Critical Habitats

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

For most salmon and steelhead, 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 (NMFS 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 is serving another important role.

For southern DPS green sturgeon, a team similar to the CHARTs — a critical habitat review team (CHRT) — identified and analyzed the conservation value of particular areas occupied by southern green sturgeon, and unoccupied areas necessary to ensure the conservation of the species (USDC 2009). The CHRT identified areas in the LCR extending from the Pacific Ocean to RM 46, which is approximately 40 miles downstream of the proposed marine terminal. As such, the only effects of the proposed action on green sturgeon critical habitat will occur within the lower estuary and ocean habitats as the result of transporting limestone from Calder Bay, Alaska.

For southern DPS eulachon, critical habitat includes portions of 16 rivers and streams in California, Oregon, and Washington (USDC 2011). We designated all of these areas as migration and spawning habitat for this species.

A summary of the status of critical habitats considered in this opinion is provided in Table 3, below. The source documents are incorporated by reference.

Table 3. Critical habitat, designation date, federal register citation, and status summary for critical habitat considered in this opinion.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Lower Columbia River Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 47 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some, or high potential for improvement. We rated conservation value of HUC5 watersheds as high for 30 watersheds, medium for 13 watersheds, and low for four watersheds.
Upper Columbia River spring-run Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses four subbasins in Washington containing 15 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. We rated conservation value of HUC5 watersheds as high for 10 watersheds, and medium for five watersheds. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River spring/summer-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers (except the Clearwater River) presently or historically accessible to this ESU (except reaches above impassable natural falls and Hells Canyon Dam). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Willamette River Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon containing 56 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 22 watersheds, medium for 16 watersheds, and low for 18 watersheds.
Snake River fall-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers presently or historically accessible to this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Columbia River chum salmon	9/02/05 70 FR 52630	Critical habitat encompasses six subbasins in Oregon and Washington containing 19 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 16 watersheds, and medium for three watersheds.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Lower Columbia River coho salmon	2/24/16 81 FR 9252	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 55 occupied watersheds, as well as the lower Columbia River and estuary rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 34 watersheds, medium for 18 watersheds, and low for three watersheds.
Snake River sockeye salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers; Alturas Lake Creek; Valley Creek; and Stanley, Redfish, Yellow Belly, Pettit and Alturas lakes (including their inlet and outlet creeks). Water quality in all five lakes generally is adequate for juvenile sockeye salmon, although zooplankton numbers vary considerably. Some reaches of the Salmon River and tributaries exhibit temporary elevated water temperatures and sediment loads that could restrict sockeye salmon production and survival (NMFS 2015b). Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Washington containing 31 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.
Lower Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses nine subbasins in Oregon and Washington containing 41 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 28 watersheds, medium for 11 watersheds, and low for two watersheds.
Upper Willamette River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses seven subbasins in Oregon containing 34 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 25 watersheds, medium for 6 watersheds, and low for 3 watersheds.
Middle Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 15 subbasins in Oregon and Washington containing 111 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.
Snake River basin steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 25 subbasins in Oregon, Washington, and Idaho. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.

2.2.2 Status of the Species

Table 4, below provides a summary of listing and recovery plan information, status summaries and limiting factors for the species considered in this opinion. More information can be found in recovery plans and status reviews for these species. Recovery plans and 5-year status reviews for all 13 species of salmonids are available on the NMFS West Coast Region website (http://www.westcoast.fisheries.noaa.gov/) and are incorporated by reference.

Table 4. Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for each species considered in this opinion.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River Chinook salmon	Threatened 6/28/05	NMFS 2013	NWFSC 2015	This ESU comprises 32 independent populations. Twenty-seven populations are at very high risk, 2 populations are at high risk, one population is at moderate risk, and 2 populations are at very low risk Overall, there was little change since the last status review in the biological status of this ESU, although there are some positive trends. Increases in abundance were noted in about 70% of the fall-run populations and decreases in hatchery contribution were noted for several populations. Relative to baseline VSP levels identified in the recovery plan, there has been an overall improvement in the status of a number of fall-run populations, although most are still far from the recovery plan goals.	• Reduced access to spawning and rearing habitat • Hatchery-related effects • Harvest-related effects on fall Chinook salmon • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Contaminant
Upper Columbia River spring-run Chinook salmon	Endangered 6/28/05	Upper Columbia Salmon Recovery Board (2007)	NWFSC 2015	This ESU comprises four independent populations. Three are at high risk and one is functionally extirpated. Current estimates of natural origin spawner abundance increased relative to the levels observed in the prior review for all three extant populations, and productivities were higher for the Wenatchee and Entiat populations and unchanged for the Methow population. However, abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Recovery Plan for all three populations.	• Effects related to hydropower system in the mainstem Columbia River • Degraded freshwater habitat • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Persistence of non-native (exotic) fish species • Harvest in Columbia River fisheries

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River spring/summer-run Chinook salmon	Threatened 6/28/05	NMFS 2016a	NWFSC 2015	This ESU comprises 28 extant and four extirpated populations. All expect one extant population (Chamberlin Creek) are at high risk. Natural origin abundance has increased over the levels reported in the prior review for most populations in this ESU, although the increases were not substantial enough to change viability ratings. Relatively high ocean survivals in recent years were a major factor in recent abundance patterns. While there have been improvements in abundance and productivity in several populations relative to prior reviews, those changes have not been sufficient to warrant a change in ESU status.	• Degraded freshwater habitat • Effects related to the hydropower system in the mainstem Columbia River, • Altered flows and degraded water quality • Harvest-related effects • Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Willamette River Chinook salmon	Threatened 6/28/05	NMFS 2011	NWFSC 2015	This ESU comprises seven populations. Five populations are at very high risk, one population is at moderate risk (Clackamas River) and one population is at low risk (McKenzie River). Consideration of data collected since the last status review in 2010 indicates the fraction of hatchery origin fish in all populations remains high (even in Clackamas and McKenzie populations). The proportion of natural origin spawners improved in the North and South Santiam basins, but is still well below identified recovery goals. Abundance levels for five of the seven populations remain well below their recovery goals. Of these, the Calapooia River may be functionally extinct and the Molalla River remains critically low. Abundances in the North and South Santiam rivers have risen since the 2010 review, but still range only in the high hundreds of fish. The Clackamas and McKenzie populations have previously been viewed as natural population strongholds, but have both experienced declines in abundance despite having access to much of their historical spawning habitat. Overall, populations appear to be at either moderate or high risk, there has been likely little net change in the VSP score for the ESU since the last review, so the ESU remains at moderate risk.	• Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats • Altered food web due to reduced inputs of microdetritus • Predation by native and non-native species, including hatchery fish • Competition related to introduced salmon and steelhead • Altered population traits due to fisheries and bycatch

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River fall-run Chinook salmon	Threatened 6/28/05	NMFS 2015a	NWFSC 2015	This ESU has one extant population. Historically, large populations of fall Chinook salmon spawned in the Snake River upstream of the Hells Canyon Dam complex. The extant population is at moderate risk for both diversity and spatial structure and abundance and productivity. The overall viability rating for this population is 'viable.' Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of listing and compared to prior status reviews. The single extant population in the ESU is currently meeting the criteria for a rating of 'viable' developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Dam complex.	• Degraded floodplain connectivity and function • Harvest-related effects • Loss of access to historical habitat above Hells Canyon and other Snake River dams • Impacts from mainstem Columbia River and Snake River hydropower systems • Hatchery-related effects • Degraded estuarine and nearshore habitat.
Columbia River chum salmon	Threatened 6/28/05	NMFS 2013	NWFSC 2015	Overall, the status of most chum salmon populations is unchanged from the baseline VSP scores estimated in the recovery plan. A total of 3 of 17 populations are at or near their recovery viability goals, although under the recovery plan scenario these populations have very low recovery goals of 0. The remaining populations generally require a higher level of viability and most require substantial improvements to reach their viability goals. Even with the improvements observed during the last five years, the majority of populations in this ESU remain at a high or very high risk category and considerable progress remains to be made to achieve the recovery goals.	• Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Degraded stream flow as a result of hydropower and water supply operations • Reduced water quality • Current or potential predation • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River coho salmon	Threatened 6/28/05	NMFS 2013	NWFSC 2015	Of the 24 populations that make up this ESU, 21 populations are at very high risk, 1 population is at high risk, and 2 populations are at moderate risk. Recent recovery efforts may have contributed to the observed natural production, but in the absence of longer term data sets it is not possible to parse out these effects. Populations with longer term data sets exhibit stable or slightly positive abundance trends. Some trap and haul programs appear to be operating at or near replacement, although other programs still are far from that threshold and require supplementation with additional hatchery-origin spawners .Initiation of or improvement in the downstream juvenile facilities at Cowlitz Falls, Merwin, and North Fork Dam are likely to further improve the status of the associated upstream populations. While these and other recovery efforts have likely improved the status of a number of coho salmon populations, abundances are still at low levels and the majority of the populations remain at moderate or high risk. For the Lower Columbia River region land development and increasing human population pressures will likely continue to degrade habitat, especially in lowland areas. Although populations in this ESU have generally improved, especially in the 2013/14 and 2014/15 return years, recent poor ocean conditions suggest that population declines might occur in the upcoming return years	• Degraded estuarine and near-shore marine habitat • Fish passage barriers • Degraded freshwater habitat: Hatchery-related effects • Harvest-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River sockeye salmon	Endangered 6/28/05	NMFS 2015b	NWFSC 2015	This single population ESU is at very high risk dues to small population size. There is high risk across all four basic risk measures. Although the captive brood program has been successful in providing substantial numbers of hatchery produced fish for use in supplementation efforts, substantial increases in survival rates across all life history stages must occur to re-establish sustainable natural production In terms of natural production, the Snake River Sockeye ESU remains at extremely high risk although there has been substantial progress on the first phase of the proposed recovery approach – developing a hatchery based program to amplify and conserve the stock to facilitate reintroductions.	• Effects related to the hydropower system in the mainstem Columbia River • Reduced water quality and elevated temperatures in the Salmon River • Water quantity • Predation
Upper Columbia River steelhead	Threatened 1/5/06	Upper Columbia Salmon Recovery Board 2007	NWFSC 2015	This DPS comprises four independent populations. Three populations are at high risk of extinction while 1 population is at moderate risk. Upper Columbia River steelhead populations have increased relative to the low levels observed in the 1990s, but natural origin abundance and productivity remain well below viability thresholds for three out of the four populations. The status of the Wenatchee River steelhead population continued to improve based on the additional year's information available for the most recent review. The abundance and productivity viability rating for the Wenatchee River exceeds the minimum threshold for 5% extinction risk. However, the overall DPS status remains unchanged from the prior review, remaining at high risk driven by low abundance and productivity relative to viability objectives and diversity concerns.	• Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded floodplain connectivity and function, channel structure and complexity, riparian areas, large woody debris recruitment, stream flow, and water quality • Hatchery-related effects • Predation and competition • Harvest-related effects

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River steelhead	Threatened 1/5/06	NMFS 2013	NWFSC 2015	This DPS comprises 23 historical populations, 17 winter-run populations and six summer-run populations. Nine populations are at very high risk, 7 populations are at high risk, 6 populations are at moderate risk, and 1 population is at low risk. The majority of winter-run steelhead populations in this DPS continue to persist at low abundances. Hatchery interactions remain a concern in select basins, but the overall situation is somewhat improved compared to prior reviews. Summer-run steelhead populations were similarly stable, but at low abundance levels. The decline in the Wind River summer-run population is a source of concern, given that this population has been considered one of the healthiest of the summer-runs; however, the most recent abundance estimates suggest that the decline was a single year aberration. Passage programs in the Cowlitz and Lewis basins have the potential to provide considerable improvements in abundance and spatial structure, but have not produced self-sustaining populations to date. Even with modest improvements in the status of several winter-run DIPs, none of the populations appear to be at fully viable status, and similarly none of the MPGs meet the criteria for viability.	• Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Reduced access to spawning and rearing habitat • Avian and marine mammal predation • Hatchery-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Willamette River steelhead	Threatened 1/5/06	NMFS 2011	NWFSC 2015	This DPS has four demographically independent populations. Three populations are at low risk and one population is at moderate risk. Declines in abundance noted in the last status review continued through the period from 2010-2015. While rates of decline appear moderate, the DPS continues to demonstrate the overall low abundance pattern that was of concern during the last status review. The causes of these declines are not well understood, although much accessible habitat is degraded and under continued development pressure. The elimination of winter-run hatchery release in the basin reduces hatchery threats, but non-native summer steelhead hatchery releases are still a concern for species diversity and a source of competition for the DPS. While the collective risk to the persistence of the DPS has not changed significantly in recent years, continued declines and potential negative impacts from climate change may cause increased risk in the near future.	• Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats due to impaired passage at dams • Altered food web due to changes in inputs of microdetritus • Predation by native and non-native species, including hatchery fish and pinnipeds • Competition related to introduced salmon and steelhead • Altered population traits due to interbreeding with hatchery origin fish
Middle Columbia River steelhead	Threatened 1/5/06	NMFS 2009	NWFSC 2015	This DPS comprises 17 extant populations. The DPS does not currently include steelhead that are designated as part of an experimental population above the Pelton Round Butte Hydroelectric Project. Returns to the Yakima River basin and to the Umatilla and Walla Walla Rivers have been higher over the most recent brood cycle, while natural origin returns to the John Day River have decreased. There have been improvements in the viability ratings for some of the component populations, but the DPS is not currently meeting the viability criteria in the MCR steelhead recovery plan. In general, the majority of population level viability ratings remained unchanged from prior reviews for each major population group within the DPS.	• Degraded freshwater habitat • Mainstem Columbia River hydropower-related impacts • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Harvest-related effects • Effects of predation, competition, and disease

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River basin steelhead	Threatened 1/5/06	NMFS 2016	NWFSC 2015	This DPS comprises 24 populations. Two populations are at high risk, 15 populations are rated as maintained, 3 populations are rated between high risk and maintained, 2 populations are at moderate risk, 1 population is viable, and 1 population is highly viable. Four out of the five MPGs are not meeting the specific objectives in the recovery plan based on the updated status information available for this review, and the status of many individual populations remains uncertain A great deal of uncertainty still remains regarding the relative proportion of hatchery fish in natural spawning areas near major hatchery release sites within individual populations.	• Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded freshwater habitat • Increased water temperature • Harvest-related effects, particularly for B-run steelhead • Predation • Genetic diversity effects from out-of-population hatchery releases

2.3. Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

The effects of the action at the development site include upland areas, the shoreline, and aquatic habitats modified by presence of the marine terminal. The effects of the action at the mitigation site include upland areas, the shoreline, and aquatic habitats that are modified by application of herbicides, LWD installation, trash removal, minor excavation, and walkway construction, and maintenance. The effects of the action may be permanent, (e.g., rock riprap, mooring dolphins, altered vegetation cover, large woody debris) or temporary effects that occur during construction (e.g., underwater noise from pile installation, presence of overwater structure from moorage of marine barges). The action area includes all areas where the effects of the action will occur, together with the effects of the interrelated and interdependent activities such as vessel moorage, unloading limestone rock, and vehicular traffic at the development site. In this case, the proposed action includes the effects of construction, as well as the ongoing existence and operation of both the marine terminal and the proposed mitigation site (Figure 7).

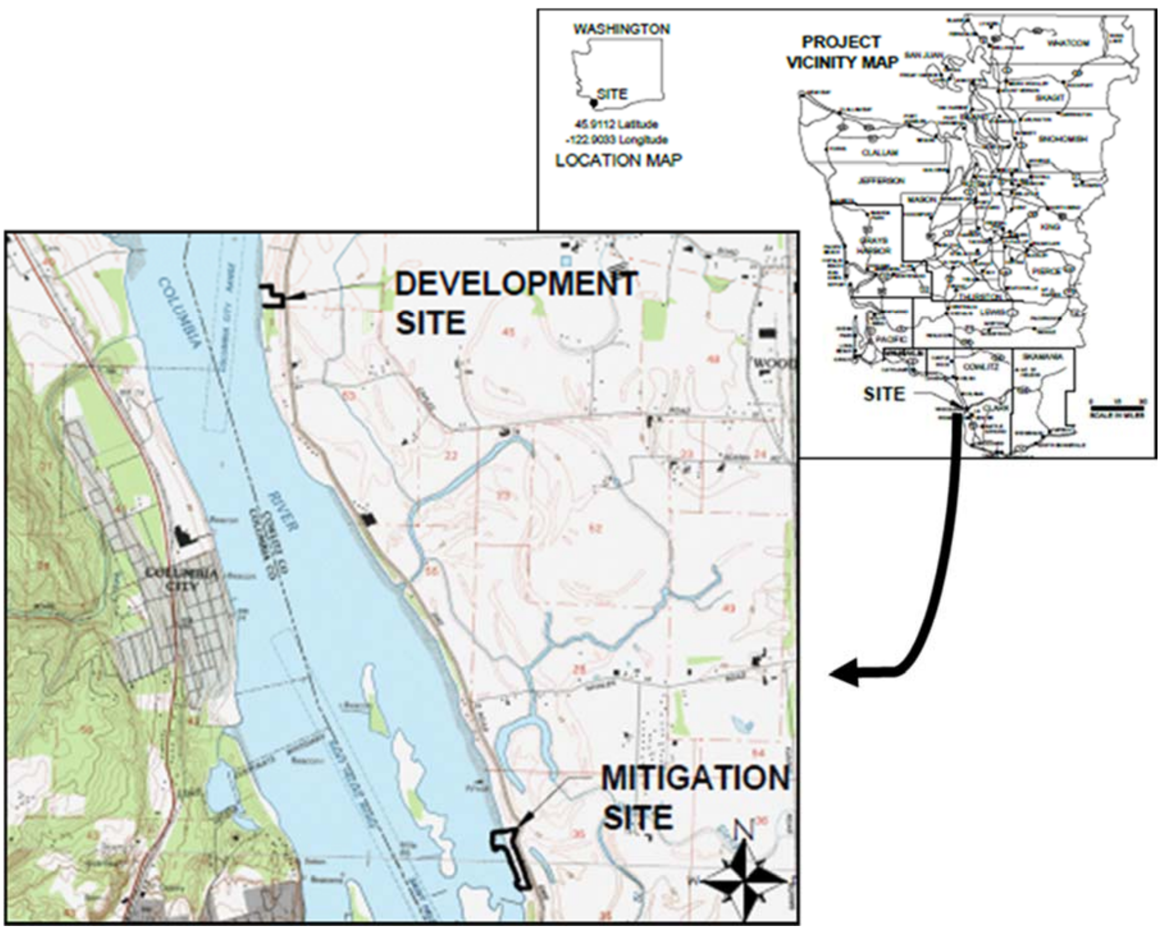

Figure 7. Site vicinity of construction sites in the Columbia River.

The action area for this consultation is the area of overlap between the most spatially extensive effects of the action and the presence or distribution of listed species and/or their critical habitat.

The temporary effects associated with underwater noise during pile installation are the effects of the action that extend the farthest and that overlap with listed species and/or critical habitats. The sound pressure created during pile installation process will exceed thresholds that is reasonably certain to alter behavior of fish within 7.36 square miles of the development site (Figure 8). This distance encompasses an approximately 11-mile reach of the LCR.

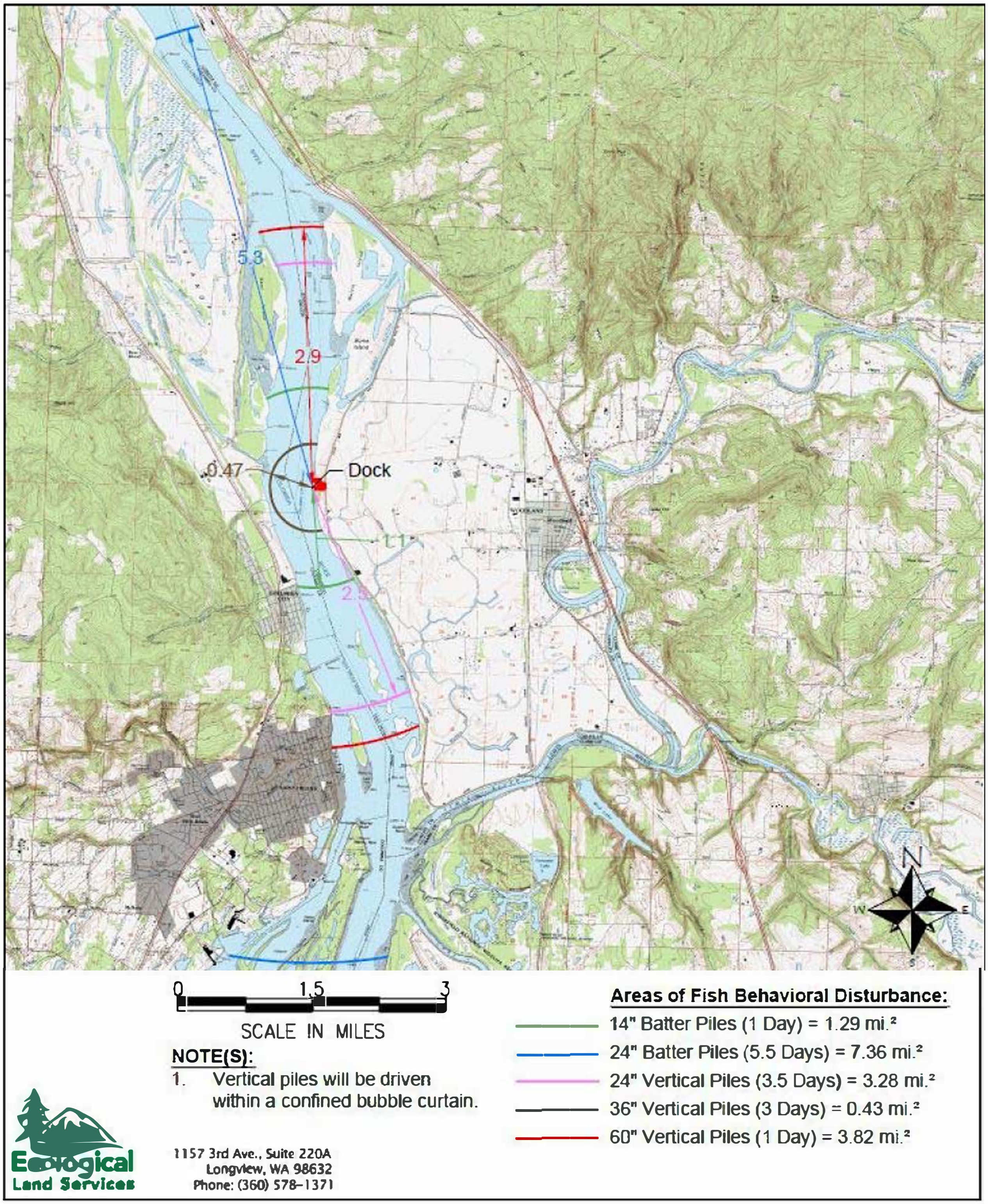

Figure 8. *Extent of action area in aquatic habitats as measured by adverse effects to behavior of caused by impact hammering (sound pressure is outlined in blue).The figure notes the linear extent (isopleths) and spatial extent (area) of sound pressure effects.*

2.4. Environmental Baseline

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

The action area is located in a portion of the mainstem of the Lower Columbia River that is tidally influenced, and its current conditions is influenced by multiple factors occurring upstream and upland, in addition to features of the specific site. Historically, the mainstem LCR was less than 20 feet deep, and supported vegetated wetlands within the floodplain that supplied the estuary with an abundance of macrodetritus, the base-level food source for juvenile salmonids (NMFS 2011a). Subsequent modifications to the LCR have reduced the quality, amount, and accessibility of habitat, resulting from diking, dredging, and filling for agricultural, urban, industrial, and hydroregulation for power generation and flood control activities. Regulation of river flow has reduced spring freshet flows to about 50% of the natural level, and has increased fall minimum flows by 10 to 50% (Simenstad et al. 1992). As a result of flow regulation, increased nutrients, increased water clarity and temperature, the current base-level food source in the LCR consists of microdetritus, such as phytoplankton and zooplankton transported from areas throughout the Columbia watershed (Sherwood et al 1990; Weitkamp 1994). Nearly all emergent aquatic vegetation in the LCR is located in tidal swamps near brackish water areas (Weitkamp 1994). The action area is located in a reach of the Columbia River with rapid flow and coarse sand and does not support the presence, nor establishment of submerged aquatic vegetation.

The combined effects of water withdrawals for irrigation, hydroregulation, diking and filling have reduced the surface area of the estuary by approximately 20 percent over the past 200 years, resulting in decreased access to up to 77 percent of historical tidal swamps and peripheral wetlands (Fresh et al. 2005). Currently a lack of habitat and reduced habitat quality are identified as factors limiting viability of salmonids in the mainstem LCR (NMFS 2011b). Overbank flooding that normally would aid juveniles in accessing off-channel refugia and food resources has been virtually eliminated, and sediment transport processes that build habitat and constitute refugia habitat have been impaired (NMFS 2011a). Bottom et al. (2005) noted the near complete elimination of overbank flood events in the LCR and the separation of the river from its floodplain, both conditions that have altered the food web by reducing macrodetrital inputs by approximately 84 percent. Currently, phytoplankton detrital sources from upstream reservoirs now dominate the base of the food chain. This change from a food web based on macrodetritus to one based on microdetritus has profound effects on the estuary ecosystem to support migration and rearing of juvenile salmonids.
Upstream dams have prevented sediments from entering the estuary, while dredging activities have increasingly deepened the channel and exported sand and gravel out of the estuary. Since the late nineteenth century, sediment transport from the interior basin to the Columbia River estuary has decreased about 60 percent and total sediment transport has decreased about 70 percent (Jay and Kukulka 2003). Currently, sand is exported from the estuary at a rate approximately three times higher than that at which it enters the estuary. The full impact of these

changes is unknown; however, sediment transport is a primary habitat-shaping force that determines the type, location, and availability of habitats distributed in the estuary and plume. It is thought that reductions in the amount of fine sediment have increased water clarity, allowing avian and aquatic predators to more easily locate and consume salmonids during both adult and juvenile life stages.

Toxic contaminants are widespread in the estuary, both geographically and in the food chain, with the urban and industrial portions of the estuary contributing significantly to juvenile salmon's toxic load (LCREP 2007). Some of these contaminants are water-soluble agricultural pesticides and fertilizers, such as simazine, atrazine, and diazinon, and copper-based chemicals (Hecht et al. 2007). Industrial contaminants include polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). Also present are pharmaceuticals, personal care products, brominated fire retardants, and other emerging contaminants. Concentrations of toxic contaminants in the bodies of juvenile salmonids in the estuary sometimes are above levels estimated to cause health effects. In a 2007 study, this was the case for PCBs, PAHs, and DDT, and juveniles showed evidence of exposure to hormone-disrupting compounds (LCREP 2007). Salmon and steelhead experience both short-term exposure to toxic substances and long-term exposure to contaminants that accumulate over time and magnify through the food chain. Even when exposures are sublethal, they can cause significant developmental, behavioral, health, and reproductive impairments.

The LCR is has become a central point of economic growth, particularly in areas between Longview, Washington and Portland, Oregon. Marine terminal facilities at the ports of Longview, Kalama, Portland, Vancouver, and Woodland dominate use of shorelines on the Columbia River. Three large industrial marine terminals, similar to CRC's proposed marine terminal, and more than 10 acres of overwater structure at the Port of St. Helens, Oregon are located on the west side of the river (Figure 9).

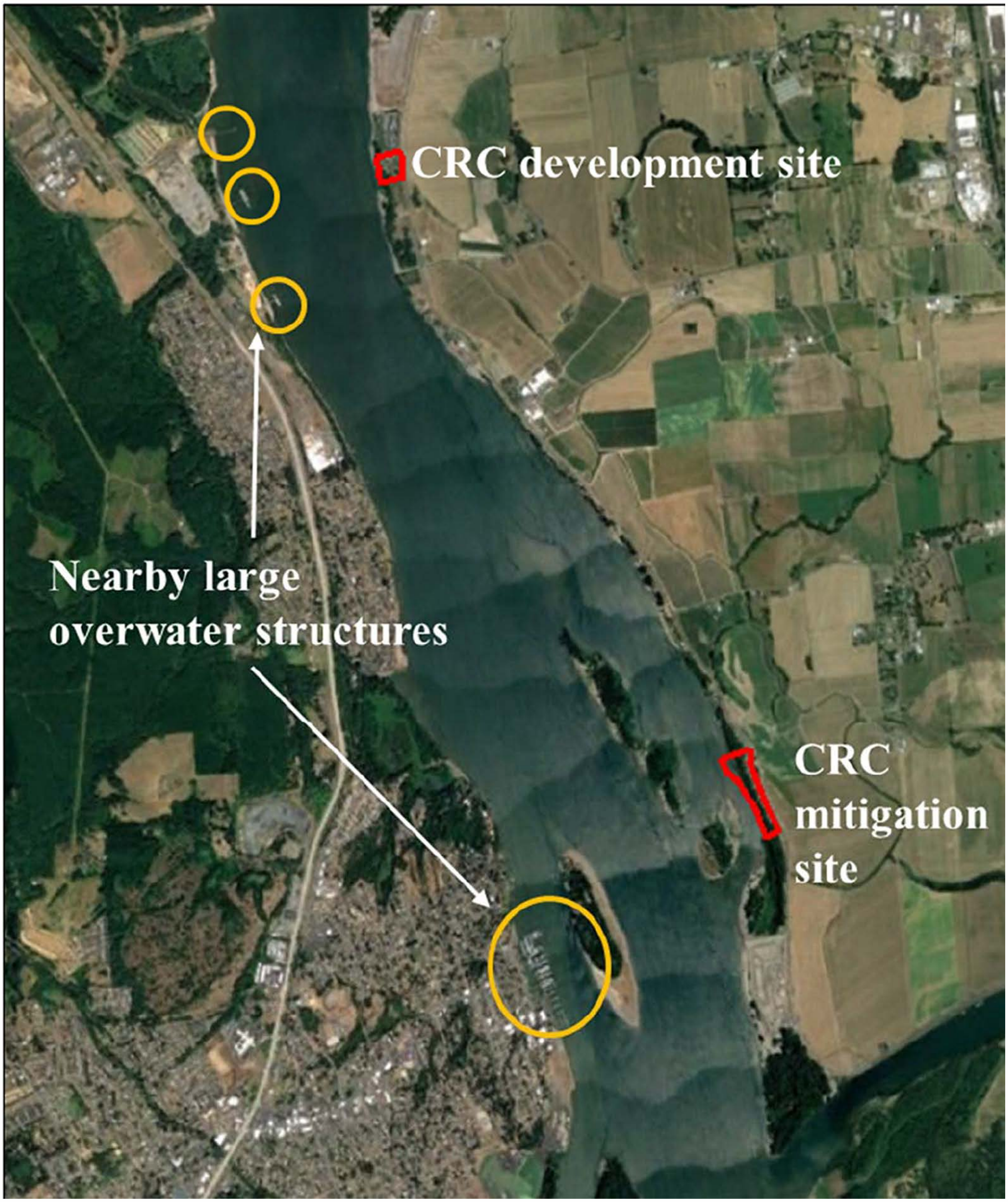

***Figure 9**. Industrial and port facilities contributing to the environmental baseline. Proposed development and mitigation sites are outlined in red. Existing large overwater structures are outlined in orange.*

Present conditions at the development and mitigation sites include:

The marine terminal development is a 3.75-acre parcel with about 440 feet of shoreline. Existing vegetation consists of mature cottonwood (*Populus trichocarpa*) and native shrub and grasses (Figure 10). Shoreline vegetation is strongly influenced by annual high streamflow events. These flow conditions mobilize a large volume of medium to coarse grain sand, which prevents the establishment of aquatic vegetation in areas that are not with velocity shadows. Sediment composition within aquatic habitats consists of 93-96 percent medium to coarse-grain sand, which is similar to most main channel shorelines in the LCR (McCabe et al. 1998). However, a 0.9-acre area located below OHW is flooded once every two years. This area provides off-channel rearing and refugia habitat for salmonids (Figure 3) within typical hydraulic connectivity occurring every other year for periods ranging in duration from 1 to 60 days (ELS 2018). Anecdotal observations from adjacent landowners suggest that fish become stranded in this depression when river flows recedes because the depression has no outlet (ELS 2018), and are predated upon by avian and terrestrial animals.

***Figure 10**. Baseline conditions at the proposed marine terminal construction site.*

Current conditions at the mitigation site are influenced by three primary factors: 1) the 1.4-acre pile dike system managed by the COE Civil Works, Portland District to maintain alignment of the federal navigation channel, 2) historical dredge material placements that formed the

Woodland Islands as well as additional proposed placements shoreward of the islands for the stated purpose of improving shallow water habitat, and 3) the existing levee on which Dike Road is located (Figure 11). Regarding the additional placements referenced in 2), the COE has consulted on a proposal to place approximately 400,000 cubic yards of sediment on the east side of the Woodland Islands (WCR-2018-10183), located adjacent to the proposed mitigation site.

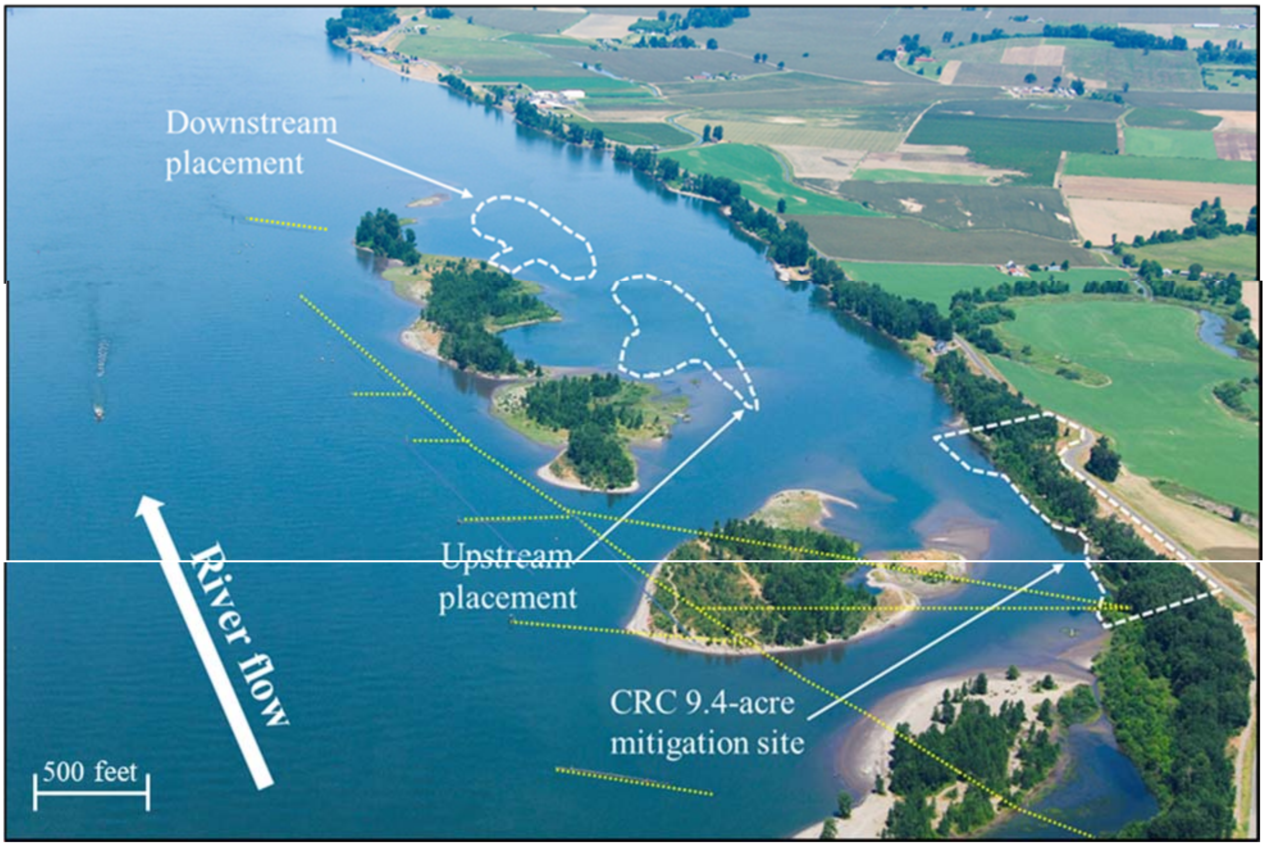

***Figure 11**. Location and status of the proposed mitigation site. Concurrent actions (i.e., dredge material placement and construction at mitigation site parcel) are denoted with dashed white lines. The location of the pile dike (approximately 1.9 miles in length) is denoted with dotted yellow lines.*

Upland conditions at the mitigation site are relatively undisturbed, apart from degradation caused by invasive vegetation, 50 CY of illegally-deposited trash, and 0.2 acres of undeveloped dirt roads created by unauthorized off-road vehicle use. Development of the parcel was imminent, as ELS (2018) reports the previous property owner planned to construct a single-family residence on the northeast portion of this parcel. Prior to completion of the sale to CRC, the property owner had prepared for residential development by excavating septic pits, which met soil percolation approval requirements.

The COE originally created the Woodland Islands in the lee of the pile dikes by placing several million cubic yards of dredged material during the 1920s to the late 1970s. At its largest size, the COE placed enough dredged material to form a contiguous peninsula extending from the Washington shore to the end of the pile dikes. Since dredged material placement and maintenance ceased in the 1970s, river flow has eroded the dredge material into a string of small islands. The relatively protected side channel behind the islands is a nearly 300-acre, low velocity embayment that is slowly aggrading with sand eroded from the islands and fine material from the river. The off-channel area between the islands and the Washington shoreline is relatively shallow (0-15 feet deep) and provides high quality rearing and refugia habitat for juvenile salmonids, particularly subyearling migrants that occupy the top six feet of the water column. Other than the Woodland Islands areas, other notable locations within the action area containing high-quality shallow water habitat where fish are most likely to be present include the Lewis River confluence (RM 87). High-quality shallow water habitat present 1.5-3.0 miles downstream of the development site exist adjacent to Burke Island, Goat Island, and Martin Island (Figure 8).

Species status, presence, and habitat use in the action area

The action area is used by 13 species of salmon and steelhead and the southern DPS of eulachon. Numerous early life history strategies expressed by juvenile salmonids in the LCR have been lost as a result of past management actions discussed above (Bottom et al. 2005). Bottom et al. (2005) suggests that as many as six distinct life histories were exhibited by juvenile salmonids during their migration to the ocean. Today, three remain: yearling, subyearling, and fry migrants. Nearly all juvenile salmonids exhibit a yearling (stream-maturing) or subyearling (ocean-maturing) life history. Habitat preferences of juvenile salmonids were closely associated with life history strategies (Dawley et al. 1986; Ledgerwood et al. 1991). These researchers found that larger yearling migrants such as Chinook salmon and steelhead were more likely to use deeper mid-water habitats, while subyearling Chinook salmon were most often found in nearshore, shallow water areas. Still others, such as sockeye salmon and steelhead inhabited mid-water areas 98 percent of the time. All species cease migrating at night, and occupy deeper waters during this period (Ledgerwood et al. 1991).

Most species are present in the action area for migration and pass through the action area within hours to days (Dawley et al. 1986; Matter and Sandford 2003; McMichael et al. 2011). Others, particularly juvenile Chinook salmon migrate as subyearlings and rear in the LCR for days to weeks (McNatt et al. 2016). Presence of juvenile salmon in the LCR is summarized by NMFS (2017) and is included in Table 5 (see Appendix B). Juvenile salmon are most abundant during one or two periods from late winter through summer, with lesser presence in the fall (http://www.cbr.washington.edu/dart). Juvenile sockeye salmon, or steelhead likely spend the least amount of time in the estuary. Various life history types of Chinook salmon and most chum salmon may remain for longer periods, while they actively feed and grow before ocean entrance (Healey 1982; Thorpe 1994).

Some species, such as UWR Chinook salmon and LCR Chinook salmon, continue to maintain populations exhibiting both ocean-type and stream-type life histories as juveniles (LCFRB 2010; Schroeder et al. 2016). Stream-type salmon and steelhead typically rear in upstream tributary habitats for over a year. These include LCR Chinook salmon (spring runs), LCR steelhead, LCR coho salmon, MCR steelhead, UWR steelhead, UWR Chinook salmon, SR spring/summer Chinook salmon, UCR Chinook salmon, SR steelhead, SR sockeye, and UCR steelhead. These fish tend to be 100 to 200 mm in size during migration through the action area. Species exhibiting a stream-type life history typically migrate as smolts, which migrate quickly downstream, and will pass through the action area within one to two days. Ocean-type juvenile salmon tend to move out of spawning streams and migrate towards the LCR estuary as subyearlings and are actively rearing within the Lower Columbia River. This includes LCR Chinook salmon (fall runs), CR Chum salmon, SR fall-run Chinook salmon, and UWR Chinook salmon that are smaller in size (less than 100 mm) and more likely to spend days to weeks in the action area foraging (Carter et al. 2009, McNatt et al. 2016, NMFS 2013; Schroeder et al. 2007; 2016).

LCR steelhead display two distinct life history types of steelhead (e.g., summer and winter runs) that differ in degree of sexual maturity at freshwater entry, spawning time, and frequency of repeat spawning. Most summer-run steelhead from the LCR steelhead DPS re-enter freshwater between May and October and require several months to mature before spawning, generally between late February and early April. Most winter-run steelhead re-enter freshwater between December and May as sexually mature fish; peak spawning occurs later than for summer steelhead, in late April and early May (NMFS 2013). Observations of steelhead in the LCR suggest that the species used mid-river habitats 98 percent of the time (Ledgerwood et al. 1991).

In addition to variations in outmigration timing, juvenile ESA-listed species also have a wide horizontal and vertical distribution in the CR related to size and life history stage. Generally speaking, juvenile salmonids occupy the action area across the width of the river, and to average depths of up to 35 feet (Carter et al. 2009). Smaller-sized fish use the shallow inshore habitats and larger fish use the channel margins and main channel. The pattern of use generally shifts between day and night. The smaller salmonids congregate along the nearshore areas in shallow water and extend into the channel margins (Bottom et al. 2011). At night these younger fish swim into the deeper areas of the river away from the shoreline and are closer to the bottom of the channel (Carter et al. 2009). Yet, as Carlson et al. (2001) indicated, there is higher use of the channel margins than previously thought and considering the parameters above, relative juvenile position in the water column suggests higher subyearling use in areas of 20 to 30 feet deep.

Specific populations mostly likely to occur in the action area as juveniles (for rearing and migration) are summarized below in Table 6.

Table 6*. Number of populations of salmon and steelhead originating in the LCR. Shaded rows indicate populations affected by the proposed action.*

Population origin	LCR Chinook Salmon number of populations	LCR coho salmon number of populations	LCR Steelhead number of populations	CR chum salmon number of populations
Youngs River	1	1	-	1
Big Creek	1	1	-	1
Grays River	1	1	-	1
Elochoman River	1	1	-	1
Clatskanie River	1	1	-	1
Mill/Abernathy/Germany creeks	1	1	-	1
Scappoose Creek	1	1	-	1
Cowlitz River	5	4	4	2
Coweeman River	1	1	1	-
Toutle River	1	2	2	-

Population origin	LCR Chinook Salmon number of populations	LCR coho salmon number of populations	LCR Steelhead number of populations	CR chum salmon number of populations
Kalama River	2	1	2	1
Lewis River	**2**	**2**	**4**	**1**
Salmon Creek	**1**	**1**	**1**	**1**
Clackamas River	**1**	**1**	**1**	**1**
Washougal River	**1**	**1**	**2**	**1**
Sandy River	**2**	**1**	**1**	**1**
Gorge tributaries	**2**	**3**	**2**	**2**
Wind River	-	-	**1**	-
White Salmon River	**2**	-	**2**	-
Hood River	**2**	-	-	-
Number of affected populations	**13**	**9**	**14**	**7**

Presence of adult salmonids in the action area will most likely range from early spring to early fall (http://www.cbr.washington.edu/dart) for those species originating upstream of Bonneville Dam figures 12-14 (see Appendix C). Chinook salmon species returning to locations upstream of Bonneville Dam (i.e., SR spring/summer Chinook salmon, SR fall Chinook salmon, UCR spring Chinook salmon) migrate through the action area during the spring and early summer (Figure 12). Adult SR sockeye salmon migrate through the action area during late spring through late summer (Figure 13). Adult steelhead (MCR steelhead, SRB steelhead, and UCR steelhead) migrate through the action area from mid-June through early October (Figure 14).

LCR Chinook salmon include populations that return to freshwater as adults in the spring, fall, or late fall. Spring-run adults enter the LCR from March through June, fall–run adults enter freshwater from August to September, and late-fall run adults enter the Columbia River from August to October (NMFS 2013). LCR coho salmon are typically categorized into early and late-returning stocks (NMFS 2013). Early-returning (Type S) adult coho salmon enter the Columbia River in mid-August and begin entering tributaries in early September, with peak spawning from mid-October to early November (NMFS 2013). Late-returning (Type N) coho salmon pass through the lower Columbia from late September through December and enter tributaries from October through January. Adult CR chum salmon are a fall-run species that enter fresh water from mid-October through November and spawn from early November to late December (LCFRB 2010). LCR steelhead are present from May through October (summer run) and December through May (winter run) (NMFS 2013).
Other species that utilize the action area include UWR Chinook salmon and UWR steelhead. Adult UWR Chinook salmon appear in the action area during January, with fish entering the Clackamas River as early as March (NMFS 2011a). Adult UWR steelhead are present from mid-February to mid-May (NMFS 2011a).CR chum salmon from Cowlitz, Kalama, Lewis, Salmon Creek, Washougal, lower Gorge tributaries and upper Gorge tributaries. Of these, the populations are virtually extirpated with the exception of the Washougal and lower Gorge populations.

Estimates of eulachon gathered from commercial catch data shows the amount of adult fish returning often by orders of magnitude, not only in the Columbia River and its tributaries (Smith and Saalfeld 1955), but in Canadian rivers (Hay and McCarter 2000; Gustafson et al. 2010). In years of low abundance adults returning to the Columbia River and its tributaries may number in the hundreds of thousands, and in years of high abundance the species may numbers in the tens of millions (Gustafson et al. 2010). Thus, the presence of adult fish and their eggs and larvae is reasonably expected to vary in the action area from weeks to months. The eulachon utilize the action area as adults migrate upstream followed by eggs and larvae drifting downstream. Adult eulachon ascend large tributaries of the CR such as the Cowlitz, Elochoman, Grays, Kalama, Lewis, Sandy, and others during late winter and spring (Smith and Saalfeld 1955; Gustafson 2010). Some of these individuals migrate through the action area to access spawning sites in nearby watersheds such as the Lewis, Sandy, and Washougal rivers as well as along beaches up to Bonneville Dam (Howell and Uusitalo). Adult eulachon may return as early as late November (NMFS 2016b), but typically this occurs from January through April. Eulachon produce millions, if not hundreds of millions, of eggs with a sticky exterior covering that adheres to the substrate or vegetation until larvae hatch and are rapidly transported downstream as passive, free-floating drift (Parente and Snyder 1970; Smith and Saalfeld 1955; Howell et al. 2001).

2.5. Effects of the Action

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

The proposed action includes temporary construction effects, and long-term effects that are either repetitive or permanent. Long-term repetitive actions occurring for the operational lifespan of the facility include noise and shade caused by mooring vessels in shallow water habitat and procedures associated with unloading limestone. Permanent effects of the proposed action resulting from shoreline construction include alteration of the shape and function of habitat features at development site within upland, shoreline, and aquatic habitats).

CRC proposes to manage the separate 9.4 acre parcel they own to prevent commercial or residential development. Restoration work to rehabilitate this site will create some temporary detrimental effects such as use of chemical herbicides to control invasive plant species (i.e., false indigo bush, Himalayan blackberry, reed canary grass); increased human access to the area via a gravel walkway improvement; and the grading used to remove potential points of juvenile salmon stranding. The long-term effects are expected to improve habitat conditions.

2.5.1 Effects to Critical Habitat

The proposed action will occur within designated critical habitat for all 13 species of salmon and steelhead. The physical and biological features (PBFs) of critical habitat for the 13 species of salmonids considered in this consultation include rearing areas for juveniles and migration corridors for juveniles and adults. The relevant PBFs for salmonids in the mainstem LCR are noted below in Table 7.

Construction proposed by CRC will result in temporary and permanent effects to PBFs of designated critical habitats within aquatic, floodplain, and upland areas. Temporary construction effects at the development site will be caused during pile installation, terminal construction, shoreline grading, and fill in shoreline and upland areas. Shoreline armoring, and the presence and use of the marine terminal will result in indefinite, repetitive impacts to critical habitat PBFs in the action area.

In contrast, the proposed construction at the mitigation site will last for 4-6 weeks, although additional herbicide treatments at the mitigation site in areas below OHW may be necessary to eliminate invasive vegetation. These actions will result in a small increase in shade and cover that improve habitat function. Maintaining intact floodplain forest and shallow water refugia habitat on the 9.4-acre parcel will remove the potential for future degradation caused by commercial or residential development. These habitats will continue to provide abundant forage and rearing opportunities and access to the floodplain forest during seasonal peak flow conditions.

Table 7. PBFs identified for freshwater critical habitats of thirteen ESA-listed salmon and steelhead species and corresponding species life history events.

Species	Site Type	Site Attribute	Species Life History Event
LCR Chinook salmon UCR spring Chinook salmon UWR spring Chinook salmon CR chum salmon LCR coho salmon LCR steelhead MCR steelhead UWR steelhead	Adult and juvenile rearing areas and migration corridors	Forage Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
SR spring/summer Chinook salmon SR fall Chinook salmon SR sockeye salmon SRB steelhead	Adult and juvenile rearing areas and migration corridors	Access (sockeye) Cover/shelter Food (juvenile rearing) Riparian vegetation Safe passage Space (Chinook) Substrate Water quality Water quantity Water temperature Water velocity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration

Water quality. Good water quality is an important part of habitat for all salmonids at both adult and juvenile life stages. Construction of the marine terminal will temporarily degrade water quality as a result of inwater construction in aquatic and upland habitats.

<u>Suspended sediment:</u> Positioning and installing piles and placement of LWD will resuspend small quantities of fine sediments directly into the water column. The degraded water quality conditions will occur near the sediment surface and the resulting turbidity plume is unlikely to be visible from the shoreline. The increase in turbidity will be brief and otherwise imperceptible from background conditions. Installation of LWD material for habitat structures or vehicle barriers will occur in the summer dry season when the shoreline is exposed. Excavation and installation of habitat structures at lower elevations will also resuspend a small amount of fine

sediment into the water column during construction that may occur over the course of 1-6 days required for installation of LWD structures at the development site. However, resuspension of fine sediments at the water surface will be perceptible as turbidity plume adjacent to the shoreline and will persist for hours during and shortly after installation of each LWD structure. Based on the 90-95 percent medium to coarse sand substrate composition (McCabe et al. 1997) NMFS estimates the turbidity plume will extend for about 50 feet from the construction footprint of each LWD structure and dissipate within minutes. Although depending on flow conditions and construction activity such that any increase in turbidity will be brief and otherwise imperceptible from background conditions. Standard construction BMPs (silt fencing, straw bales, and site flagging) used to cordon shoreline and upland construction areas will reduce the amount of fine sediment entering the river from construction in upland areas.

Construction and operation of the marine terminal facility will cause will cause sediment erosion by wind and precipitation. The proposed use of standard construction BMPs will minimize the potential for dispersal of petrochemical contaminants and sediment into the river. Additionally, daily operation of trucks and construction equipment necessary for loading and transport of limestone rock is reasonably certain to result in small spills of petrochemicals. These repetitive and permanent effects associated with operation of the marine terminal facility will produce small amounts of pollutants that are limited to upland areas. CRC has designed stormwater prevention and treatment systems for construction and permanent operation of the marine terminal facility to treat suspended sediment to levels below those producing behavioral effects (Newcombe and Jensen 1996) as well as absorb small quantities of petrochemicals associated with vehicle traffic. NMFS estimates that the potential delivery of suspended sediment into the river is extremely low based on the location of the stockpiling site in an upland location and design of stormwater treatment systems to regional standards according to the Department of Ecology Stormwater Manual for Western Washington (WDOE 2014).

Chemical contaminants: There is potential for water quality degradation when chemicals are used for erosion or vegetation control, or when heavy equipment is operated in or near a waterway. Stormwater treatment systems and implementation of a spill prevention program will preclude the likelihood of large petrochemical spills during construction and operation of the marine terminal. Temporary stormwater treatment systems used during construction phase supplemented by BMPs (e.g., silt fencing, straw bales, and oil-absorbent boom) will substantially reduce the chance of chemical contaminants spills that degrade water quality. Normal operation of the marine terminal will result in small amounts of petroleum-based oils, lubricants, and greases from aquatic and upland sources that degrade water quality caused by operation of marine vessels used to mobilize large transfer barges and use of heavy construction equipment (e.g., front loaders and dump trucks) in upland and barge-based deployments to transfer limestone rock. We expect that such small amounts of such petroleum-based contaminants will enter the LCR during operation of the terminal facility over a period of years.

Polyacrylamides used at the development site for control dust and soil stabilization may leach into the river and degrade water quality conditions over the course of the several months during the summer when repeated applications may be necessary for dust control. The effect of polyacrylamides will have an indirect effect causing a localized reduction in benthic invertebrates (Krautter et al. 1986). Brown et al. (1982) found doses as low as 50 micrograms reduced aquatic insect diversity within 5 hours of exposure and persist for about 2 weeks (Xiong et al. 2018). Based upon these literature sources and professional assessment by the NMFS on physical degradation of polyacrylamides in the conditions in which they will be applied the use of polyacrylamides will reduce benthic invertebrates within the shoreline footprint and extending 50 feet downstream. Therefore, the potential use of this chemical is expected to degrade PBFs that will affect listed species via two pathways: direct toxicity, and prey reduction.

In addition, small amounts of herbicides may enter the Columbia River. This is most likely to occur during foliar applications. The proposed action relies primarily on mechanical vegetation removal methods and limited use of herbicides (i.e., basal stem injection, foliar application), particularly in areas below OHW. Basal stem application of herbicides will result in substantially less quantities and likelihood for these chemicals to disperse into aquatic habitats. Further limited use of herbicides, coupled with application during weather conditions that limit potential for herbicidal drift, substantially limits the potential for transport of these chemicals into the LCR.

Forage. Installation of piles will permanently remove approximately 200.5 square feet of aquatic habitat where benthic invertebrates are present that constitute forage PBF of juvenile salmon habitat. Most of the piles and mooring dolphins that support the towers and berthing terminal are located in waters greater than 15 feet in depth and at distances greater than 100 feet from the shoreline. Loss of benthic forage is most likely to result from displacement via pile installation and not from shading because the development site lacks aquatic vegetation that would produce abundant prey items for juvenile salmonids. The primary forage item of juvenile salmonids is *Corophium salmonis*, a tube-dwelling amphipod that inhabits the river benthos and whose density and abundance is highly variable, typically associated with shallow water and clay and mud substrates, and is unaffected by shading (McCabe et al. 1997). Other forms of commercial development in the LCR, particularly dredging, have a limited effect on benthic forage items lasting 3 to 6 months because benthic invertebrates transported as drift are constantly recolonizing habitat (McCabe et al. 1998). Thus, the abundance and diversity of forage items in this section of the LCR is dictated by substrate composition and absence of aquatic vegetation. To the extent that diminishment of forage items will occur as a result of the proposed installation of inwater and overwater structure this will occur from displacement of benthic habitat (i.e., pile installation), not as a result of shading of submerged aquatic vegetation, of which there is none.

Permanent fill of 0.9 acres at elevations below OHW will result in a loss of seasonally available floodplain habitat. A reduction in the amount of floodplain habitat will reduce the amount of terrestrial forage items available to juvenile salmonids. Access to forage in seasonally-flooded habitats is important for growth and survival at the juvenile life stage (Beechie et al. 2013; Bottom et al. 2005, 2011; Katz et al. 2017; Sommer et al. 2001). The reduction of forage from permanent loss of aquatic and floodplain habitats will reduce the overall function of PBFs.

A temporary loss of benthic forage is likely to be limited to shallow water habitat adjacent to the shoreline resulting from use of polyacrylamides. This loss will be limited to dry summer months during the construction period when polyacrylamides may be used for dust control. Rapid mixing and dilution of the chemical will occur in areas that are frequently connected with the river via changes in flow or tidal conditions (Xiong et al. 2018), which will preclude the potential for adverse effects to benthic invertebrates to waters with about 5 feet from the shoreline. We estimate that polyacrylamides will be diluted to a low level where the abundance of benthic invertebrates is not reduced within 50 feet downstream of the development site. Although each application of polyacrylamide will degrade within two weeks (Xiong et al. 2018) repeated applications may continually degrade abundance of benthic invertebrates over the course of a 2-3 month period in which dust control is necessary.

Safe Passage - Sound. Increased sound pressure from pile installation will temporarily degrade safe passage and migratory conditions important for both adult and juvenile life stages. Degraded conditions will be limited to 14 days during the proposed October 1 through December 15 work window. Lower intensity sound pressures exceeding 150 decibels (dB), the threshold at which fish behavior is altered (Caltrans 2015) will occur across a 7.36 square mile area centered at the development site. This will degrade rearing and migratory functions of critical habitat for all species across an 11-mile long reach of the LCR. Pile driving will create sound pressures exceeding thresholds for injury to juvenile fish less than two grams (183 dB) and those greater than two grams (187 dB) (Table 8). Maximum distance thresholds for injury to 2 gram fish from sound pressure are included in Appendix D (Figure 15) an area of approximately 119 acres. Sound pressures within 20 to 82 feet of the installation site, an area of approximately 0.48 acres will exceed 206 dB, which may result in immediate death. The majority of adverse effects from sound pressure will result from the process of installing angled 24-inch piles that are installed without the use of bubble curtain for attenuation. Both factors (i.e., pile angle and use of sound attenuation) are critical determinants of sound pressure propagation when considering piles of similar characteristics (Caltrans 2015).

The proposed installation of 34 rock anchors inside of the 24-inch piles will create noise, although the casing effect of piles will attenuate the sound pressure to some degree. As a result it is unlikely the sound pressure created during installation of rock anchors will exceed the 150 dB threshold at which behavior alterations occur (Caltrans 2015). This relatively low-level sound pressure will occur over 25 days.

Table 8. *Sound pressures produced during installation of steel piles, with distance thresholds for behavior and injury.*

Pile characteristics and proposed placement					
Pile diameter (inches)	14	24	24	36	60
Number of piles installed	4	22	13	8	2
Orientation	Angle	Vertical	Angle	Vertical	Vertical
Number of impact hammer strikes	500	800	500	1,000	1,000
Attenuation (dB)	n/a	7	n/a	7	7
Sound pressure					
Sound Exposure Level (dB)	170	174	181	179	178
Root mean square(dB)	182	182	189	194	188
Peak (dB)	198	205	212	207	203
Cumulative Sound Exposure Level(dB)	197	203	208	209	208
Distance to threshold (in feet)					
150 dB (Behavioral effects)	9,812	4,458	13,061	28,139	11,204
183 dB (Injury to fish <2g)	617	709	1,519	1,774	1,522
187 dB (Injury to fish ≥2g)	335	384	823	961	823
206 dB (Instant mortality)	20	30	82	39	20

The proposed action will also create noise during regular operation of the facility. Marine vessels used to guide barges will create noise during 24 berthings per year. Noise created during operation of marine vessels will likely be difficult to distinguish from the effects of large commercial oceangoing vessels that regularly transit the LCR between Portland, Oregon and the ocean, in part because this activity is likely to be limited to a few hours each month such that the contribution to noise within the action area will be minute and difficult to distinguish for other vessel traffic. Operation of marine vessels necessary to dock and undock the transport barge from the terminal will take one hour. Under these conditions marine vessels will operate under reduced power, and consequently, marine vessels will produce less noise than required for full operation. This level of noise is less than 150 dB characteristic of background noise in areas with commercial vessel traffic. Thus, the limited and low-level increase in noise associated with vessel operation will have an indiscernibly small effect on safe passage.

Effects from noise are also likely to result from operation of a front-loader or similar heavy construction equipment used to load limestone from the barge onto the conveyor belt as the loader bucket scrapes against the steel barge deck. The repetitive docking and unloading of the marine barge at the facility will require between one to four days for each barge, or about 2 to 8 days per month. This process amounts to about 16-64 hours each month in which barge unloading is likely to generate sound pressure levels similar to bucket dredging, which creates brief high intense noise at levels that exceed 150 dB (Dickerson et al. 2001). However, research by Nakada et al. (2005) suggests that construction equipment buckets can be designed to reduce noise by 5 dB.

The action area includes critical habitat for CR chum salmon and LCR Chinook salmon, the majority of which weigh less than two grams as subyearlings. Thus, size at migration is an important aspect when considering effects on critical habitat of these species. CRC's proposed use of vibratory hammer may vary from 6-10 days depending on the depth of bedrock at which point impact driving will be necessary. We anticipate the effects from 14 days of impact pile driving will further diminish critical habitat function for rearing, migration of salmonids at both adult and juvenile life stages within approximately 119 acres of the LCR near the development site (Figure 15, see Appendix D). The area in which safe passage conditions will be degraded varies from about 50-60% of the width of the Columbia River.

In summary, sound pressure effects will vary widely as a result of the proposed action. Impact pile driving will result in conditions that may cause injury or death will persist for several hours over the course of 14 days. Other actions, such as rock anchor drilling and vibratory pile driving will not result in injury, but will reduce rearing and migration suitability within a ten mile reach of the LCR. Repetitive actions, such as marine vessel operation and barge unloading, will create low-intensity effects are relatively minor and will only be present for around 70-80 hours each month. The period of operation is based upon CRC's estimate of 1 to 4 days required to unload each barge (ELS 2018). Critical habitat will function normally upon cessation of all activities causing noise that are described above.

Safe (Adult and Juvenile) Passage – Inwater and Overwater Structures and Predation. The presence of inwater and overwater structures will permanently reduce the PBFs for migration and safe passage. These structures include walkways, berthing terminal, mooring dolphins, hoist and transfer towers, and the material conveyor tube. The effects on safe passage associated with these structures varies considerable given the varying size and heights of these structures above the water surface. Presence of these structures will reduce light penetration, create localized areas of reduced water flow, and obstruct safe passage PBFs of listed species to varying degrees. Inwater and overwater structures will obscure light transmission primarily in deep waters, but also in small areas near the shoreline. Construction of the walkways allowing 60 percent light penetration will limit the effects on migratory habitat. In contrast, most inwater structures, as well as mooring dolphins, will completely obscure light penetration. The temporary and repetitive presence of a marine barge at the mooring terminal is likely to have the greatest effect in this respect due to the large surface area (i.e., 0.91 acre), no light attenuation, and volume of water displaced.

The use of overwater task lighting will illuminate the surrounding water column between about 2 to 6.5 hours during 4 to 8 days each month when transport barges are being unloaded (Figure 16). Because of the reduced amount of natural light during the fall and winter months, the effect of lighting on juvenile salmonids will occur from October through March. Petersen and Gadomski (1994) found that the predation rate of northern pikeminnow on juvenile salmon was inversely related to light levels, with most predation occurring at light levels of about 0.03 lux, which is typical of clear, moonlight nights. Lighting for employees near the berthing terminal is likely to be about 50-80 lux. As a result light levels far away from the terminal, including shallow water habitats near the shoreline occupied by small juvenile salmonids, will be temporarily modified near the optimum level for pikeminnow predation. Petersen and Gadomski (1994) note that salmon may be particularly vulnerable to predation by northern pikeminnow during low lighting conditions present at dawn and dusk, yet suggest that light intensity greater than 0.4 lux may cause a localized area where predation is reduced . Tabor et al. (2004) found that artificial lighting affected behavior of juvenile sockeye salmon and increased vulnerability of this species to small piscine predators in nearshore environments. Thus, the temporary and repetitive use of overwater lighting is likely to create areas of greater risk to safe passage in nearshore areas that are several hundred feet from the berthing terminal where lighting conditions are similar to those favored by piscine predators. These areas where safe passage will be temporarily reduced will occur in nearshore habitats.

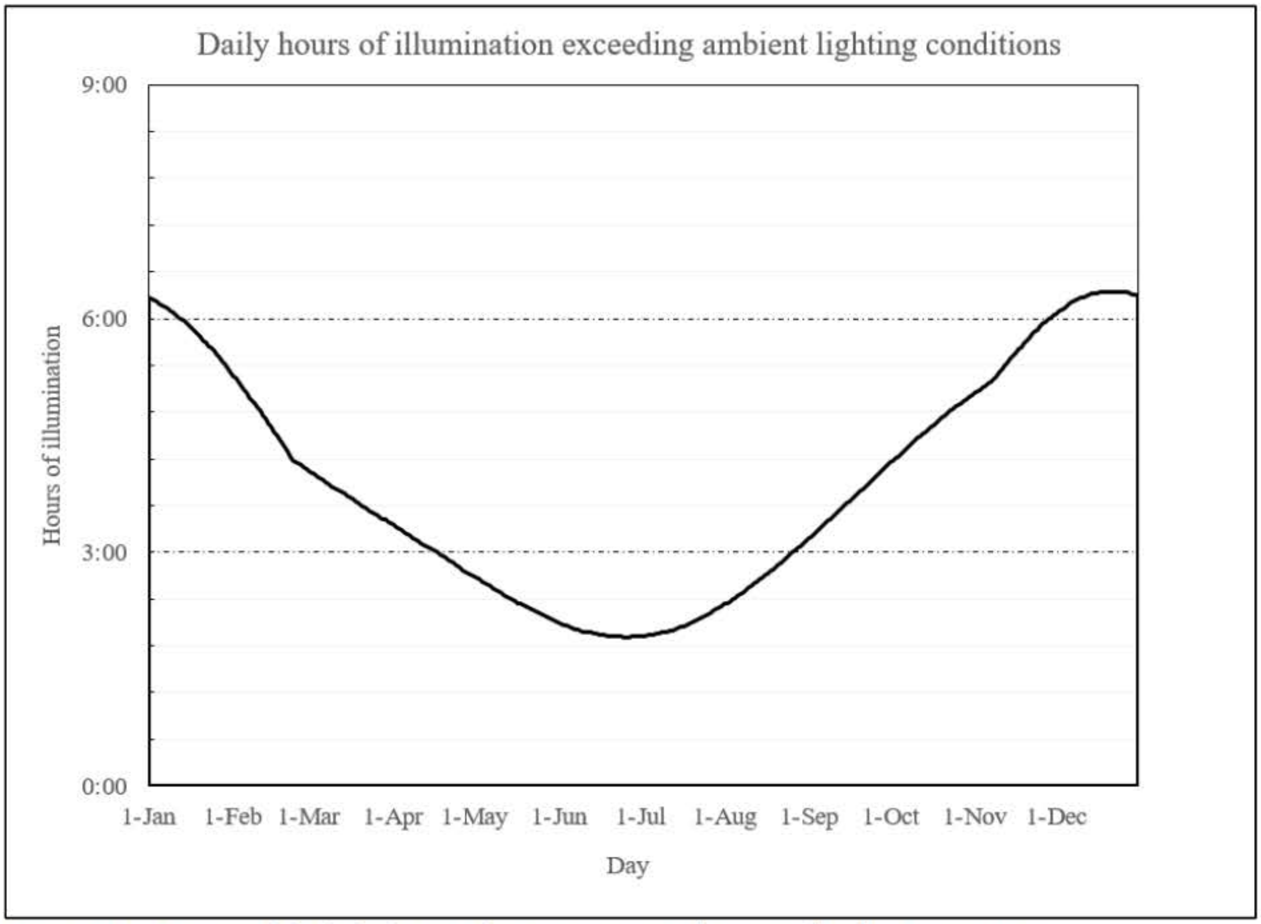

Figure 16. Estimated daily light use during transport barge unloading operations.

Presence of inwater and overwater structures on both a permanent and temporary basis will create localized areas of reduced light intensity and microhabitats where predatory fishes may reside (Helfman 1981b; Howick and O'Brien 1983). Overwater structures produce shade that disruptions migration of juvenile salmonids by creating a visual barrier resulting in disorientation (Carrasquero 2001). Prey species are better able to see predators under high light intensity, thus providing the prey species with an advantage (Hobson 1979; Helfman 1981a). Native predator species, such as northern pikeminnow (*Ptychocheilus oregonensis*), and non-native species, such as largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), and others that consume juvenile salmonids (Kahler et al. 2000; Ward et al. 1994) use shade-producing structures such as docks, piers, and wharfs and their associated piles for foraging and refuge. Thus, inwater and overwater structures will adversely affect rearing, migration, and safe passage for juvenile salmonids.

The 66-foot tall hoist tower and transfer 98-foot tall transfer towers have large elevated spans that may serve as areas for birds to perch. Some avian species include California gulls (*Larus californicus*), Caspian terns (*Hydroprogne caspia*), and double-crested cormorants (*Phalacrocorax auritus*) are known to use overwater structures as loafing, nesting, or foraging habitats (Collis et al. 2000; Lyons et al. 2007). White et al. (2008) noted that avian species, like piscine predators, also take advantage of contrasts in light caused structure and decreased visibility in the water column. Towers and horizontal cross members provide ample perching platforms for double-crested cormorants, from which they can launch feeding forays or dry plumage (Harrison 1983). Because their plumage becomes wet when diving, cormorants spend considerable time drying out feathers on pilings and other structures near feeding grounds (Harrison 1984). Krohn et al. (1995) indicated that cormorants can reduce fish populations in forage areas, thus possibly affecting adult returns as a result of smolt consumption.

The key factors that determine the impact of each structure on critical habitat features are size, light permeability, and positioning. The presence of inwater and overwater structures will modify critical habitat indefinitely, which will reduce the quality of the habitat critical to migration and rearing for juvenile salmonids. The designs proposed by CRC will reduce, but not eliminate, the degradation to migratory and rearing habitat because most of the structures are located in deep water, at distances of more than 150 feet from the shoreline, and constructed of materials allowing greater than 60 percent light penetration. As noted above, the permanent addition of inwater and overwater structure will degrade flow and light penetration, features that support proper functioning for migration and rearing for salmonids. These conditions are favorable to piscivorous fishes and some species of birds (Carrasquero 2001; Lyons et al. 2007).

Floodplain Connectivity. The proposed marine terminal will fill 3.75 acres of habitat within the 100-year floodplain. This aspect of construction is important considering: 1) the proposed action will eliminate approximately 0.9 acres of off-channel habitat below OHW used by juvenile salmonids during the migration season, and 2) loss of off-channel and floodplain habitat resulting for diking and filling is one of the greatest threats limiting recovery of salmonids in the LCR (NMFS 2011b). In this case, excavation and filling within OHW will reduce the transfer of forage items into the LCR as well as reduce the space available for juveniles to rearing and seek refuge during high flow periods. The proposed removal of mature trees and shrubs will reduce shade in addition to reduced leaf litter that supports benthic macroinvertebrates.

Cover/Shelter, Forage, Riparian Conditions, Safe Passage (Juveniles). CRC's purchase of the 9.4-acre parcel and prevention of commercial or residential development through binding easement or similar legal instrument is expected to provide benefit to several PBFs of rearing and migration critical habitats. The proposed action includes improvements to habitat features, such as: invasive vegetation removal, native vegetation installation, large woody debris (LWD) placement in low elevation floodplain areas, removal of 50 CY of illegally deposited trash, and minor grading to remove depressions totaling about 0.2 acres that pose a risk to fish stranding. As discussed above, some aspects of site rehabilitation associated with improvement in PBFs at the mitigation site will result in minor, short term degradation. Installation of LWD, removal of trash, and minor grading will disturb substrates causing small amounts of suspended sediment near the shoreline during high flow periods. However, the increase will be a minor immediate improvement to baseline conditions. The permanent effects of these actions will result in increased native, natural cover and quality of rearing habitat resulting from installation of LWD and invasive vegetation removal, and re-establishment of native vegetation. Removal of trash from in the site will reduce the amount of physical and chemical contamination. Removal of invasive vegetation by herbicides or mechanical means will result in a minor reduction in cover that will persist for months. Re-establishment of native vegetation increases riparian diversity, soil nutrient dynamics, and food web interactions (Gregory et al. 1991) that support habitat features especially important for juvenile rearing. Final recording of deed, conservation easement, or similar legal instrument is necessary for long-term security of these physical and biological features as described above.

The habitat equivalency analysis (HEA) conducted by CRC indicates that habitat functions associated with modification of critical habitat at the development site will result in a reduction of 26.410 discount service acre years (DSAYs). The purchase of the 9.4-acre mitigation parcel and activities necessary to enhance existing habitat features yields a total of 31.548 DSAYs under CRC's analysis (ELS 2018). The net surplus of 5.138 DSAYs will yield a slight improvement in habitat function based on the proposed establishment of a conservation easement or deed restriction to manage the site in perpetuity, as part of the proposed action, for the purposes of preservation (ELS 2018). The following PBFs will improve as a result of the proposed mitigation action: cover, forage, riparian vegetation, and natural substrates. Off-channel habitat is identified in recovery plans of all species as having high intrinsic value necessary for recovery (NMFS 2011b; 2013). CRC's mitigation site purchase will preserve the amount off-channel rearing habitat, a limiting factors for all species considered in this consultation.

2.5.2 Effects to the Species

Effects from the action on species are based on exposure to the effects experienced by fish as a result of habitat changes, as described above, or occurring to the fish themselves. In this case, 13 ESA-listed species of salmon and steelhead from the Snake River, the upper, middle, lower Columbia, and Willamette basins, will pass through the action area. We assumed all the aforementioned listed species will be exposed to the permanent habitat effects during their migration through the action area, whereas some species, due to their migratory timing, will not be exposed to construction effects scheduled to occur during the work window. These effects include degradation to critical habitat features from construction of the marine terminal and permanent operation of the facility, in addition to conservative attributes from long term maintenance of critical habitat features associated with purchase and rehabilitation of the 9.4-acre parcel for mitigation.

The level of exposure to these effects varies by timing and location of activity and the densities and habitat use of the ESA-listed fishes. The ESA-listed fish species will experience to greater or lesser degrees:

1. Degraded water quality
2. Reduced forage
3. Degraded safe passage (sound pressure)
4. Degraded safe passage (in- and overwater structures)
5. Degraded safe passage (predation)
6. Reduction in off-channel habitat (floodplain connectivity)

Exposure and response – degraded water quality. Grading, fill, and installation of inwater and overwater structure at the construction site will result in increased levels of suspended sediment entering the LCR. The use of silt fencing, straw bales, and associated construction BMPs in upland areas will preclude the delivery of sediment from upland sources because construction is proposed to occur during the dry season graded and filled sediment will enter the LCR during limited rainfall events. Proposed construction at both the development and mitigation sites (i.e., installation of LWD structures and grading) will disturb soils in upland areas and on the shoreline. The delivery of sediment from shoreline and upland areas due to construction will be limited to small amounts during precipitation events lasting for a period of minutes to hours. As described above, inwater construction will also re-suspend small amounts of suspended sediment directly into the water column, but this is likely to occur at or near the sediment surface. As a result, species that migrate near the sediment surface or rear in shallow water habitats near the construction area are most likely to experience elevated levels of suspended sediment.

As previously noted, nearly all salmonids are present in the LCR during October through December 15 when pile installation is proposed. Species that rear in the LCR during the proposed inwater work window are most likely to be exposed to suspended sediment, which include: LCR Chinook salmon, LCR coho salmon, LCR steelhead, SR fall Chinook salmon, and UWR Chinook salmon. Both LCR Chinook salmon and LCR coho salmon will be exposed at the adult and juvenile life stages, which increases the potential for adverse effects to these species. And, as noted above, about 50 percent of the populations from the following species originating in the LCR (i.e., LCR Chinook salmon, LCR coho salmon, LCR steelhead, and CR chum salmon) are at somewhat greater risk due to the close proximity of their natal tributaries to the development site. Those include populations in the Clackamas, Hood, Lewis, Sandy, Washougal, and Wind rivers, in addition to the mainstem Columbia River (lower Gorge population). Adult chum salmon are abundant during this period and are migrating through the action area to reach spawning tributaries (LCFRB 2010).

Adult salmonids are strong swimmers that are relatively tolerant of increased levels of suspended sediment (Servizi and Martens 1991; 1992). Due to their increased tolerance of turbid conditions, adult salmonids that do experience increased levels of suspended sediment are likely to exhibit only behavioral effects such as alarm reaction and avoidance that do not result in adverse effects associated with reduced growth or fitness (Newcombe and Jensen 1996). Bisson and Bilby (1982) found that salmonids are able to detect and distinguish turbidity and other water quality gradients. The amount and intensity of exposure experienced by adult fish will likely result in no more than a slight alteration in migratory path away from the shoreline before individuals find refuge and/or passage conditions within unaffected adjacent areas.

Species are typically less tolerant of increased levels of suspended sediment at early life stages (Newcombe and Jensen 1996). Yet, the decreased visibility coinciding with turbid conditions also decreases the likelihood that small fishes are consumed by larger, piscivorous species, thereby providing some benefit concurrent with short-term adverse behavioral effects such as reduction in feeding rates and abandonment of cover (Newcombe 2003). Juvenile salmonids will experience degraded rearing conditions immediately adjacent to the construction area for several weeks when pile installation occurs due to the suspended sediment effects described above. This will result in a short-term reduction in growth and fitness of a small number of individuals. Smaller, ocean-type subyearling migrants (e.g., LCR Chinook salmon, LCR coho salmon, SR fall Chinook salmon, and UWR Chinook salmon) that rear in the LCR will be more likely to experience adverse effects than larger, stream-type yearling migrants (UCR Chinook salmon, SR sockeye salmon, and five species of steelhead).

Degraded water quality conditions caused by use of polyacrylamides at the construction site will likely result in low level, short-term damage to gill tissue to fishes as well as aquatic insects (Krautter et al. 1986), suggesting chemical contamination may result in localized diminishment of benthic invertebrate communities. Researchers documented short-term harm from gill swelling polyacrylamides while prolonged exposure resulted in profound changes in gill structure (Krautter et al. 1986; Kerr et al. 2014). CRC is most likely to apply polyacrylamides during the construction phase of the project, which may include 3-4 months during the summer to reduce erosion caused by wind and rainstorms. Repeated application of polyacrylamides may accumulate a reach 160 milligrams per liter, which is the lethal concentration of midges, a common forage of juvenile salmonids will occur (Krautter et al. 1986). These researchers state that the threshold concentration resulting in mortality to juvenile steelhead is 410 milligrams per liter. While such a high concentration of polyacrylamides causing mortality is extremely unlikely, repeated applications of this chemical over the 2-3 month construction period are sufficient to cause temporary injury to gill tissues (Kerr et al 2014). Adult salmonids occupy deep water and will be exposed to extremely minute concentrations of this chemical insufficient to result in any adverse effect, but juvenile salmonids such as LCR Chinook salmon, LCR coho salmon, and SR fall Chinook salmon that occupy shallow water habitats during the summer months are reasonably certain to be injured by exposure to polyacrylamides.

As noted previously, limited use and proper site and weather-specific use of herbicides will limit the potential for transport of these chemicals into the LCR. The amount of herbicide delivered to the LCR as a result of application of herbicides at the mitigation site will be minor.

Exposure and response - reduction in forage. Sediment composition is a driving factor determining the abundance and diversity of benthic invertebrates that constitute the forage for juvenile salmonids. Current shoreline structure and sediment composition characteristics are typical of the LCR as a whole. Haskell and Tiffan (2011) found benthic invertebrate communities associated with mainstem sites the LCR were populated predominantly by amphipods (*Corophium spp*.). These findings conformed to those previously reported by McCabe et al. (1997; 1998), who noted amphipods are the dominant prey item consumed by juvenile salmonids throughout the LCR. Although juvenile salmonids will consume a variety of benthic invertebrates, including flatworms (*Turbellaria*), annelid worms (*Oligocheata*), bivalve clams (*Corbicula fluminea*), and midges (*Chironomidae* and *Ceratopogonidae*) in addition to amphipods, we anticipate loss of this dominant prey item is the most likely result from fill and construction at the development site.

As previously discussed, polyacrylamides used for erosion control may leach into surrounding shoreline habitats and affect prey communities. The exposed tidal shoreline, with constant wave action and swift river flow is likely to rapidly dilute concentrations of this chemical such that small organisms (i.e., benthic invertebrates) present in shallow water habitats will be exposed to doses sufficient to result in mortality of prey species. Juvenile salmonids are likely to experience indirect effects related to reduced abundance and diversity of benthic invertebrate forage within a narrow area surrounding the shoreline because the distribution of polyacrylamides in deeper water will be rapidly diluted. Biodegradation will occur within about 2 weeks (Xiong et al. 2018), limiting the potential exposure after this period. Forage conditions will return to baseline levels soon thereafter, such that overall effect of reduced prey availability on individuals is minute.

Construction and fill within floodplain and upland areas will also reduce the amount of terrestrial-based forage exported from areas below the OHW and floodplain habitats that are infrequently connected with the main channel during spring floods. Roegner et al. (2010) noted that juvenile salmonids consumed primarily midges in reconnected tidal wetlands of the lower Grays River and transitioned to amphipods in locations near the confluence with the Columbia River. These researchers noted that the transfer of forage items from floodplain and terrestrial areas were important to growth of juvenile salmonids. In addition, as described in the critical habitat analysis, the proposed installation of inwater structure (piles and mooring dolphins), overwater structure, and fill material within areas below OHW will decrease the abundance of benthic invertebrates available to listed salmonids. The reduction in productivity and abundance of benthic invertebrates will be minute when considered at the scale of individual fish because the footprint from inwater structure is minimal (i.e., 200 square feet) and adjacent sites should retain the baseline level of forage. However, the aggregate permanent loss of benthic and seasonally-inundated floodplain habitat will decrease growth and survival of all species of juvenile salmonids.

Exposure and response – sound pressure. The proposed action will cause intense sound pressure in migration and rearing areas during pile installation, ground anchor drilling, barge operation, and limestone unloading activities. As noted above in the critical habitat section, the most intense noise created during installation of angled piles that are proposed to be installed with no bubble curtain to attenuate sound pressure. Underwater noise generated within 20-82 feet of these pile placement locations will exceed 206 dB, the level at which fish are instantly killed. Outside of this area sound pressures will be less intense, but still sufficient to result cause injury. The size of the area in which injury or death may occur is about 119-acres (Figure 15, see Appendix D). Elevated sound pressures from pile installation will be limited to 14 days.

Impact hammering creates intense sound pressure that is known to cause a range of potential injuries to fishes. These injuries, known a barotraumas, depend on the duration and intensity of exposure that range from temporary decreased hearing sensitivity consistent with of reduced fitness, growth and reproductive, to immediate injury or death (Popper and Hastings 2009; Stadler and Woodbury 2009). Even fish exposed to underwater noise not leading to injury may exhibit behavioral effects such as elevated heartrate and stress hormones and respond by seeking cover (Caltrans 2015). Injuries to capillaries and soft tissues may heal after a short period, or lead to a latent mortality by accelerated degradation of organs. The onset of behavioral effects, such as increased heart rate and elevated cortisol levels that may interrupt courtship and spawning activity (Wysocki et al. 2006). Some fish may migrate through the action area closer to the pile installation and experience temporary decreased hearing sensitivity consistent with sub-lethal effects of reduced fitness, growth and reproductive, although exposure at close range, or for longer periods can result in injury, or death (Popper and Hastings 2009; Stadler and Woodbury 2009). Injuries may also result in temporary or permanent hearing loss, movement of fish away from feeding grounds, and increased vulnerability to predators, reduction or elimination of the ability to locate prey, inability to communicate, and inability to sense the physical environment (Caltrans 2015). Furthermore, although initial responses may include changes in swimming behavior, orientation, and startle reactions fish may not perceive the origin of sound (Pearson et al. 1992; Wardle et al. 2001; Hassel et al. 2004) and habituate to continuously repeated sounds produced at levels causing injury (Popper et al. 2014).

Based upon proposed number of strikes (i.e., exceeding 1,000 per day in some cases) impact hammering of piles greater than 24-inches in diameter will produce sound pressures exceeding injury thresholds (183 dB for fishes less than 2 grams). The main channel of the CR at the development site is about 0.6 miles wide. As noted above, impact hammering will create sound pressures causing injury to juvenile and adult salmonids within a 119-acre area that comprises about 56 percent of the channel width. We conservatively estimate that adult and juvenile salmonids will be uniformly distributed across the width of the river channel through the action area. This will result in 56 percent of fish migrating through the action area being exposed to injurious levels of sound pressure for the duration of the 14 days of impact pile driving. All species of salmonids are likely to be present, although most species will be present in low abundances with the exception of LCR Chinook salmon, SR fall Chinook salmon, LCR coho salmon, LCR steelhead, and UWR Chinook salmon (see Appendix B; Table 5).

Adverse effects to behavior of species are expected across the entire width of the channel within a 7.36 square mile area from the development site. Behavioral effects will consist of startle response, seeking cover, and elevated heart rate and blood cortisol levels (Caltrans 2015). Behavioral effects are temporary and those fish exposed will resume normal behaviors within a few minutes to 18 hours, depending on the proximity to the construction and duration of exposure (Popper et al. 2005). Fish exposed may experience a temporary reduction in growth rate while active pile driving is underway. The majority of fish rear and migrate in the LCR for days to weeks during the spring and summer in the process of outmigrating to the ocean (Bottom et al. 2005; 2011). Fish present in the action area during the mid to late fall will be rearing or migrating slowly and are most likely to be found in shallow water wetland habitats where abundant forage and refugia are present.

The proposed location and installation of most piles will occur at distances between 100-300 feet from the shoreline. At the very least, fish migrating through these areas will exhibit behavioral responses such as erratic swimming and startle responses that may increase their vulnerability to predators. Juvenile salmonids will be more susceptible to piscine and avian predation during and briefly after each pile driving event as individuals recover from the temporary shift in hearing threshold (Popper et al. 2014). Fish migrating between 100-300 feet from the shoreline will be exposed to high intensity sound pressures from pile driving that may cause instantaneous death. Yet, as previously discussed, sound pressures created by pile driving will cause injury to all fish present within a 119-acre area adjacent to the shoreline. The impact hammer will produce acute effects to adults migrating through this section of the Columbia River, however growth and fitness are concerns more associated with juvenile fish due to the greater sensitivity of small fish.

Species most likely to be affected by sound pressure from pile driving are subyearlings and species from within the LCR region that rear in and/or migrate through the mainstem LCR during the fall and winter, although nearly all species may be present in low abundances during the proposed inwater work window. Those species most susceptible to injury, as these species migrate slower and within shallow water habitats close to the shoreline (Dawley et al. 1986;

Carter el al. 2009), which include: LCR Chinook salmon, LCR coho salmon, SR fall Chinook salmon, and UWR Chinook salmon. However, the action area is located in a reach with relatively few off-channel areas where fish are likely to reside for extended periods and be repeatedly exposed to injurious levels of sound pressure created by pile driving. Other species, such as CR chum salmon, MCR steelhead, SR spring/summer Chinook salmon, SRB steelhead, SR sockeye salmon, UCR spring-run Chinook salmon, UCR steelhead, and UWR steelhead will have little to no potential for exposure as juveniles because they will be absent, or present in low abundances during the period when pile driving is proposed.

Based upon the action area size and species-specific observations in the mainstem LCR (NMFS 2017; Appendix A) a total of 13 species may have juvenile and/or adult life stages that may be exposed to underwater noise. Two species, CR chum salmon and LCR coho salmon, will have juveniles and adults exposed to pile driving, which increases the level of risk. Furthermore, both of these species spawn in tributaries and/or the mainstem LCR shortly after exposure and still recovering from exposure. The limited duration of impact hammering will reduce the number of individuals exposed. Species at greatest risk of exposure to effects related to pile driving are LCR Chinook salmon, LCR coho salmon, SR fall Chinook salmon, and UWR Chinook salmon due to the combination of shallow water habitat use, extended use of mainstem habitats for rearing, and co-occurrence during the proposed pile installation. Species exhibiting a stream-type life history that migrate as yearlings will have limited exposure at the juvenile life stage during October through December. Adult salmonids, including CR chum salmon and LCR coho salmon as discussed above, will be present in the action area, but more likely to migrate through the mid-channel (Carter et al. 2009) and not close enough to result in injury. Species returning to spawn in the late fall are most at-risk of exposure. Overall, the proposed fall work window during the period when many species of salmonids are absent from the action area will decrease the potential for injury and mortality.

In contrast, other aspects of the proposed action, such as operation of marine transport barges and offloading limestone will also be ephemeral but repetitive, occurring multiple times annually throughout the lifespan of the marine terminal. Noise from these activities are typically less than 150 dB, the sound pressure characteristics associated with behavioral effects to fishes, and are more likely to cause behavioral changes that temporarily impair predator and prey detection. As a result, fish that are injured from barotrauma are more likely to be consumed by predators.

Exposure and response - migratory obstruction. The construction of towers, mooring dolphins, elevated walkways, piles and moorage of transport barges will permanently add large structures to the eastern shoreline of the LCR. Most inwater and overwater structure will permanently modify habitat features, but moorage of transport barges will be temporary, although repetitive at a rate of about four days each month. Overwater structures produce shade that disrupts migration of juvenile salmonids by creating a visual barrier resulting in disorientation (Carrasquero 2001). Simenstad et al. (1999) reported that changes in the underwater light environment affect juvenile salmonid physiology and behavior that alter fish migration behavior and increase mortality risk. Tabor et al. (2004) noted that fry migrants delayed migration and sought lower velocity habitats upon experiencing visual barriers created by overwater structures, thus increasing their exposure to piscine predators. As a result, smaller juveniles that migrate near the shoreline are most likely to be exposed to changes in light and flow created by presence of these structures. LCR Chinook salmon, CR chum salmon, and UWR Chinook salmon, in particular, are species with relatively large numbers of non-hatchery origin individuals that migrate through the area at a smaller size than most subyearling migrants (LCFRB 2010; Sather et al. 2016).

Salmonids are most likely to be affected at the juvenile life stage, particularly Chinook salmon, chum salmon, and coho salmon, because these individuals are typically oriented near the shoreline and are likely to interact with structures (Ledgerwood et al. 1991; Carter et al. 2009). Because most piles are located in close proximity (i.e., several piles tied together to form a mooring dolphin) individuals will be able to locate spaces that are less altered by piles and shade.

Migration patterns of juvenile salmonids may also be modified by night-time use of overwater lighting. Wickham (1973) and Puckett and Anderson (1988) found steelhead to be attracted to mercury lights under certain circumstances, thus altering their normal migration behavior. Nemeth and Anderson (1992) also found areas with lighting were associated with increased coho salmon and Chinook salmon activity.

Because larger stream-type yearling migrants tend to migrate in deeper water near the thalweg these fish are less likely to encounter inwater structure. If these fish do encounter inwater structure they will respond by migrating away from the shoreline with some minor adjustment in path. In some cases juveniles will avoid mooring dolphins and piles, yet may occasionally use these structures as refuge (Carlson et al. 2001). In general, larger yearling migrants are more advanced stage of smoltification such that they will be able to migrate around structures with minimal additional effort or delay.

Even minor adjustments to the migration route of small fish are known to increase energetic expenditure, and increase opportunities for piscivorous predators to prey on affected juveniles (Anderson et al. 2005). These same migration adjustments will have no effect on adult salmonids because these individuals are more mid-river oriented, have greater capacity to move with ease, and are not at risk to predation by avian or piscine species that use inwater and overwater structures.

Exposure and response - predation. The construction of towers, mooring dolphins, elevated walkways, inwater piles, and transport barges will permanently add large structures to the Washington shoreline of the LCR. The addition of inwater and overwater structure will result in reduced light penetration and microhabitats with reduced flow that creates abundant habitat for piscine predators (Metcalfe et al. 1997). Pribyl et al. (2005) noted that smallmouth bass are commonly found near beaches and rock outcrops more frequently in the winter and spring, and highly associated with pilings regardless of the season. Ward (1992) found that northern pikeminnow consumed 30% more salmonids in developed areas of Portland Harbor than in undeveloped areas even though northern pikeminnow were more abundant in undeveloped areas. These findings suggest that the abundance of inwater and overwater structures present in the construction footprint will provide refuge for piscine predators and therefore predation opportunities will increase.

There are four recognized, major predatory strategies used by piscivorous fish: they pursue and overtake prey; ambush prey; habituate prey to a non-aggressive illusion; or stalk prey (Hobson

1979). Ambush predation is the most common strategy wherein predators lie in wait, then dart out at the prey in an explosive rush (Gerking 1994). Predators frequently use sheltered areas that provide slack water to ambush prey fish in faster currents (Bell 1991). Predicting piscine predation remains somewhat difficult due to site-specific and seasonally-variable factors. Nonetheless, the addition of large overwater structures increases microhabitats used by piscine predators as habitat from which to forage for smaller subyearling salmonids such as: CR chum salmon, LCR coho salmon, and LCR Chinook salmon. Other salmonids are too large and are mid-channel oriented during migration, and thus will have little exposure to piscine predators.

Operation of overwater lighting during transport barge unloading may cause conditions favorable to predation of juvenile salmonids (Tabor et al. 2004; 2011). Northern pikeminnow is the most prevalent species of piscine predator throughout this reach of the LCR and are estimated to consume millions of juvenile salmonids each year (Petersen and Gadomski 1994; Knutsen and Ward 1999). Researchers have observed juvenile salmon are attracted to light produced by marine terminal structures in Puget Sound, which may increase the potential vulnerability to predation near overwater structures. However, given the relatively uniform habitat conditions near the proposed marine terminal and ephemeral use of task lighting during barge unloading operations it is unlikely that piscine predation will occur from non-native species present in the LCR (i.e., black bass, crappie, walleye, etc.). Thus, the only threat to juvenile salmonids is likely to originate from pikeminnow. Results from Petersen and Gadomski (1994) suggest that any increase in juvenile salmon predation will likely occur in nearshore areas where lower light levels present advantageous foraging conditions for pikeminnow.

In addition to piscine predators the Columbia River Basin hosts several species of colonial nesting waterbirds that consume juvenile salmonids: Caspian terns (Hyd*orprogne caspia*), double-crested cormorants (*Phalacrocorax auritus*), and various species of gulls (*Larus spp.*). All species have been documented loafing, nesting, and roosting near large water bodies in the LCR. Caspian terns prefer flat, open areas allowing unobstructed views of the water and are currently nesting on islands, abandoned barges, industrial warehouse rooftops, and an abandoned industrial waterfront sites in the Columbia Basin or Puget Sound (Roby et al. 2017). Double-crested cormorants and gulls are gregarious perching birds use a variety of different structures for these purposes including power line towers, bridges, and piers (Bartholomew 1942) in addition to islands within the sage lands of the interior Columbia Basin (Evans et al. 2012).

Given the proposed construction, nearby vegetation and shoreline-based construction activity, the development site will provide more foraging and loafing habitat for double-crested cormorants and gull species, but not Caspian terns. Cormorants and gulls have different foraging strategies: gulls are plunge divers and are limited to preying on fish near the surface (Cuthbert and Wires 1999), whereas double-crested cormorants are foot-propelled pursuit divers and can access prey several meters below the water surface (DeGraaf et al. 1985). The additional elevated overwater structure will create attractive loafing and foraging habitat for avian species to prey upon all species of juvenile salmonids. In river reaches near large waterbird nesting colonies predation rates can exceed 10 percent for some species, particularly steelhead, which migrate near the water surface (Evans et al. 2012). Double-crested cormorants and gulls using the development site as loafing and foraging habitat are most likely to consume steelhead and subyearling, ocean-type migrants, especially those from nearby tributaries that are rearing in the mainstem CR and not actively out-migrating into the ocean (Evans et al. 2012; 2016; Sebring et al. 2013). Predation rates of small gull colonies located between Bonneville Dam and McNary Dam suggest that less than 0.1 percent of juvenile salmonids will be consumed (Evans et al. 2012). In this location of the Lower Columbia River species vulnerable to avian predation include LCR Chinook salmon, LCR coho salmon, SR fall Chinook salmon, and UWR Chinook salmon. There is very little evidence of avian predation of CR chum salmon (NMFS 2011). However, researchers used genetic analysis of double-crested cormorant gut contents suggests CR chum salmon were present in less than 0.25 percent of identifiable samples (Lyons et al. 2014).

Exposure and response - reduction in off-channel habitat (floodplain connectivity). The proposed action will result in permanent loss of rearing and migratory habitat for juvenile and adult salmonids caused by construction and fill of approximately 0.9 acres of floodplain habitat (i.e., less than 12.7 feet CRD) at the development site. NMFS (2011b) listed lack of access to shallow water, floodplain habitats as a factor limiting recovery of several ESA-listed species. However, historical evidence suggests that not all cohorts of juvenile salmonids will experience lack of access to off-channel habitat at the development site as a result of the proposed action because it was only accessible on a variable basis. The 0.9 acres of floodplain habitat was accessible to juvenile salmonids about 50 percent of the last 15 years (ELS 2018). The number of days when the off-channel habitat was connected to the main river channel varied from 1 to 60 days. The reduction in floodplain habitat and resulting decreased growth and survival will be minimal for most juvenile salmonids because connectivity to floodplain habitats is highly variable, and typically occurs for a few days. However, research suggests that increased access to habitats with ample forage yield increase growth and survival for species that are present when floodplain connectivity occurs (Beechie et al. 2013; Bottom et al. 2005, 2011; Katz et al. 2017; Sommer et al. 2001). This suggests that the reduction in forage and rearing opportunities caused by lost floodplain habitat will result in reduced growth and survival of a small number of juvenile salmonids such that the population-level effects are extremely small.

In addition, the effects of losing the habitat is minimized somewhat by the entrapment risks to fish which would use it. Due to site-specific topography the 0.9 acres of floodplain habitat that will be lost does not always allow egress for fishes after high river flow recedes and adjacent landowners have observed birds consuming fish trapped within this area. To the extent the 0.9 acres of off-channel habitat provides juvenile salmonids forage and rearing opportunities, access to this particular area is not without risk of entrapment and mortality which individuals are presumably unable to perceive. Thus, while species exhibiting subyearling migration histories (i.e., LCR Chinook salmon, LCR coho salmon, SR fall Chinook salmon, CR chum salmon, and UWR Chinook salmon) are likely to experience loss of rearing and foraging opportunities associated with loss of off-channel habitat, these same species will no longer experience risk of entrapment.

2.6. Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). 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 future environmental conditions in the action area caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4). Assuming that CRC intends to operate its proposed facility for 25-40 years, we can reasonably expect, however, that climate change is likely to create more variable conditions in water temperatures, volumes (flood levels and low water levels), and possible long term changes in salinity, all of which can modify foodwebs and in turn put greater stress on salmonid populations.

Future state and private activities outside of the action area are expected to cause habitat and water quality changes that are expressed as cumulative effects within the action area. Our analysis considers: (1) how future activities in the Columbia River basin are likely to influence habitat conditions in the action area, and (2) cumulative effects caused by specific future activities in the action area.

Approximately 6 million people live in the Columbia River basin, concentrated largely in urban centers. During the past 10 years the human population within the seven counties comprising the Portland-Vancouver metropolitan area increased annually by about 5 percent (PMC 2016). The human population in the Columbia River watershed is projected to continue increasing although at a somewhat slower rate. The past effect of that population is expressed as changes to physical habitat and loadings of pollutants contributed to the Columbia River. These changes were caused by residential, commercial, industrial, agricultural, and other land uses for economic development, and are described in the Environmental Baseline (Section 2.4). Additional degradation to physical and biological features is likely to continue to occur as the human population in the area continues to increase.

Effects associated with increased human population are continued development, such as increased pollutants, shoreline habitat degradation, underwater noise, and wake stranding will likely increase from greater commercial and recreational boat and ship traffic. The collective effects of these activities tend to be expressed most strongly in lower river systems where the impacts of numerous upstream land management actions aggregate to influence natural habitat processes and water quality. As such, these effects accrue within this action area, though most are generated from actions upstream of the action area.

As previously discussed in Section 2.2, changing climate conditions will put additional stress on the ability of critical habitat to support all of the physical and biological features necessary to sustain listed species in the Columbia River watershed. Summer low flows throughout much of the Columbia watershed may decrease between 35-75 percent (Beechie et al. 2013). As human population in the Portland-Vancouver area continues to grow residential development will reduce the quality and quantity of floodplain habitat as riparian vegetation is cleared and streambank armoring actions are approved to reduce erosion. Some researchers suggest increased connectivity to floodplain areas has high potential to offset for lack of growth areas were habitat characteristics and growth potential is lacking (Katz et al. 2017).

While widespread degradation of aquatic habitat associated with intense natural resource uses is no longer common, ongoing and future land management actions are likely to continue to have adverse effects on aquatic habitat quality in the Columbia River basin and within the action area. Improvements in the quality of available aquatic habitat is likely to be slow in most areas.

2.7. Integration and Synthesis

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

In this biological opinion, NMFS determined that all 13 species of salmon in the Columbia River may potentially be injured, killed or have their normal behavior patterns disrupted as result of temporary effects from construction (chemical contaminants, suspended sediment and sound pressure) and permanent habitat effects (predation and reduced growth and survival) caused by large inwater and overwater structures and operation of the marine terminal within areas used by salmonids for rearing and migration at adult and juvenile life stages. Species at greatest risk are those that migrate or rear within shallow water habitat disrupted by placement of large overwater structures and marine transport barges. Those species include CR chum salmon, LCR Chinook salmon, LCR coho salmon, SR fall-run Chinook salmon, and UWR Chinook salmon. However, this does not preclude exposure of other species that may be present in low abundances in the LCR during the proposed work window, although the likelihood of adverse effects is less.

Several populations originate downstream of the action area and will not be exposed to effects of the proposed action as noted previously in Table 6. However, individuals from all 13 salmonid species considered in this consultation will migrate through the action area during juvenile and adult life stages. Considering the status of the ESA-listed species, all but two of the species considered are threatened with extinction, and those two (i.e., UCR Chinook salmon and SR sockeye salmon) are endangered. The probability of persistence of nearly all of the component populations are low, or very low, including 8 of 9 populations originating from the nearby Lewis River Basin that are at a very low probability of persistence (NMFS 2013). The late-fall run of Chinook salmon from the Lewis River watershed is currently rated at a very high probability of persistence. Overall risk and reduction in abundance from project effects among other species such as, SR fall Chinook salmon, UWR Chinook salmon is likely to be more evenly distributed among populations. Therefore, the risk to these species will be less than to LCR Chinook salmon and LCR coho salmon.

Factoring in the current environmental baseline, fish from the component populations identified in Table 5 (see Appendix B) include the following species residing upstream of the action area, such as LCR Chinook salmon, LCR coho salmon, LCR steelhead, and CR chum salmon, in addition to all fish from SR fall Chinook salmon, and UWR Chinook salmon will move through the action area. All these fish encounter habitat conditions that have been historically degraded by restricted natural flows, reduced water quality from substantial chemical pollution, loss of functioning floodplains and secondary channels, and loss of vegetated riparian areas and associated shoreline cover. The significance of the degradation is reflected in the limiting factors identified in the LCR estuary recovery module (NFMS 2011b) including habitat access to floodplain and secondary channels, degraded habitat, loss of spawning and rearing space, pollution, and increased predation.

Critical Habitat

Within this context, the proposed action will create acute, temporary construction-related effects and incremental chronic long-term effects of inwater and overwater structures and associated uses within rearing and migratory habitat at the project site. Construction of the berthing terminal and LWD structures, and use of polyacrylamide chemicals will degrade water quality. Safe passage will be degraded by pile driving, predation by avian and piscine species that consume juvenile salmonids, and the presence of the berthing terminal that adds a physical obstacle with the migratory corridor. Installation of piles and floodplain fill will reduce the amount of forage available to juvenile salmonids. However, the loss of off-channel habitat at the development site will be offset by purchase and legal protection of the 9.4-acre mitigation site in perpetuity. Preventing future residential or commercial development at the mitigation site will retain accessible off-channel refugia habitat for juvenile salmonids during seasonal high flows. On balance, PBFs of critical habitat are not diminished to a degree that impairs conservation values because actions causing high-intensity degradation to habitat features will only occur during construction and return to normal immediately thereafter, whereas permanent modification to habitat features are either low-intensity or offset by preservation of high-quality habitat in a nearby, offsite location.

Species

The intense sound pressure resulting from pile installation is likely to pose the greatest risk to individual fish, but will be limited to 14 days during the period when most species are not at peak abundance. Fish that are injured or killed would be from a single cohort, and are expected to be too low to appreciably alter the population viability, even for nearby populations of LCR Chinook salmon and LCR coho salmon that will have individuals exposed at both adult and juvenile life stages. Any reduction in abundance should be indiscernible among juvenile cohorts as returning fish or among spawning success of adult fish due to the timing and duration of the proposed pile driving. In short, productivity, spatial structure, and diversity are likely to remain unaltered by construction effects.

Subsequent cohorts of populations from all species considered in this consultation will experience the conditions of degraded migratory habitat, predation, and loss of floodplain connectivity at the project site. Fish will slightly delay or alter their migration path upon encountering the berthing terminal, and will also be exposed to an increased risk of predation, and lack of access to floodplain habitats. While these permanent alterations of critical habitat will not affect adult salmonids, juvenile fish will have slight decrease in survival. Yet, the degree to which survival is decreased will be immeasurably small. However, all the same cohorts of populations/species will have continued access to floodplain and shallow water habitats at the mitigation site where these beneficial habitat features will be prevented from degradation due to commercial or residential development.

Preservation of shallow water and floodplain habitat at the mitigation site through establishment of a conservation easement or deed restriction, or other legal instrument near the Lewis River a source of cold water refuge and areas with high conservation value (i.e., Ridgefield Wildlife Refuge, and the Wapato Conservation Bank) is expected to provide both habitat and species level benefits. Close proximity of the mitigation site to high-quality floodplain and shallow water habitats will likely result in greater conservation benefit given the aggregative benefit of larger conservation area (Cantú-Salazar and Gaston 2010; Possingham et al. 2015; and Kuempel et al. 2018). The existing commercial and residential land ownership near the mitigation site suggests that development of the 9.4-acre parcel is likely to occur. Purchase and legal protection of the parcel under a conservation easement or deed transfer will prevent loss of PBFs at the mitigation site. Therefore, existing habitat features described in the environmental baseline as well as habitat enhancement (i.e., LWD installation, road decommissioning, native vegetation installation, and trash and invasive plant removal) will slightly improve PBFs at the mitigation site for the indefinite future while the marine terminal is operational. The mix of shallow water and subtidal habitats, along with undeveloped floodplain, will maintain functioning of physical features for juvenile salmonids to rear and seek refuge during their outmigration. Maintaining current floodplain and shallow water habitat features are priorities to ensuring recovery of all 13 species salmonids addressed in this opinion.

2.8. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the species considered in this consultation or destroy or adversely modify designated critical habitat.

2.9. Incidental Take Statement

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

1. Underwater noise
2. Reduced water quality from chemical contaminants
3. Reduced safe passage of migratory habitat/predation
4. Release of suspended sediment
5. Reduction in forage from benthic or upland locations

Take caused by the adverse habitat effects of the proposed action will include injury or death of a small number of juvenile and adult salmon. Exceeding the indicators for the extent of take listed below will trigger the reinitiation provisions of this opinion.

1) Underwater Noise: Take caused by installation of piles is reasonably certain to injure or kill all 13 species of salmonids at the juvenile life stage, although some adults will also be injured by sound pressure (CR chum salmon, LCR Chinook salmon, LCR coho salmon). We cannot quantify the number of fish likely to be injured or killed because the number of fish present at the time the pile driving occurs can be highly variable and it is not practicable to ascertain which fish are injured. The potential injury and mortality to salmonids is related to the amount, or duration of impact hammer use per day, so we use as a surrogate a maximum of 1,100 strikes per day for 14 days of work with an impact driver. Even though the maximum strikes per day is somewhat coextensive with the proposed action, it nevertheless functions as an effective reinitiation trigger because it can be measured on a daily basis.

2) Take caused by use of polyacrylamides to decrease upland erosion is reasonably certain to harm or injure LCR Chinook salmon, LCR coho salmon, and SR fall Chinook salmon at the juvenile life stage. We cannot quantify the number of fish likely to be harmed or injured because highly variable environmental conditions dictate the number of fish using shoreline habitats. The potential harm or injury to fish is related to the amount of area in which the chemical is applied. The amount of chemical applied is coextensive with the amount of area in which upland excavation will occur, yet this area will function as an effective reinitiation trigger because it can be measured on an ongoing basis during the construction season and, if it is exceeded, construction could be halted. The maximum extent of area is which polyacrylamides may be used is limited to the proposed 3.75 acres of fill at elevations above the ordinary high water mark.

3) Safe Passage/Predation: Predation of juvenile salmonids will persist for the lifetime of the marine terminal. As noted above, avian and piscine predators will use the berthing terminal, marine transport barges, mooring dolphins, and piles for cover, refuge, and foraging habitat. We estimate piscine predators using these structures will injure or consume hundreds of juvenile salmonids each year.

It is impossible to predict the exact number of juvenile salmonids consumed by avian and piscine predators that are associated with use of the marine terminal structures because predators are transient and will be foraging during periods when direct observation is impossible. Given the placement of the marine terminal in shallow and deep waters it is reasonably certain that all 13 species will be killed, injured or harmed at the juvenile life stage by avian or piscine predators. The mobility of predators suggests that most species will be vulnerable to predation although smaller, subyearling migrants (i.e., LCR Chinook salmon, LCR coho salmon, SR fall Chinook salmon, and UWR Chinook salmon) are typically easier for predators to locate and consume. Thus, NMFS will use habitat-based surrogates to identify the "extent" of take resulting from predation associated with the structures and barges, as well as operation of overwater lighting during barge unloading. The potential injury or consumption of salmonids by avian and piscine predators associated with inwater and overwater structure is associated with the areal extent of such structures because both avian and piscine predators will use the marine terminal structures for foraging, loafing, or refugia habitat. Thus, for incidental take associated with predation, the surrogate is 43,000 square feet of inwater structure (i.e., barge, pilot vessel, and piles) and 8,000 square feet of overwater structure (i.e., material conveyor, mooring dolphins, hoist and transfer platforms, and walkways). Even though the areal extent of in and over water structures is somewhat coextensive with the proposed action, it nevertheless functions as an effective reinitiation trigger because the COE has authority to conduct compliance inspections and to take actions to address non-compliance, including post-construction. 33 CFR 326.4.

Lighting effects will harm a small number of juvenile salmonids by alterations to their migration pathway and exposure to some individuals to predation in nearshore, shallow water areas. The surrogate for incidental take caused by operational lighting is overwater lighting used for a maximum of 8 days of operation per month. This surrogate is causally linked to the amount of predation resulting from lighting because the longer lighting is used, the longer the conditions will favor predation. Even though the maximum days of lighting is somewhat coextensive with the proposed action, it nevertheless functions as an effective reinitiation trigger because it can be measured on a monthly basis.

4) Suspended sediment/turbidity: Inwater activities will increase suspended sediment conditions that will result in harm to a small number of fish. The potential release of suspended sediment will be limited to a 14 to 20-day period when piles and LWD are installed.

It is impossible to predict the exact number of juvenile salmonids that will harmed in this way because we can't know how many fish may be migrating by the marine terminal structures during the construction period due to unknown environmental conditions that dictate when fish migrate through the action area and also do not have the inability to conduct direct observation. The number of days in which inwater construction may occur is directly related to actions in which suspended sediment will be released into the water column and thus to the number of juvenile salmonids that are reasonably certain to be harmed by suspended sediment. The surrogate extent of construction on shoreline and inwater locations is limited to no more than 22 days occurring from October 1 to December 15. Even though the maximum number of construction days is somewhat coextensive with the proposed action, it nevertheless functions as an effective reinitiation trigger because that number can be monitored on an ongoing basis and construction halted if the number is reached.

5) Reduced forage: Installation of piles and construction within the ordinary high water will reduce the amount of benthic and terrestrial forage items available to ESA-listed juvenile salmonids which is reasonably certain to result in harm. The quantity of forage is proportional to the amount of inwater and floodplain habitat that is modified by floodplain fill where benthic or terrestrial invertebrates reside and the potential availability of these organisms to juvenile

salmonids. The amount of area filled is proportional to the quantity of forage loss and also the amount of harm/death to juvenile salmonids. Thus, for incidental take associated with reduced forage from pile installation and construction, the surrogate is no more than the proposed 0.9 acres of floodplain habitat altered by sediment placement at elevations less than 12.7 feet CRD. Even though this surrogate is somewhat coextensive with the proposed action, it nevertheless functions as an effective reinitiation trigger because the COE has authority to conduct compliance inspections and to take actions to address non-compliance, including post-construction (33 CFR 326.4).

2.9.1 Effect of the Take

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

2.9.2 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02). The COE and/or CRC or its contractors shall:

1. Minimize underwater noise
2. Minimize degradation to water quality
3. Minimize predation
4. Provide action monitoring

2.9.3 Terms and Conditions

The terms and conditions described below are non-discretionary, and the COE or any applicant must comply with them in order to implement the RPMs (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 lapse.

1. A. To implement term and condition 1 (minimize underwater noise) the COE shall ensure that the Columbia River Carbonates CRC:
    a. Minimizes the amount of impact hammer use during October to the maximum extent practicable.
    b. Uses a vibratory hammer during pile installation to the maximum extent practicable.
    c. Uses a bubble curtain deployed on the substrate in a rectangular configuration during impact hammer installation of angled steel piles if this method is technically feasible.

B. To implement term and condition 1 (minimize underwater noise) the Columbia River Carbonates shall install a non-metallic wear plate on the base of the loader bucket to reduce noise created by contact of the steel front loader bucket and the barge deck when barges are unloaded.

2. To implement term and condition 2 (minimize degradation to water quality) the COE shall ensure the applicant use polyacrylamides for erosion or dust control to the minimal extent possible.
3. To implement term and condition 3 (minimize predation) the COE shall ensure the Columbia River Carbonates CRC:
    a. Installs spikes or excluder devices on horizontal surfaces of the hoist and transfer tower to reduce the potential loafing and roosting area for piscivorous birds.
    b. Installs directional lighting for overwater task lighting to reduce the amount of light penetration into nearshore areas.
4. To implement term and condition 4 (action monitoring) Columbia River Carbonates CRC shall:
    a. Document the dates and number of days when pile driving occurs, number of impact hammer strikes per day, number of days where impact hammer is used, size of pile installed, and minutes of vibratory hammer operation.
    b. Document the area over which polyacrylamides are applied, in addition to the volumes applied and the dates of application.
    c. Provide a post-construction report to NMFS documenting the following information as part of the proposed action:
        i. The total square footage of in-water and over-water structures constructed.
        ii. The linear extent of shoreline construction.
        iii. Area filled at elevations below ordinary high water (i.e., 12.7 feet CRD).
    d. Document the square footage of over-water barge coverage and number of barge trips and days of on-site moorage on an annual basis.
    e. Conduct monitoring each morning (Monday through Friday) for a period of three years to document the absence or presence of gulls, cormorants, pelicans, terns, other piscivorous bird species on the barge, terminal structures (hoist and transfer towers), and overwater structures (berthing dolphin and mooring dolphins) during the juvenile salmonid migration season (April through July). If birds are present, document the number of each family (i.e., Cormorant, Gull, Pelican, and other).Monitoring reports may be conducted by non-technical personnel and documented via hand-written field notes or electronic spreadsheets.
    f. The applicant shall transmit annual summary observations each year, where applicable, by January 31 to the NMFS email inbox at projectreports.wcr@noaa.gov and also contact NMFS immediately if any of the take surrogates are reached.

2.10. Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). The NMFS recommends the applicant:

1. Select native, riparian vegetation suited to maximize soil stability in the predominantly sandy shoreline substrates that provide localized input of leaf litter.

2.11. "Not Likely to Adversely Affect" Determinations

Eulachon and Critical Habitat: Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington (USDC 2011). Designated critical habitat for eulachon in the mainstem Columbia River extends from the CR mouth to Bonneville Dam, a distance of 143.2 miles. The LCR mainstem provides a large migratory corridor to access spawning areas in the tributaries. These areas are also used as a larval migration corridor, and occasionally for egg incubation when adults spawn in the mainstem LCR. The PBFs associated with adult and larval migration of designated critical habitat for sDPS of eulachon are listed below in Table 8.

Table 8. PBFs of freshwater critical habitats for the sDPS of eulachon and corresponding species life history events.

Site Type	Site Attribute	Species Life History Event
Freshwater spawning and incubation	Substrate Water flow Water quality Water temperature	Adult spawning Egg incubation
Freshwater migration	Migratory corridor Water flow Water quality Water temperature Food	Adult and larval mobility Larval feeding

Eulachon spawning in the Columbia River typically occurs in low gradient areas of large tributaries such as the Cowlitz, Grays, Elochoman, Lewis, Kalama, and Sandy rivers (Smith and Saalfeld 1955) where flow conditions and the mixed gravel and sand substrate are located. The change in sediment grain size resulting from the proposed action will not alter any of the features of critical habitat for this species. Adults do not spawn in the LCR or adjacent tributaries until late December at the earliest, and eggs and larvae will not be present until January (WDFW and ODFW 2001). Due to the timing of the proposed sediment deposition in October and November it is extremely unlikely that any sDPS eulachon will be present in the Columbia River, let alone the action area during project construction and thus fish exposure to construction effects is not likely to adversely affect eulachon.

With regard to critical habitat, there is minimal construction in areas below OHW at the development site and none at the mitigation site, apart from minor soil disturbance from LWD installation. Eulachon are not shoreline oriented during upstream or downstream migration. Thus, there is no potential for disruption to the migratory corridor as a result of the marine terminal construction. Operation of the marine vessels used to transport limestone to the terminal, and spills from small, periodic spills of chemical contaminants are unlikely to be of sufficient quantity or frequency to adversely affect water quality in a manner that eulachon would respond to during their brief freshwater life history.

Lastly, while Marston et al. (2002) found large number of avian and mammalian species predated upon eulachon in two shallow river deltas in southeast Alaska, adult eulachon are typically 6-8 inches in length (Gustafson 2016), which is beyond the gape limit of all but the largest piscine predators in the LCR. Thus, it is extremely unlikely that this species will be subjected to increased predation as the result of the action. Because we do not anticipate predation to be associated with effects of the proposed action we find this potential effect discountable both for eulachon and their critical habitat.

Green Sturgeon and Critical Habitat. The designated critical habitat for sDPS green sturgeon extends upstream from the estuary to RM 46 in the mainstem Columbia River and RM 49 of Westport Slough, a tidal slough of the mainstem Columbia River with no upstream connection. Thus, the proposed action will not adversely affect designated critical habitat for this species. Based on rearing, holding, and migration patterns in the LCR it is extremely unlikely sDPS green sturgeon will be present within the action area. Presence of green sturgeon in the LCR is limited to habitats with saltwater influence from May through October (Moser and Lindley 2007). These authors cite commercial catches of green sturgeon from other estuarine fisheries peak in October in the Columbia River estuary, and records (Willapa Bay and Grays Harbor, Washington) support the idea that sturgeon are only present in these estuaries from June until October. Even though comprehensive fishery sampling has not been conducted year-round in the Columbia River estuary, the location of the action area about 35 miles upstream of the upstream extent of designated critical habitat suggests that the presence of sub-adult or adult green sturgeon to construction effects is extremely unlikely. Thus, effects to green sturgeon and their critical habitat from the proposed action are discountable.

2.12. Reinitiation of Consultation

This concludes formal consultation for the Columbia River Carbonates Marine Terminal.

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 habitat 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 habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

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

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect 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 EFH assessment provided by the COE and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

As part of the information provided in the request for ESA concurrence, the COE determined that the proposed action would adversely affect EFH designated for five species of Chinook salmon (LCR, SR fall-run, SR spring/summer-run, UCR, and UWR) and LCR coho salmon. The action area includes those designated as EFH for various life history stages of Chinook salmon and coho salmon (PFMC 2014). The effects of the proposed action on EFH are the same as those described above in the ESA portion of this document. As discussed above in the ESA effects analysis (section 2.5) in greater detail, the proposed action will adversely affect aquatic, floodplain, and upland habitat and Chinook salmon and coho salmon migrating through the action areas during construction and operation of the marine terminal.

3.2. Adverse Effects on Essential Fish Habitat

Based on the information provided in the biological assessment and the analysis of effects presented in the ESA portion of this document, the NMFS concludes the proposed action will have adverse effects on EFH designated for Chinook salmon and coho salmon. These effects include:

1. Suspended sediment (reduced water quality)
2. Reduced function of migratory habitat (obstructions and predation)
3. Reduction in forage from benthic and upland sources
4. Underwater noise

3.3. Essential Fish Habitat Conservation Recommendations

The NMFS recommends the COE require the following actions to minimize effects on Pacific Coast salmon EFH:

1. Minimize the amount of impact hammer use during October to the maximum extent practicable.
2. Select lights with a low color temperature (i.e., less than 4500 Kelvin) that does not produce lighting effects similar to daylight.

3. Select native, riparian vegetation suited to maximize soil stability in the predominantly sandy shoreline substrates and provide localized input of leaf litter.
4. Use a bubble curtain deployed on the substrate in a rectangular configuration during impact hammer installation of angled steel piles.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, approximately three acres of designated EFH for Pacific Coast salmon.

3.4. Statutory Response Requirement

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

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

3.5. Supplemental Consultation

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the U.S. Army Corps of Engineers, Regulatory Division, Seattle District, Columbia River Carbonates, and Ecological Land Services (LLC). 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.

5. REFERENCES

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

Anderson, J.J., E. Gurarie, and R. Zabel. 2005. Mean free-path length theory of predator-prey interactions: application to juvenile salmon migration. Ecological Modelling 186:196-211.

Bartholomew Jr., G.A. 1942. The fishing activities of double-crested cormorants on San Francisco Bay. The Condor 44:13-21.

Beechie, T., H. Imaki, J. Greene, A. Wade, H. Wu, G. Pess, P. Roni, J. Kimball, J. Standford, P. Kiffney, and N. Mantua. 2013. Restoring salmon habitat for a changing climate. River Research and Applications 29:969-960.

Bell, M.C. 1991. Fisheries handbook of Engineering requirements and biological criteria. Fish Passage Development and Evaluation Program. U.S. Army Corps of Engineers, North Pacific Division.

Bottom, D.L., C.A. Simenstad, J. Burke, A.M. Baptista, D.A. Jay, K.K. Jones, E. Casillas, and M.H. Schiewe. 2005. Salmon at river's end: the role of the estuary in the decline and recovery of Columbia River salmon. U.S. Dept. Commerce, NOAA Technical Memo. NMFS-NWFSC-68, 246 pages.

Bottom, D.L., A. Baptista, J. Burke, L. Campbell, E. Casillas, S. Hinton, D.A. Jay, M.A. Lott, G. McCabe, R. McNatt, M. Ramirez, G.C. Roegner, CA. Simenstad, S. Spilseth, L. Stamatiou, D. Teel, and J.E. Zamon. 2011. Estuarine Habitat and Juvenile Salmon: Current and Historical Linkages in the Lower Columbia River and Estuary. Final Report 2002-2008. Report of research by the Northwest Fisheries Science Center to the U.S. Army Corps of Engineers, Portland District. December 2011.

Brown, L., K.C.C. Bancroft, and M.M. Rhead. 1982. Qualitative and quantitative studies on the in situ adsorption, degradation and toxicity of acrylamide by the spiking of the water of two sewage works and a river. Water Resources 16(5):579-591.

Carlson, T.J., G.E. Ploskey, R.L. Johnson, R.P. Mueller, M.A. Weiland, P.N. Johnson. 2001. Observations of the behavior and distribution of fish in relation to the Columbia River navigation channel and channel maintenance activities. Report to U.S. Army, Corps of Engineers – Portland District, Contract DE-AC06-76RL01830. 114 pages.

Carter, J.A., G.A. McMichael, I.D. Welch, R.A. Harnish, and B.J. Bellgraph. 2009. Seasonal Juvenile Salmonid Presence and Migratory Behavior in the Lower Columbia River. PNNL-18246, Pacific Northwest National Laboratory, Richland, Washington.

Caltrans (California Department of Transportation). 2015. Technical guidance for assessment and mitigation of the hydroacoustic effects of pile driving on fish. November 2015. 532 pages.

Cantú-Salazar, L. and K.J. Gaston. 2010. Very large protected areas and their contribution to terrestrial biological conservation. Bioscience 60:808-818.

Carrasquero, J. 2001. Over-water structures: Freshwater issues. White paper submitted to Washington Department of Ecology, Washington Department of Fish and Wildlife, and Washington Department of Transportation. April 2001.

Collis, K., S. Adamany, D.D. Roby, D.P. Craig, and D.E. Lyons. 2000. Avian Predation on Juvenile Slmonids in the Lower Columbia River. 1998 Annual Report to the Bonneville Power Administration and U.S. Army Corps of Engineers. April 2000.

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

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

Cuthbert, F.J., and L.R.Wires. 1999. Caspian tern (*Sterna caspia*). Pages 1–32 *in* A. Poole and F. Gill, editors. The Birds of North America, number 403. The Birds of North America, Philadelphia.

Dawley, E.M., R.D. Ledgerwood, T.H. Blahs, C.W. Sims, J.T. Durkin, R.A. Rica, A.E. Rankis, G.E. Mohan, and F.J. Ossiander. 1986. Migrational Characteristics, Biological Observations, and Relative Survival of Juvenile Samonids entering the Columbia River Estuary, 1966-1983. Report of Research to the Bonneville Power Administration and U.S. Department of Energy from the National Marine Fisheries Service, Seattle, Washington. 269 pages.

DeGraaf, R. M., N. G. Tilghman, and S. H. Anderson. 1985. Foraging guilds of North American birds. Environmental Management 9:493–536.

Dickerson, C., K.J Reine, and D.G. Clarke. 2001. Characterization of underwater sounds produced by bucket dredging operations. DOER Technical Notes Collection (ERDC TN-DOER-E14), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

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

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

ELS (Ecological Land Services). 2018. Biological assessment for Columbia River Carbonates Woodland Marine Terminal near Woodland, Washington, ESA and MSA consultation. Prepared by Ecological Land Services, Inc., Longview, Washington. June 25, 2018.

Evans, A.F., D.D. Roby, K. Collis, D.E. Lyons, B.P. Sandford, R.D. Ledgerwood, and S. Sebring. 2012. Systemwide evaluation of avian predation on juvenile salmonids from the Columbia River based on recoveries of passive integrated transponder tags. Transaction of the American Fisheries Society 141:975-989. Available on the internet at DOI: 10.1080/00028487.2012.676809

Evans, A.F., Q. Payton, A. Turecek, B. Cramer, K. Collis, D.D. Roby, P.J. Loschl, L. Sullivan, J. Skalski, M. Weiland, and C. Dotson. 2016. Avian Predation on Juvenile Salmonids: Spatial and temporal analysis based on acoustic and Passive Integrated Transponder tags. Transactions of the American Fisheries Society 145:860–877.

Feely, R.A., T. Klinger, J.A. Newton, and M. Chadsey (*editors*). 2012. Scientific summary of ocean acidification in Washington state marine waters. NOAA Office of Oceanic and Atmospheric Research Special Report.

Fresh, K.L., E. Casillas, L.L. Johnson, and D.L. Bottom. 2005. Role of the Estuary in the Recovery of Columbia River Basin Salmon and Steelhead: An Evaluation of the Effects of Selected Factors on Salmonid Population Viability. NOAA technical memorandum, Northwest Fisheries Science Center, National Marine Fisheries Service. Seattle, WA. 136 pp.

Gerking, S.D. 1994. Feeding Ecology of Fish. Academic Press Inc., San Diego, California. 416 pages.

Glick, P., J. Clough, and B. Nunley. 2007. Sea-Level Rise and Coastal Habitats in the Pacific Northwest: An analysis for Puget Sound, southwestern Washington, and northwestern Oregon. National Wildlife Federation, Seattle, WA.

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

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. BioScience 41:540–551.

Gustafson, R.G., M.J. Ford, D. Teel, and J.S. Drake. 2010. Status review of eulachon (*Thaleichthys pacificus*) in Washington, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-105. 360 pages.

Gustafson, R. G., L. Weitkamp, Y.W. Lee, E. Ward, K. Somers. V. Tuttle, and J. Jannot. 2016. Status Review Update of Eulachon (Thaleichthys pacificus) Listed under the Endangered Species Act: Southern Distinct Population Segment. US Department of Commerce, NOAA, Online at: http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/other_species/eulachon/eulachon_2016_status_review_update.pdf.

Harrison, P. 1983. Seabirds: an Identification Guide. Houghton Mifflin Company. Boston. 448 pages.

Harrison, C.S. 1984. Terns Family Laridae. Pages 146-160 in Seabirds of eastern North Pacific and Arctic waters. D. Haley, *editor*. Pacific Search Press. Seattle. 214 pages.

Haskell, C.A. and K.F. Tiffan. 2011. Crims Island—Restoration and monitoring of juvenile salmon rearing habitat in the Columbia River Estuary, Oregon, 2004–10: U.S. Geological Survey Scientific Investigations Report 2011–5022, 50 p.

Hassel, A., T. Knutsen, and J. Dalen. 2004. Influence of seismic shooting on the lesser sand eel (*Ammodytes marinus*). Journal of Marine Science 61:1165–1173.

Hecht, S. A., D. H. Baldwin, C. A. Mebane, T. Hawkes, S. J. Gross, N. L. Scholz. 2007. An overview of sensory effects on juvenile salmonids exposed to dissolved copper: Applying a benchmark concentration approach to evaluate sublethal neurobehavioral toxicity. NOAA Technical Memorandum, NMFS-NWFSC-83.

Helfman, G.S. 1981a. The advantages to fishes of hovering in shade. Copeia 2:392-400.

Helfman, G.S. 1981b. Twilight activities and temporal structure in a freshwater fish community. Canadian Journal of Fisheries and Aquatic Sciences 38:1405-1420.

Hobson, E.S. 1979. Interactions between piscivorous fishes and their prey. Pages 231-242 in R. H. Stroud and H. Clepper, editors. Predator-Prey Systems in Fisheries Management. Sport Fishing Institute, Washington, D.C.

Howell, M.D. and N. Uusitalo. 2000. Eulachon (*Thaleichthys pacificus*) studies related to Lower Columbia River channel deepening operations. 30 pages.

Howell, M.D., M.D. Romano, and T.A. Rien. 2001. Outmigration timing and distribution of larval eulachon, *Thaleichthys pacificus*, in the Lower Columbia River, Spring 2001. Report to Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife. December 2001. 35 pages.

Howick, J.L., and W.J. O'Brien. 1983. Piscivorous feeding behavior of largemouth bass: and experimental analysis. Transactions of the American Fisheries Society 112:508-516.

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

IPCC (Intergovernmental Panel on Climate Change). 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (*editor*)]. IPCC, Geneva, Switzerland, 151 pp.

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

Kahler, T., M. Grassley, and D. Beauchamp. 2000. A Summary of the effects of bulkheads, piers, and other artificial structures and shorezone development on ESA-listed salmonids in lakes. Final Report to the City of Bellevue. July 2000.

Katz, J.V.E., C. Jeffres, J.L. Conrad, T.R. Sommer, J. Martinez, S. Brumbaugh, N. Corline, P.B. Moyle. 2017. Floodplain farm fields provide novel rearing habitat for Chinook salmon. PLOS One:1-16. Available on the internet at: https://doi.org/10.1371/journal.pone.0177409

Kerr, J.L., J.S. Lumsden, S.K. Russell, E.J. Jasinska, and G.G. Goss. 2014. Effects of anionic polyacrylamide products on gill histopathology in juvenile rainbow trout (*Oncorhynchus mykiss*). Environmental Toxicology and Chemistry 5: 373-377.

Krautter, G.R., R.W. Mast, H.C. Alexander, C.H. Wolf, M.A. Friedman, F.K. Koschier, and C.M. Thompson. 1986. Acute aquatic toxicity tests with acrylamide monomer and macroinvertebrates and fish. Environmental Toxicology and Chemistry 33(7): 1552-1562.

Krohn, W.B., R.B. Allen, J.R. Moring, and A.E. Hutchinson. 1995. Double-crested cormorants in New England; population and management histories. Pages 99-109 *in* The Double-crested Cormorant: biology, conservation and management (D.N. Nettleship and D.C. Duffy, *editors*) Colonial Waterbirds 18 (Special Publication 1).

Kuempel, C.D., V.M. Adams, H.P. Possingham, and M. Bode. 2018. Bigger or better: The relative benefits of protected area network expansion and enforcement for the conservation of an exploited species. Conservation Letters. December 9, 2017.

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

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

LCFRB (Lower Columbia Fish Recovery Board). 2010. Washington Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan: N. Washougal Subbasin. May 2010. Available on the internet at: https://www.lcfrb.gen.wa.us.

Ledgerwood, R.D., F.P. Thrower, and E.M. Dawley. 1991. Diel sampling of migratory juvenile salmonids in the Columbia River estuary. Fishery Bulletin 89:69-78.

LCREP (Lower Columbia River Estuary Partnership). 2007. Lower Columbia River estuary ecosystem monitoring: water quality and salmon sampling report. Lower Columbia Estuary Partnership.

Lyons, D.E., D.D. Roby, and K. Collis. 2007. Foraging patterns of Caspian terns and double-crested cormorants in the Columbia River estuary. Northwest Science 81(2)91-103.

Lyons, D.E., D.D. Roby, A.F. Evans, N.J. Hostetter, and K. Collis. 2014. Benefits to Columbia River anadromous salmonids from potential reductions in predation by double-crested cormorants nesting at the East Sand Island colony in the Columbia River estuary. Final Report the U.S. Army Corps of Engineers, Portland District. February 17, 2014.

Mantua, N., I. Tohver, and A. Hamlet. 2009. Impacts of Climate Change on Key Aspects of Freshwater Salmon Habitat in Washington State. In The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, edited by M.M. Elsner, J. Littell, and L.W. Binder, 217-253. The Climate Impacts Group, University of Washington, Seattle, Washington.

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

Marston, B.H., M.F. Willson, and S.M. Gende. 2002. Predator aggregations during eulachon *Thaleichthys pacificus* spawning runs. Marine Ecological Progress Series 231:229-236.

McCabe, G.T., S.A. Hinton, R.L. Emmett, and B.P. Sandford. 1997. Benthic invertebrates and sediment characteristics in main channel habitats in the Lower Columbia River. Northwest Science 71(1):45-55.

McCabe, G.T., S.A. Hinton, and R.L. Emmett. 1998. Benthic invertebrates and sediment characteristics in a shallow navigation channel of the Lower Columbia River, before and after dredging. Northwest Science 72(2):116-126.

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

McNatt, R.A., D.L. Bottom, and S.A. Hinton. 2016. Residency and movement of juvenile Chinook salmon at multiple spatial scales in a tidal marsh of the Columbia River estuary. Transactions of the American Fisheries Society 145:774-785.

Metcalfe, N.B., S.K. Valdimarsson, and N.H.C. Fraser. 1997. Habitat profitability and choice in a sit-and-wait predator: juvenile salmon prefer slower currents on darker nights. Journal of Animal Ecology 66:866-875.

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

Moser, M.L., and S.T. Lindley. 2007. Use of Washington estuaries by subadult and adult green sturgeon. Environmental Biology of Fishes 79:243-253.

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

Mote, P.W., D.E. Rupp, S. Li, D.J. Sharp, F. Otto, P.F. Uhe, M. Xiao, D.P. Lettenmaier, H. Cullen, and M.R. Allen. 2016. Perspectives on the cause of exceptionally low 2015 snowpack in the western United States, Geophysical Research Letters, 43, doi:10.1002/2016GLO69665

Nakada, K., K. Imamura, and M Yabe. 2005. Research and development of low-noise buket for construction machinery. Komatsu: Technical Report 51(156):1-6. Available on the internet at: https://home.komatsu/en/company/tech-innovation/report/pdf/156-02_E.pdf

Nemeth, R S., and J. J. Anderson. 1992. Response of juvenile coho and Chinook salmon to strobe and mercury vapor lights. N. Am. J. Fish. Mgmt. 12:684-692.

Newcombe, C.P., and J.O.T. Jensen. 1996. Channel Suspended Sediment and Fisheries: A Synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16(4):693-727.

Newcombe, C.P. 2003. Impact assessment model for clear water fishes exposed to excessively cloudy water. The Journal of the American Water Resources Association. June 2003.

NMFS. 2005. Assessment of NOAA Fisheries' critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. NMFS, Protected Resources Division, Portland, Oregon.

NMFS. 2009. Middle Columbia River steelhead distinct population segment ESA recovery plan. National Marine Fisheries Service, Northwest Region. Seattle.

NMFS. 2011a. Upper Willamette River conservation and recovery plan for Chinook salmon and steelhead. Oregon Department of Fish and Wildlife and National Marine Fisheries Service, Northwest Region. August 5, 2011.

NMFS. 2011b. Columbia River estuary ESA recovery plan module for salmon and steelhead. Prepared for NMFS by the Lower Columbia River Estuary Partnership (contractor) and PC Trask & Associates, Inc. (subcontractor). National Marine Fisheries Service, Northwest Region. Portland, Oregon. January. Available online at: http://www.nwr.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/willamette_lowercol/lower_columbia/estuary-mod.pdf.

NMFS. 2013. ESA Recovery Plan for Lower Columbia River Coho Salmon, Lower Columbia River Chinook Salmon, Columbia River Chum Salmon, and Lower Columbia River Steelhead. National Marine Fisheries Service, Northwest Region. June 2013.

NMFS. 2015a. Proposed ESA Recovery for Snake River Fall Chinook Salmon. West Coast Region, Protected Resources Division, Portland, OR, 97232.

NMFS. 2015b. ESA Recovery Plan for Snake River Sockeye Salmon. West Coast Region, Protected Resources Division, Portland, OR.

NMFS 2016a. Proposed ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon and Snake River Steelhead. West Coast Region, Protected Resources Division, Portland, OR.

NMFS. 2016b. Recovery Plan for Eulachon (*Thaleichthys pacificus*). National Marine Fisheries Service, West Coast Region, Protected Resources Division, Portland, OR.

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

PFMC (Pacific Fishery Management Council). 2014. Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18. Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon.

Parente, W. D., and G. R. Snyder. 1970. A pictorial record of the hatching and early development of the eulachon (*Thaleichthys pacificus*). Northwest Science 44:50–57.

Pearson, W.H., J. Skalski, and C.I. Malme. 1992. Effects of sounds from a geophysical survey device on behavior of captive rockfish (*Sebastes spp*). Canadian Journal of Fisheries and Aquatic Sciences 49:1343–1356.

Petersen, J.H. and D.M. Gadomski. 1994. Light-mediated predation by northern squawfish on juvenile Chinook salmon. Journal of Fish Biology 45(A):227-242.

PMFC (Portland Metropolitan Council). 2016. Portland metropolitan area population United States Census Bureau estimates. March 23, 2016. Available on the internet at: https://www.oregonmetro.gov/news

Popper, A.N., M.E. Smith, P.A. Cott, B.W. Hanna, A.O. MacGillivray, M.E. Austin, and D.A. Mann. 2005. Effects of Exposure to Seismic Airgun Use on Hearing of Three Fish Species. Journal of American Acoustic Society, 117:3958-3971.

Popper, A.N., and M.C. Hastings. 2009. The effects of human-generated sound on fish. Integrative Zoology 4:43-52.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, M.B. Halvorsen, S. Løkkeberg, P.H. Rogers, B.L. Southall, D.G. Zeddies, and W.N. Tavolga. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. 87 pages.

Possingham, H.P., M. Bode, and C.J. Klein. 2015. Optimal conservation outcomes require both restoration and protection. PLOS Biology. January 27, 2015.

Pribyl, A.L., J.S. Vile, and T.A. Friesen. 2005. Population structure, movement, habitat use and diet of resident piscivorous fishes in the Lower Willamette River. Pages 139-184 in T.A. Friesen, editor, Biology, behavior and resources of resident and anadromous fish in the lower Willamette River Final Report of Research 2000-2004. Oregon Department of Fish and Wildlife. Clackamas, Oregon.

Puckett, K. J., and J. J. Anderson. 1988. Behavioral responses of juvenile salmonids to strobe and mercury lights. FRI-UW-8717, Fish. Res. Inst., Univ. Wash., Seattle, WA.

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

Reeder, W.S., P.R. Ruggiero, S.L. Shafer, A.K. Snover, L.L Houston, P. Glick, J.A. Newton, and S.M Capalbo. 2013. Coasts: Complex Changes Affecting the Northwest's Diverse Shorelines. In Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, edited by M.M. Dalton, P.W. Mote, and A.K. Snover, 41-58. Island Press, Washington, D.C.

Roby, D.D., K. Collis, P.J. Loschl, K.S. Bixler, D.E. Lyons, Y. Suzuki, T.J. Lawes, B. Underwood, A. Turecek, and M. Hawbecker. 2017. Implementation and Evaluation of Efforts to Reduce Predation on ESA-listed Salmonids by Caspian Terns Nesting at East Sand Island, Columbia River Estuary. 2017 Final Annual Report to the Bonneville Power Administration. Contract No. 60846. 59 pages.

Roegner, G.C., E.W. Dawley, M. Russell, A. Whiting, and D.J. Teel. 2010. Juvenile salmonid use of reconnected tidal freshwater wetlands in Grays River, Lower Columbia River Basin. Transactions of the American Fisheries Society 139:1211-1232.

Sather, N.K., G.E. Johnson, D.J. Teel, A.J. Storch, J.R. Skalski, and V.I. Cullinan. 2016. Shallow tidal freshwater habitats of the Columbia River: Spatial and temporal vianbility of fish communities and density, size, and genetic stock composition of juvenile Chinook salmon. Transactions of the American Fisheries Society 145:734-753.

Scheuerell, M.D., and J.G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (Oncorhynchus tshawytscha). Fisheries Oceanography 14:448-457.Shared Strategy for Puget Sound. 2007. Puget Sound salmon recovery plan. Volume 1, recovery plan. Shared Strategy for Puget Sound. Seattle.

Schroeder, R.K., K.R. Kenaston, and L.K. McLaughlin. 2007. Spring Chinook in the Willamette and Sandy Basins. Annual Progress Report, Fish Research Project Number F-163-R-11/12. Oregon Department of Fish and Wildlife, Salem, OR.

Schroeder, R.K., L.D. Whitman, B. Cannon, and P. Olmsted. 2016. Juvenile life-history diversity and population stability of spring Chinook salmon in the Willamette River basin, Oregon. Canadian Journal of Fisheries and Aquatic Sciences 73:921-934.

Sebring, S.H., M.C. Carper, R.D. Ledgerwood, B.P. Sandford, G.M. Matthews, and A.F. Evans. 2013. Relative Vulnerability of PIT-tagged subyearling fall Chinook salmon to predation by Caspian terns and double-crested cormorants in the Columbia River estuary. Transactions of the American Fisheries Society 142:1321-1334. Available on the internet at DOI: 10.1080/00028487.2013.806952

Servizi, J.A. and D.W. Martens. 1991. Effect of temperature, season, and fish size on acute lethality of suspended sediments to coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences 48: 493-497.

Servizi, J.A. and D.W. Martens. 1992. Sublethal responses of coho salmon (*Oncorhynchus kisutch*) to suspended sediments. Canadian Journal of Fisheries and Aquatic Sciences 49: 1389-1395.

Sherwood, C.R., D.A. Jay, R.B. Harvey, P. Hamilton, and C.A. Simenstad. 1990. Historical changes in the Columbia River estuary. Progressive Oceanography 25:299-352.

Simenstad, C.A, D.A. Jay, D.R. Sherwood. 1992. Impacts of watershed management on land-margin ecosystems: The Columbia River estuary. *In* Watershed Management, edited by R.J. Naiman.

Simenstad, C.A, B.J. Nightingale, R.M. Thom, and D.K. Shreffler. 1999. Impacts of ferry terminals on juvenile salmon migrating along Puget Sound shorelines, Phase I: Synthesis of state of knowledge. Report to the Washington State Transportation Commission. June 1999.

Smith, W. E., and R. W. Saalfeld. 1955. Studies on Columbia River smelt *Thaleichthys pacificus* (Richardson). Washington Dept. Fisheries, Olympia. Fish. Res. Pap. 1(3):3–26.

Sommer, T.R., M.L. Norbiga, W.C. Harrell, W. Batham, and W.J. Kimmerer. 2001. Floodplain rearing of juvenile Chinook salmon: evidence of enhanced growth and survival. Canadian Journal of Fisheries and Aquatic Sciences 58:325-332.

Stadler, J.H., and D.P. Woodbury. 2009. Assessing the effects to fishes from pile driving: application of new hydroacoustic guidelines. Inter-Noise 2009.

Sunda, W. G., and W. J. Cai. 2012. Eutrophication induced CO2-acidification of subsurface coastal waters: interactive effects of temperature, salinity, and atmospheric p CO2. Environmental Science & Technology, 46(19): 10651-10659

Tabor, R.A., G.S. Brown, and V.T. Luiting. 2004. The effect of light intensity on sockeye salmon fry migratory behavior and predation by cottids in the Cedar River, Washington. Transactions of the American Fisheries Society 24:128-145.

Tabor, R.A.,B.A. Footen, K.L. Fresh, M.T. Celedonia, F. Mejia, D.L. Low, L. Park. 2011. Smallmouth Bass and Largemouth Bass predation on juvenile Chinook salmon and other salmonids in the Lake Washington Basin. North American Journal of Fisheries Management 27:1174-1188.

Tague, C.L., J.S. Choate, and G. Grant. 2013. Parameterizing sub-surface drainage with geology to improve modeling streamflow responses to climate in data limited environments. Hydrology and Earth System Sciences 17(1): 341-354

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

USDC (United States Department of Commerce). 2009. Endangered and threatened wildlife and plants: final rulemaking to designate critical habitat for the threatened southern distinct population segment of North American green sturgeon. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 74(195):52300-52351.

USDC. 2011. Endangered and threatened species: designation of critical habitat for the southern distinct population segment of eulachon. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 76(203):65324-65352.

UCSRB (Upper Columbia Salmon Recovery Board). 2007. Upper Columbia spring Chinook salmon and steelhead recovery plan.

Ward, D.L., and A.A. Nigro. 1992. Differences in Fish Assemblages Among Habitats Found in the Lower Willamette River, Oregon: Application of and Problems With Multivariate Analysis. Fisheries Research 13:119-132.

Ward, D.L., A.A. Nigro, R.A. Farr, and C.J. Knutsen. 1994. Influence of Waterway Development on Migrational Characteristics of Juvenile Salmonids in the Lower Willamette River, Oregon. North American Journal of Fisheries Management 14:362-371.

Wardle, C.S., T.J. Carter, and G.G. Urquhart. 2001. Effects of seismic airguns on marine fish. Continental Shelf Resources 21: 1005–1027.

WDFW (Washington Department of Fish and Wildlife) and ODFW (Oregon Department of Fish and Wildlife). 2001. Washington and Oregon eulachon management plan. November 2001.

WDFW (Washington Department of Fish and Wildlife) and ODFW (Oregon Department of Fish and Wildlife) and. 2014. Studies of Eulachon smelt in Oregon and Washington. Project completion report, July 2010-June 2012. Edited by Christine Mallette. September 2014. 168 pages.

WDOE (Washington Department of Ecology). 2014. 2012 Stormwater Manual for Western Washington. Amended as of December 2014. Washington State Department of Ecology publication 14-10-055. 1,192 pages.

Weitkamp, L. 1994. A review of the effects of dams on the Columbia River estuarine environment, with special reference to salmonids. Report to the Bonneville Power Administration and Northwest Fisheries Science Center Coastal Zone and Estuaries Study Division. Contract DE-A179-93BP99021. August 1994.

White, C.R., P.J. Butler, D. Grémillet, and G.R. Martin. 2008. Behavioural strategies of cormorant (*Phalacrocoracidae*) foraging under challenging light conditions. Ibis 150(1):231-239.

Wickham, D.A. 1973. Attracting and controlling coastal pelagic fish with nightlights. Transactions of the American Fisheries Society 4:816-825.

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

Wissmar, R.C., J.E. Smith, B.A. McIntosh, H.W. Li, G.H. Reeves, and J.R. Sedell. 1994. Ecological Health of River Basins in Forested Regions of Eastern Washington and Oregon. Gen. Tech. Rep. PNW-GTR-326. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR. 65 p.

Wysocki, L.E., J.P. Dittami, and F. Ladich. 2006. Ship noise and cortisol secretion in European freshwater fishes. Biological Conservation 128:501–508.

Xiong, B., R.D. Loss, D. Shields, T. Pawlik, R. Hochreiter, A. Zydney, and M. Kumar. 2018. Nature Partner Journals, Clean Water: 1-17. Available on the internet at https://doi.org/10.1038/s41545-018-0016-8.

Zabel, R.W., M.D. Scheuerell, M.M. McClure, and J.G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20(1):190-200.

Appendix A

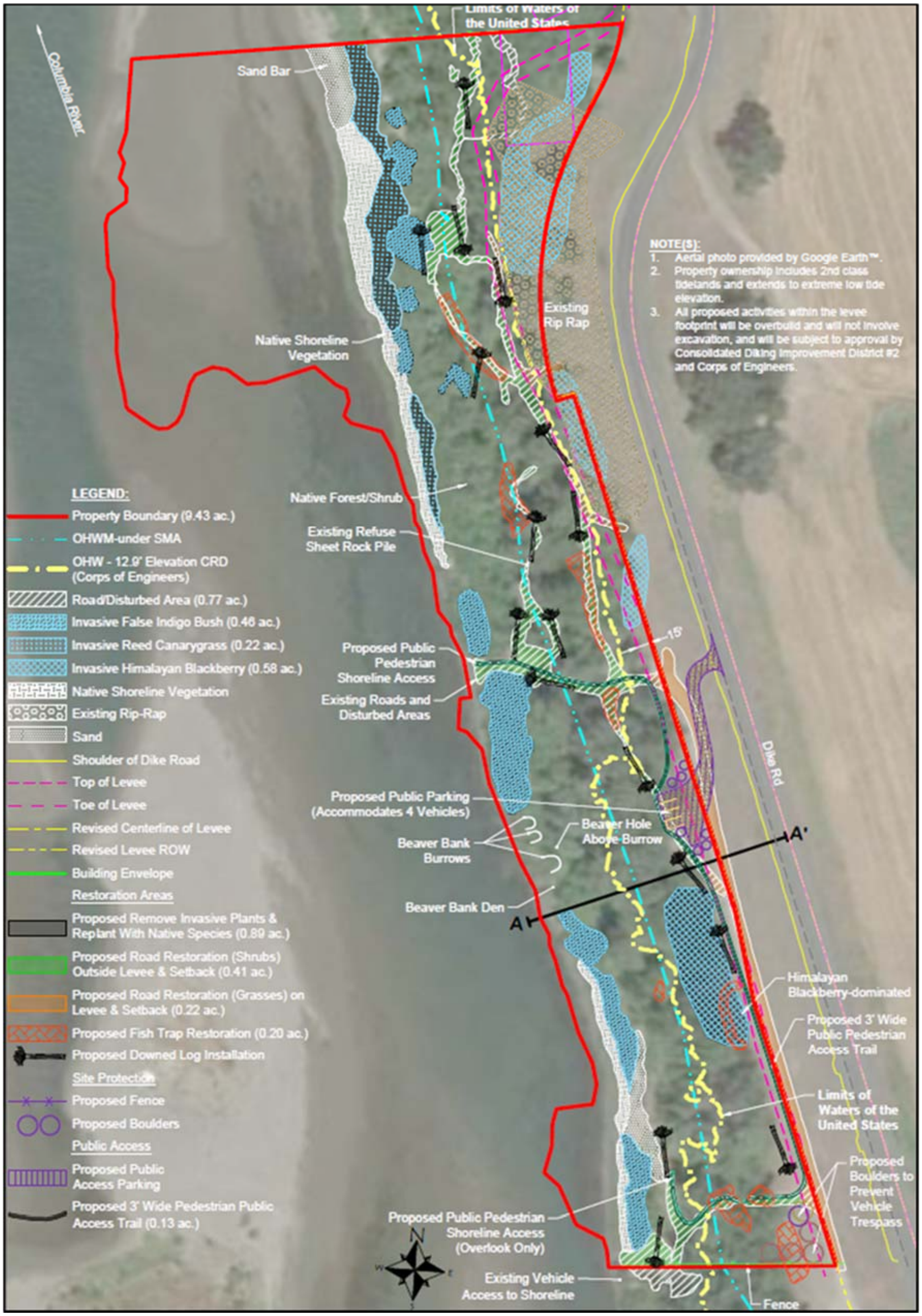

Figure 6. Overview and location of the 9.4-acre mitigation site.

Appendix B

:SA-listed fish species in the Lower Columbia River by life stage, NMFS' Northwest Fisheries Science Center, Resources Division (2017). Fish abundance is denoted using a combination of text and shading [no shading (-) hading (P) = presence; medium shading (R) = relatively abundant; dark shading (A) = peak abundance]. The

is indicated by months highlighted in green and outlined in red.

	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
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Species/Life Stage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
SR fall Chinook salmon																								
Adult migration/holding	-	-	-	-	-	-	R	R	A	A	A	A	A	R	R	R	R	R	-	-	-	-	-	-
Adult spawning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eggs & pre-emergence	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile rearing	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Juvenile emigration	-	-	R	R	A	A	R	A	A	A	A	A	A	A	A	A	R	R	R	R	R	R	R	R
CR chum salmon																								
Adult migration/holding	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		A	A	A	A	A	A	A
Adult spawning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eggs & pre-emergence	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile rearing	R	R	R	R	R	R	R	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile emigration[4]	-	-	R	R	R	R	A	A	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCR coho salmon																								
Adult migration/holding	A	A	A	A	-	-	-	-	-	-	R	R	R	R	R	R	R	R	A	A	A	A	A	A
Adult spawning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eggs & pre-emergence	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile rearing	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Juvenile emigration	-	-	-	-	R	R	R	A	A	A	A	A	A	R	R	P	P	P	P	P	-	-	-	-
SR sockeye salmon																								
Adult migration/holding	-	-	-	-	-	-	-	R	R	A	A	R	R	-	-	-	-	-	-	-	-	-	-	-
Adult spawning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eggs & pre-emergence	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile rearing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile emigration	-	-	-	-	R	R	R	R	A	A	A	R	R	P	P	P	P	P	P	-	-	-	-	-
LCR steelhead																								
Adult migration/holding	-	-	-	-	-	-	R	A	A	A	A	R	-	-	-	-	-	-	-	-	-	-	-	-
Adult spawning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eggs & pre-emergence	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile rearing	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Juvenile emigration	-	-	-	-	P	P	R	A	A	A	A	R	R	P	P	P	P	P	P	P	-	-	-	-
MCR steelhead																								
Adult migration/holding	-	-	-	-	-	-	R	A	A	A	A	R	-	-	-	-	-	-	-	-	-	-	-	-
Adult spawning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eggs & pre-emergence	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile rearing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile emigration	-	-	-	-	P	P	R	A	A	A	A	R	R	P	P	P	P	P	P	P	-	-	-	-

Species/Life Stage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
UCR steelhead																								
Adult migration/holding	-	-	-	-				R	R	A	A	R	R	-	-	-	-	-	-	-	-	-	-	-
Adult spawning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eggs & pre-emergence	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile rearing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile emigration	-	-	-	-	P	P	R	A	A	A	A	R	R	P	P	P	P	P	P	P	-	-	-	-
UWR steelhead																								
Adult migration/holding	-	-	-	R	R	R	R	R	A	A	A	R	R	-	-	-	-	-	-	-	-	-	-	-
Adult spawning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eggs & pre-emergence	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile rearing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile emigration	-	-	-	-	P	P	R	A	A	A	A	R	R	P	P	P	P	P	P	P	-	-	-	-
SRB steelhead																								
Adult migration/holding	-	-	-	-	-	-	-	R	A	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-
Adult spawning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eggs & pre-emergence	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile rearing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juvenile emigration	-	-	-	-	P	P	R	A	A	A	A	R	R	P	P	P	P	P	P	P	-	-	-	-

[1] Eulachon Status Review Update, 20 January 2010. Available at: http://www.nwr noaa.gov/Other-Marine-Species/upload/eulachon-review-update.pdf
[2] Personal communication. Conversation between WDFW (Brad James, Olaf Langness, and Steve West), ODFW (Tom Rien), and NMFS (Rob Markle, Bridgette Lohrman) regarding green sturgeon and eulachon presence in the Columbia River. June 23, 2009.
[3] Eulachon egg incubation estimated relative to spawning timing and 20 to 40 day incubation period.
[4] Carter et al. 2009 (Seasonal juvenile salmonid presence and migratory behavior in the lower Columbia River).

Appendix C

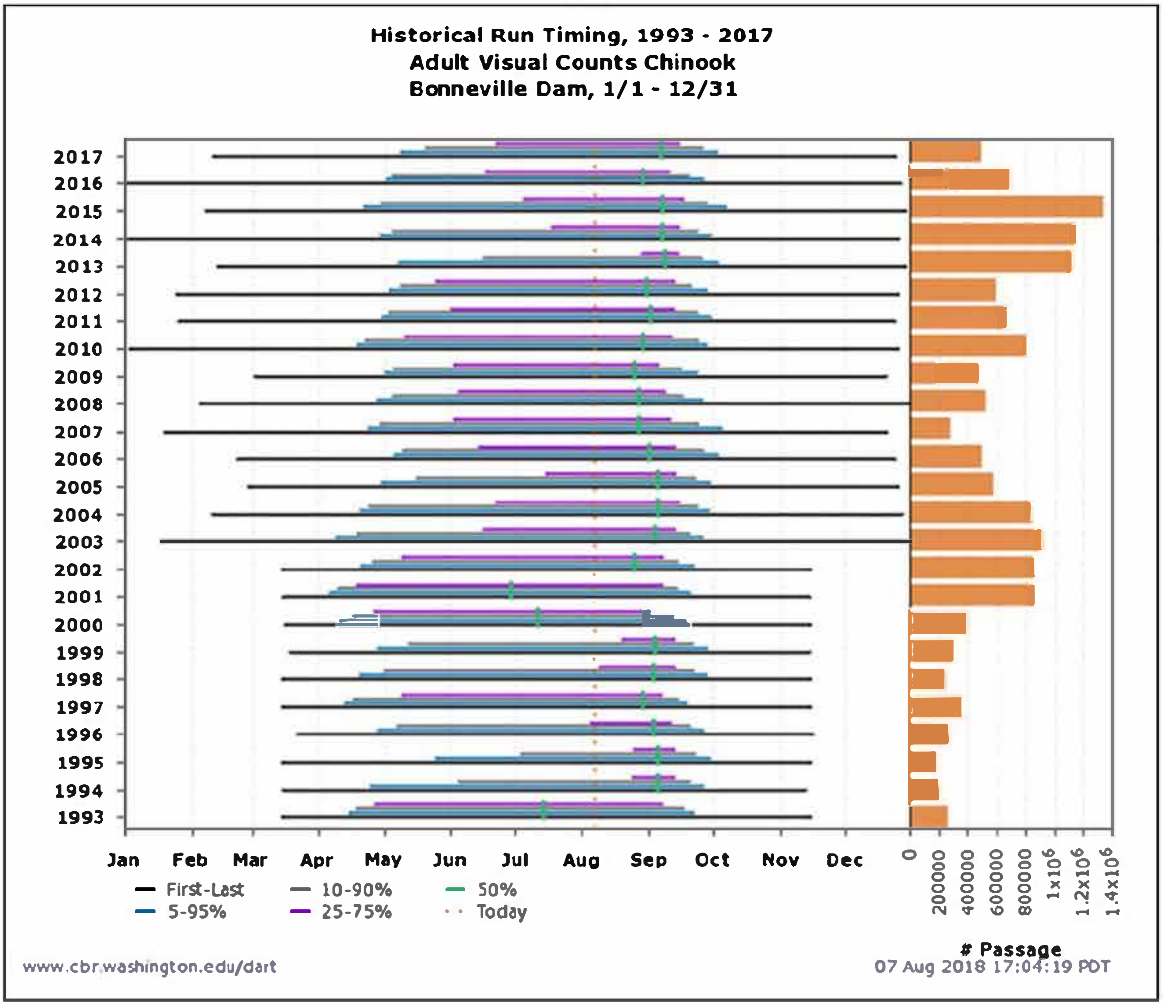

***Figure 12**. Twenty-five year record of presence of adult Chinook salmon at Bonneville Dam.*

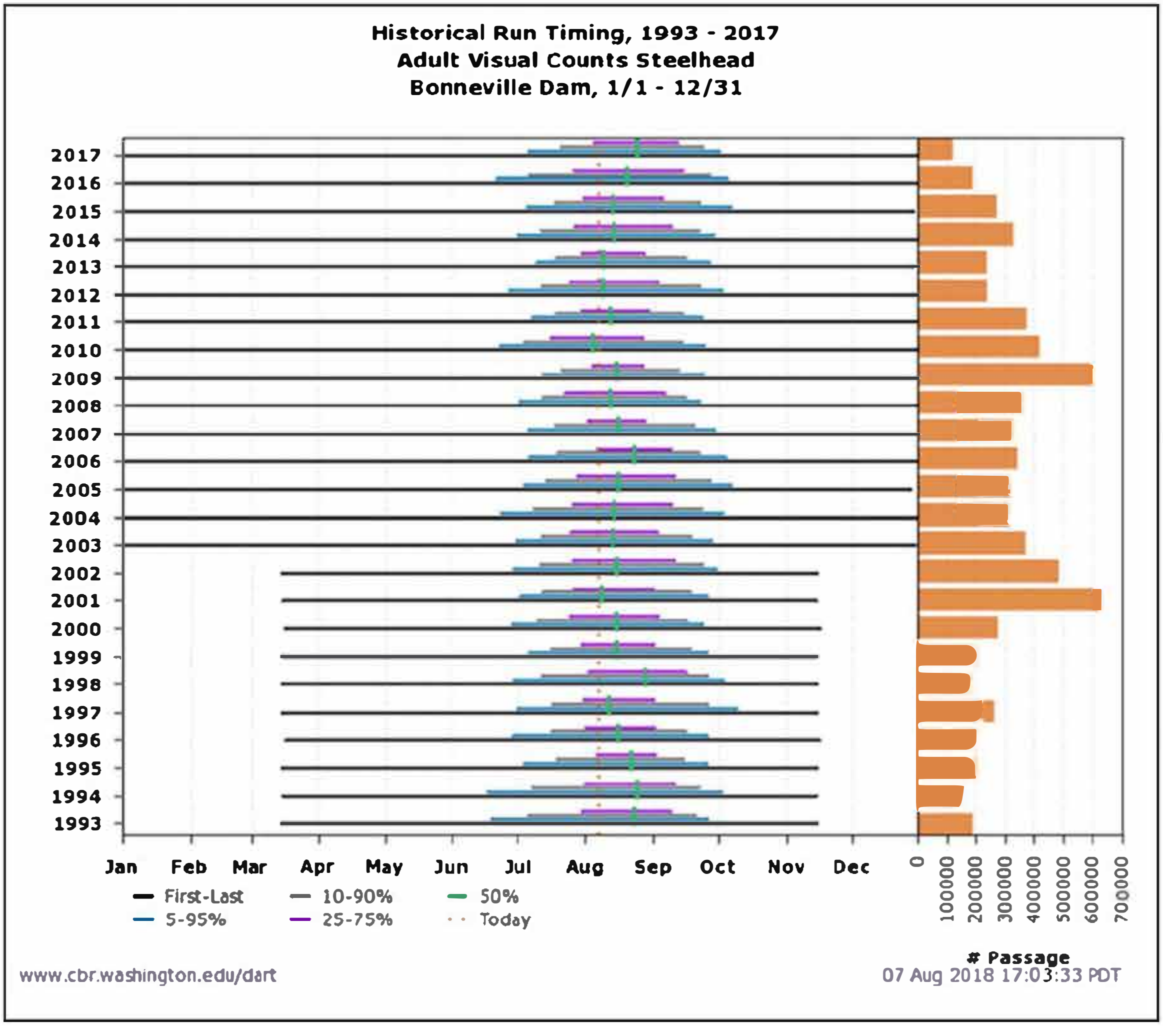

***Figure 13**. Twenty-five year record of presence of adult steelhead at Bonneville Dam.*

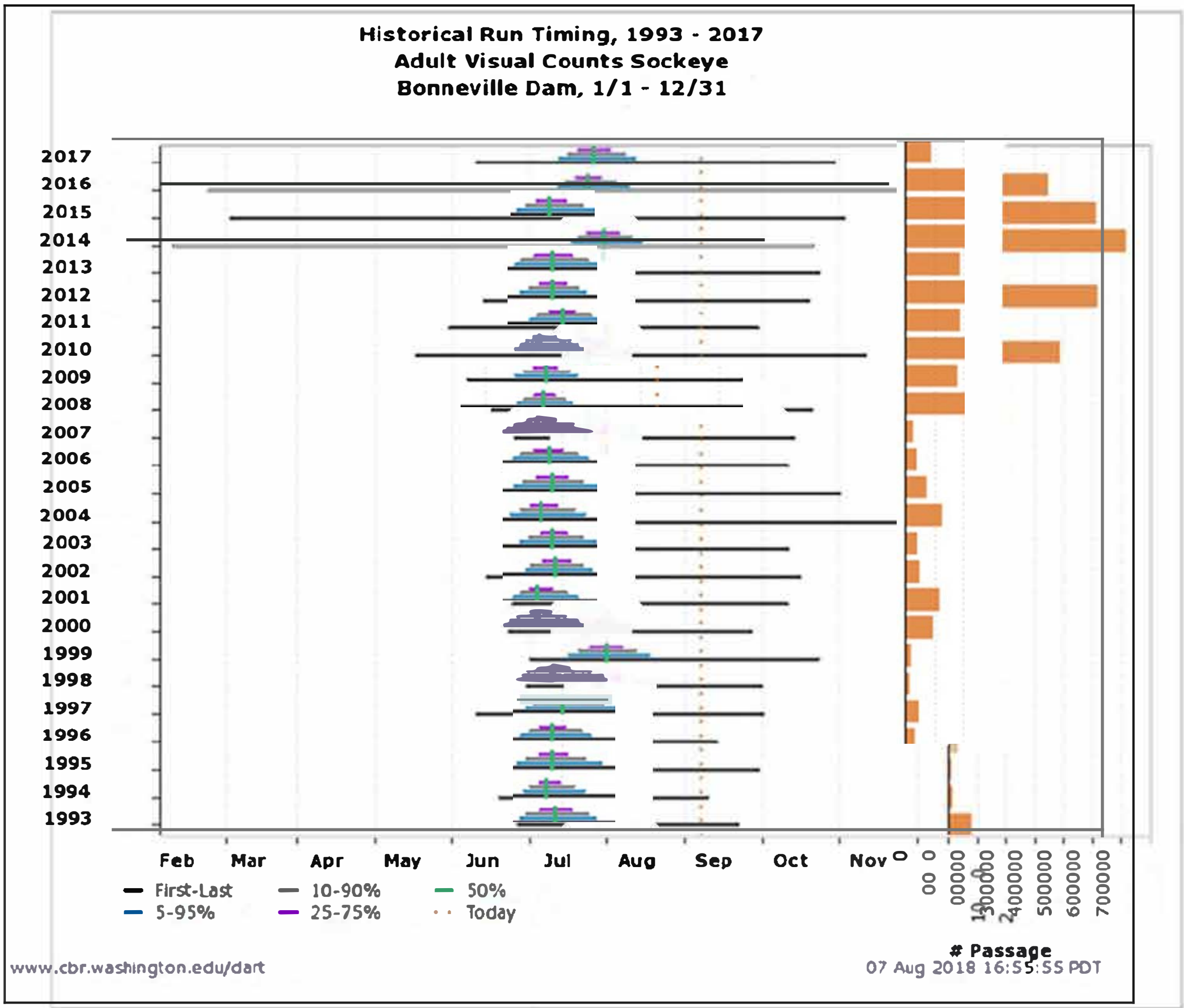

Figure 14. Twenty-five year record of adult sockeye salmon presence at Bonneville Dam.

Appendix D

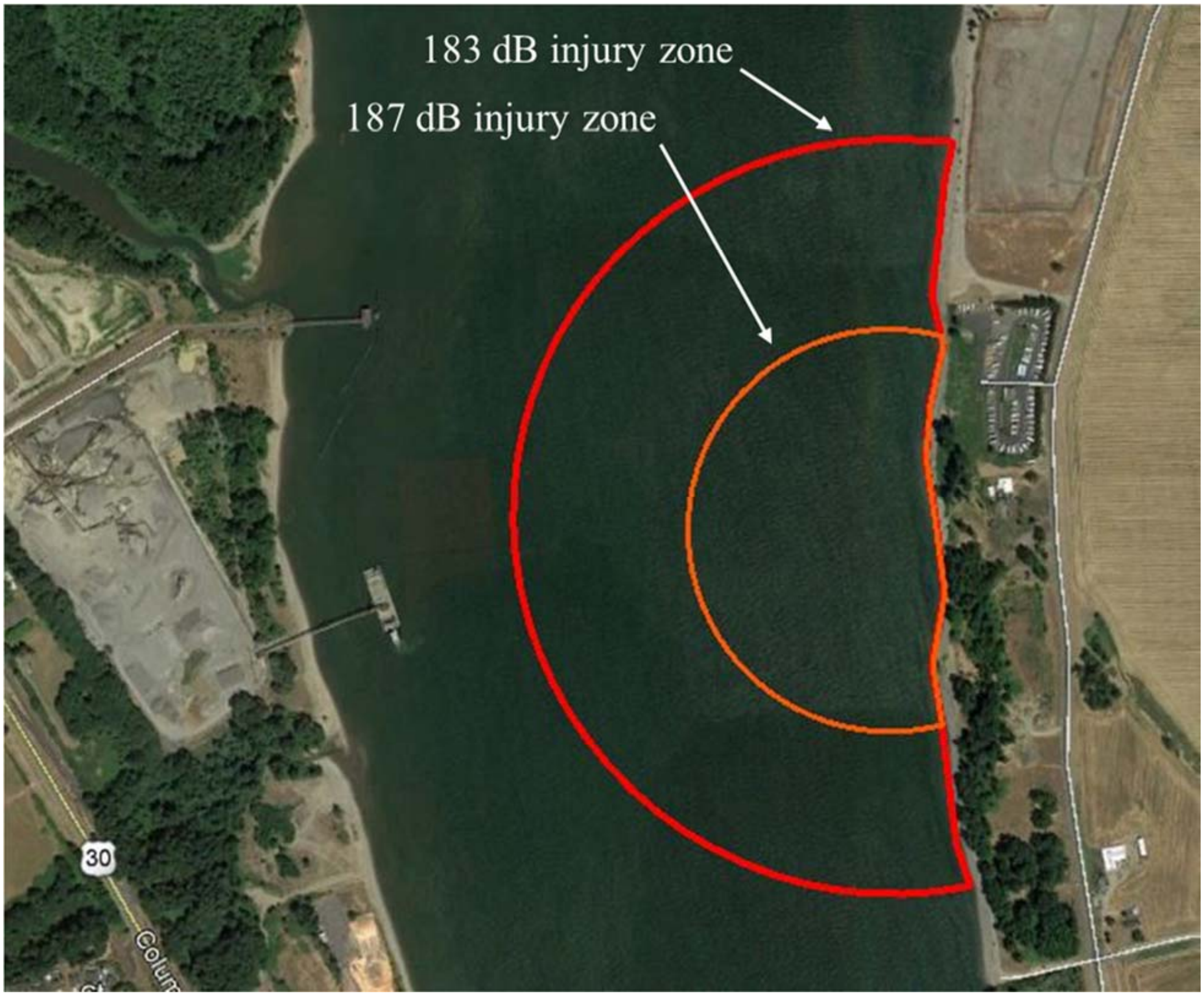

***Figure 15**. Maximum thresholds for sound pressure injury to 2 gram fish created during impact pile installation. Isopleths at 187 dB (denoted in red) and 183 dB (denoted in orange) are noted.*