



**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 No.:  
WCR-2015-3594

October 10, 2017

Shawn H. Zinszer  
Regulatory Branch Chief  
U.S. Army Corps of Engineers, Portland District  
Post Office Box 2946  
Portland, Oregon 97208-2946

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Kalama Manufacturing and Marine Export Facility, Cowlitz County, Washington (Sixth Field HUC 170800030804 Lower Columbia River) (Corps No.: NWP-2014-1772)

Dear Mr. Zinszer:

The enclosed document contains a biological opinion prepared by the National Marine Fisheries Service (NMFS) pursuant to section 7(a)(2) of the Endangered Species Act (ESA) on the effects of a proposal by the U.S. Army COE of Engineers (COE) to issue permits to the Port of Kalama for the construction of the Kalama Manufacturing and Marine Export Facility (Marine Export Facility component) on the Columbia River and to Northwest Pipeline LLC for construction of the Kalama Lateral Project. This document also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and includes two conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects on essential fish habitat.

The Corps or its applicant should direct any questions and comments regarding this opinion to Jennifer Quan, Chief, Southwest Washington-Oregon Coast Branch of the Oregon Washington Coastal Area Office at (360) 753-6054.

Sincerely,

Barry A. Thom  
Regional Administrator

cc: Kara J. Harris, DOE

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

Kalama Manufacturing and Marine Export Facility  
Kalama, Washington

**NMFS Consultation Number:** WCR-2015-3594

**Action Agency:** U.S. Army Corps of Engineers, Portland District  
U.S. Department of Energy, Washington, DC

**Affected Species and NMFS' Determinations:**

ESA-Listed Species	ESA Status	Is the action likely to adversely affect this species or its critical habitat?*	Is the Action likely to jeopardize this species?	Is Action Likely to Adversely Affect Critical Habitat?	Is the action likely to destroy or adversely modify critical habitat for this species*?
Lower Columbia River Chinook salmon	T	Yes	No	Yes	No
Upper Willamette River Chinook salmon	T	Yes	No	Yes	No
Upper Columbia River spring-run Chinook salmon	E	Yes	No	Yes	No
Snake River spring/summer run Chinook salmon	T	Yes	No	Yes	No
Snake River fall-run Chinook salmon	T	Yes	No	Yes	No
Columbia River chum salmon	T	Yes	No	Yes	No
Lower Columbia River coho salmon	T	Yes	No	Yes	No
Snake River sockeye salmon	E	Yes	No	Yes	No
Lower Columbia River steelhead	T	Yes	No	Yes	No
Upper Willamette River steelhead	T	Yes	No	Yes	No
Middle Columbia River steelhead	T	Yes	No	Yes	No
Upper Columbia River steelhead	T	Yes	No	Yes	No
Snake River Basin steelhead	T	Yes	No	Yes	No
Southern green sturgeon	T	No	No	No	No
Eulachon	T	Yes	No	Yes	No
Guadalupe fur seal	T	No	NA	NA	NA
Southern Resident killer whale	E	No	NA	NA	NA
Blue whale	E	Yes	No	NA	NA
Fin whale	E	Yes	No	NA	NA
Sei whale	E	No	NA	NA	NA
Humpback whale	E	Yes	No	NA	NA
Western North Pacific gray whale	E	No	NA	NA	NA
Sperm whale	E	Yes	No	NA	NA
North Pacific right whale	E	No	NA	NA	NA

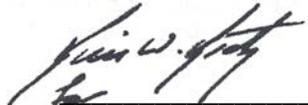
ESA-Listed Species	ESA Status	Is the action likely to adversely affect this species or its critical habitat?*	Is the Action likely to jeopardize this species?	Is Action Likely to Adversely Affect Critical Habitat?	Is the action likely to destroy or adversely modify critical habitat for this species*?
Green turtle	E	No	NA	NA	NA
Leatherback turtle	E	Yes	No	No	No
Loggerhead turtle	E	No	NA	NA	NA
Olive ridley turtle	E	No	NA	NA	NA

\*Please refer to Section 2.11 for the analysis of species or critical habitat that are not likely to be adversely affected.

Fishery Management Plan that Describes Essential Fish Habitat (EFH) in the Action Area	Would the action adversely affect EFH?	Are EFH conservation recommendations provided?
Pacific Coast Groundfish	No	No
Pacific Coast Salmon	Yes	Yes

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

**Issued By:**



Barry A Thom  
Regional Administrator

**Date:** October 10, 2017

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## LIST OF ACRONYMS

A&P	Abundance and Productivity
BA	Biological Assessment
BMP	Best Management Practice
BRT	Biological Review Team
CFR	Code of Federal Regulations
CHART	Critical Habitat Analytical Review Team
COE	U.S. Army Corps of Engineers
C.I.	Confidence Interval
CRD	Columbia River Datum
CV	Coefficient of Variance
dB	Decibel
DGN	Drift Gillnet
DO	dissolved oxygen
DOE	Department of Energy
DPS	Distinct Population Segment
DWT	Dead Weight Tonnage
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
ELJs	Engineered Log Jams
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FR	Federal Register
Gpd	gallons per day
Gpm	gallons per minute
HUC	Hydraulic Unit Code
IC	Interior Columbia
IMO	International Maritime Organization
ITS	Incidental Take Statement
IWC	International Whaling Commission
LCR	Lower Columbia River
MBR	Membrane bio-reactor
MCR	Middle Columbia River
Mg/L	milligrams per Liter
MMPA	Marine Mammal Protection Act
MFSA	Maritime Fire and Safety Association
MPG	Major Population Group
MSA	Magnuson Stevens Act
NMFS	National Marine Fisheries Service
NWIW	Northwest Innovations Works
NWR	Northwest Region
OC	Oregon Coast
ODFW	Oregon Department of Fish and Wildlife

OGV	Ocean Going Vessel
OHWL	Ordinary High Water Mark
OSRO	Oil Spill Response Organization
PAH	Polycyclic Aromatic Hydrocarbons
PBR	Potential Biological Removal
PCE	Primary constituent element
Port	Port of Kalama
PSET	Portland Sediment Evaluation Team
PWSA	Ports and Waterways Safety Act
Re: 1 $\mu$ Pa	Reference 1 MicroPascal
RM	River Mile
RMS	Root Mean Squared
RPM	Reasonable and prudent measure
SEL	Sound exposure level
SONCC	Southern Oregon Northern California Coasts
SPCC	Spill Prevention and Counter Measures Plan
SPL	Peak Sound Pressure Level
SR	Snake River
SRB	Snake River Basin
SS/D	Spatial Structure and Diversity
SWR	Southwest Region
TRT	Technical Review Team
UCR	Upper Columbia River
U.S.C.	United States Code
USCG	U.S. Coast Guard
UWR	Upper Willamette River
VSP	Viable Salmonid Population
WCR	West Coast Region
WLC	Willamette/Lower Columbia
WNP	Western Northern Pacific

## 1. INTRODUCTION

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

### 1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. §§ 1531 *et seq.*), and implementing regulations codified at 50 C.F.R. § 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 codified at 50 C.F.R. § 600.

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

### 1.2 Consultation History

The proposed action is: 1) the U.S. Army Corps of Engineers' (COE's) issuance of a permit under Section 404 of the Clean Water Act (33 U.S.C. 1344) and Section 10 of the Rivers and Harbors Act (33 U.S.C. 403) to the Port of Kalama (Port or applicant) for the construction of a marine export facility in the Columbia River, and 2) the COE's issuance of a permit under Section 404 of the Clean Water Act to Northwest Pipeline LLC for construction of the Kalama Lateral Project.

The marine export facility is one component of a larger project, the Kalama Manufacturing and Marine Export Facility (proposed project), which includes the construction and operation of a natural gas-to-methanol production plant and export facility on approximately 100 acres owned by the Port of Kalama at River Mile (RM) 72 on the Columbia River in Kalama, Washington. This facility is evaluated in this opinion as an interrelated and interdependent action – those actions that have no independent utility apart from the proposed action (50 CFR 402.02). As such the effects of the operation, including the mitigation, of this facility are also evaluated. The U.S. Department of Energy (DOE) is considering a potential loan guarantee to Northwest Innovation Works (NWIW) for the Kalama Methanol Facility. NWIW will lease the property from the applicant to develop and construct the upland portions of the project and operate the natural gas-to-methanol production plant and export facility. The COE submitted a letter and a biological assessment (BA) to the National Marine Fisheries Service (NMFS) on October 9, 2015, which was received on October 15, 2015.

In that letter, the COE concluded that the proposed action is not likely to adversely affect (NLAA) Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*), Upper Willamette River (UWR) Chinook salmon, Snake River (SR) spring/summer-run Chinook salmon, SR fall-run Chinook salmon, LCR coho salmon (*O. kisutch*), LCR steelhead (*O. mykiss*), UWR steelhead, Middle Columbia River steelhead, Upper Columbia River (UCR) steelhead, Snake River Basin (SRB) steelhead, and designated or proposed critical habitat for each of those species. The COE also concluded that the proposed action is NLAA Snake River (SR) sockeye salmon (*O. nerka*), southern distinct population of eulachon and southern distinct population of green sturgeon (*Acipenser medirostris*), (hereafter referred to as green sturgeon).

Due to the short- and long-term indirect impacts caused by the proposed project, NMFS does not concur with the COE's determination that the proposed action is NLAA for most species. We determined that the proposed project is LAA for LCR Chinook salmon, UWR Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, Columbia River chum salmon, LCR coho salmon, SR sockeye salmon, LCR steelhead (*O. mykiss*), UWR steelhead, MCR steelhead, UCR steelhead, SRB steelhead, and southern distinct population of eulachon. NMFS does concur with the COE's conclusion that the proposed action is NLAA for green sturgeon. We also concur that the proposed action will adversely affect critical habitat for any of these species.

The COE did not request consultation for marine mammals and sea turtles. Upon review of the project, NMFS determined that the proposed project may indirectly affect several species of marine mammals and sea turtles. We discussed these findings with the COE and included the following species in our analysis: Blue whales (*Balaenoptera musculus*), fin whales (*B. physalus*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), and leatherback sea turtles (*Dermochelys coriacea*). We also determined the project is NLAA for Southern Resident killer whales (*Orcinus orca*), sei whales (*B. borealis*), North Pacific right whales (*Eubalaena japonica*), Western North Pacific gray whales (*Eschrichtius robustus*), green turtles (*Chelonia mydas*), loggerhead turtles (*Caretta caretta*), Guadalupe fur seals (*Arctocephalus townsendi*), and olive ridley turtles (*Lepidochelys olivacea*). None of these species have critical habitat in the action area, except for leather back sea turtles. NMFS does not anticipate any effects on the prey species or designated critical habitat for leatherback sea turtles from the proposed project. As a result, we conclude that the proposed action will have no effect for leatherback critical habitat.

A complete record of this consultation is on file at the Oregon & Washington Coastal Area Office in Lacey, Washington. This record is briefly bulleted below.

- NMFS participated in pre-application meetings on several occasions with the Port of Kalama, NWIW, Washington State Fish and Wildlife, Washington State Office of Governor's Affairs, Washington State Department of Ecology, U.S. Fish and Wildlife Service, and consultants for the Port to coordinate development of permits and a BA for the proposed project prior to submittal for consultation.
- On October 15, 2015, NMFS received the BA from the COE.

- On October 21, 2015, NMFS coordinated with the Washington State Department of Fish and Wildlife (WDFW) over issues of concern.
- On October 29, 2015, a project discussion over changes to the mitigation proposal was held with NMFS, COE, WDFW, the Port and the consultant.
- On November 30, 2015, NMFS requested further clarification on water quality and dredging issues from the Port's consultants.
- On December 8, 2015, NMFS contacted the Cowlitz Tribe to see if there were any issues of concern.
- On December 14, 2015, NMFS received the revised mitigation plan from the Port's consultants.
- On March 9, 2016, NMFS requested more information on the outfall design and temperature discharge, and clarification on dredge disposal, from the Port.
- On March 14, 2016, the Corps informed NMFS that the DOE would be a cooperating agency on the project.
- On March 15, 2016, NMFS received information on the outfall, water quality, and dredging.
- On June 9, 2016 NMFS requested further information on ballast water and chemical constituents in the outfall discharge from the Port.
- On June 27, 2016, NMFS received clarification on ballast water and effluent concentrations.
- On September 13, 2016, NMFS received clarification on pile driving and a request to work year-round in the dry to install the Engineered Log Jams from the Port.
- On September 13, 2016, NMFS initiated formal consultation
- On January 30, 2017, the COE informed NMFS that the applicant would no longer be discharging industrial process water to the Columbia River.
- On March 1, 2017, NMFS received an updated mitigation plan.
- On June 16, 2017, NMFS provided an update on the wake stranding analysis to the COE.
- On June 20, 2017, NMFS provided information on the wake stranding analysis to the Port and applicants for the proposed Millennium Bulk Coal terminal and Vancouver Energy terminal projects on the on the Columbia River. At this meeting the three applicants expressed interest in

conducting either an individual or joint monitoring study to further understand the effects of wake stranding on juvenile salmon.

- On June 26, 2017, NMFS and the COE discussed NMFS' proposed analysis of wake stranding.
- On June 28, 2017, NMFS met with Cowlitz Tribe and discussed mitigation.
- On July 14, 2017, the COE and NMFS again discussed NMFS' proposed analysis of wake stranding.
- On July 18, 2017, the applicant provided a commitment to perform a wake stranding monitoring study.
- On August 29, 2017, NMFS transmitted a draft opinion to the COE, the applicant and the Cowlitz tribe.
- On September 13, 2017 NMFS met with the COE to discuss initial comments on the draft opinion, and the applicant provided their written comments on the draft opinion.
- On September 14, 2017 NMFS met with the COE and applicants to further discuss comments regarding the draft opinion.
- On September 19, 2017 the COE transmitted written comments on the draft opinion.
- On September 27, 2017, NMFS met with the COE and applicant to discuss how NMFS would address any comments.

### **1.3 Proposed Action**

“Action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 C.F.R. § 402.02).

The COE proposes to issue a permit under Section 10 of the Rivers and Harbors Act (33 USC 403) and Section 404 of the Clean Water Act (33 USC 1344) to the Port of Kalama for the construction of a marine export facility in the Port at River Mile (RM) 72 on the Columbia River in Kalama, Washington. The COE proposes to issue a permit under Section 404 of the Clean Water Act (33 USC 1344) to Northwest Pipeline LLC for construction of the Kalama Lateral Project.

The marine export facility is one component of a larger project, the Kalama Manufacturing and Marine Export Facility, which includes the construction and operation of a natural gas-to-methanol production plant and export facility by NWIW in upland areas. As stated above, this facility is considered here as an interrelated and interdependent action (50 CFR 402.2) and therefore the effects of the operations of the facility are also considered as an effect of the action.

DOE is considering whether or not to issue NWIW a loan guarantee to support construction and start-up of a natural gas-to-methanol production plant and export facility on approximately 100 acres in the Port at River Mile (RM) 72 on the Columbia River in Kalama, Washington. The Port of Kalama is the landowner, and will be constructing the in-water portions of the proposed facility. NWIW will lease Port property and will construct and operate the upland components of the project.

The project objective is the manufacture and shipment of methanol to global markets for use as a feedstock for manufacturing olefins used in the production of plastics and other materials. The proposed project will consist of a methanol production facility in upland areas; accessory administrative, support, and infrastructure facilities located in upland areas; and a new marine terminal located on the Columbia River (Figure 1). The marine terminal will include the construction of a new dock that will require work (pile driving, dredging, and mitigation) below the ordinary high water mark (OHWM) of the Columbia River.

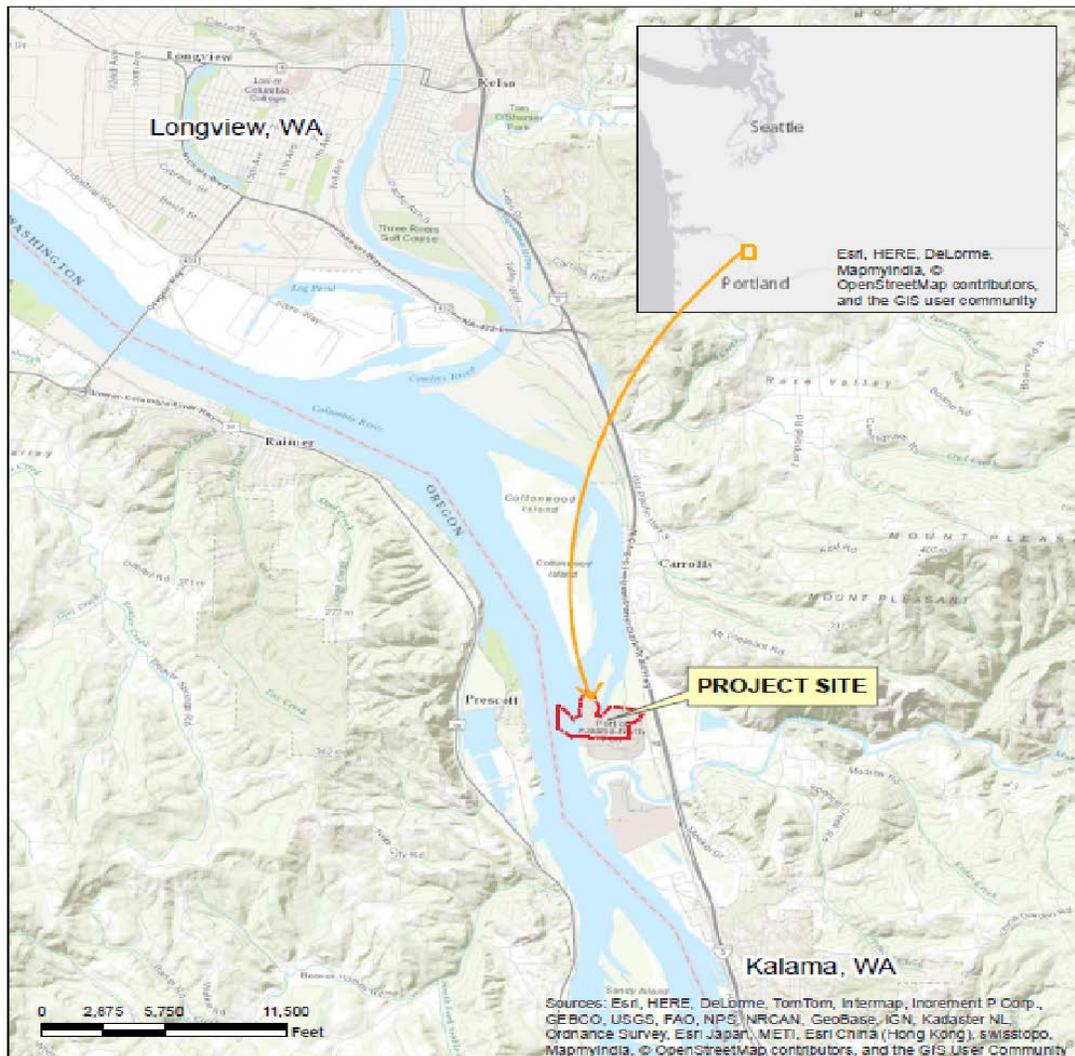


Figure 1. Project location.

The proposed project is designed to produce up to 10,000 metric tons per day of AA-grade methanol from natural gas. Methanol will be transferred by pipeline from the storage area to ocean going vessels (OGVs). After being loaded, the OGVs will travel down the Columbia River, out to the U.S. Exclusive Economic Zone, and to global markets.

### Dock Construction

Dock construction will include the following elements (Figure 2):

- Construction of a 44,943 square feet dock consisting of an access trestle, transition platform, berth trestle, turning platform, mooring dolphins, breasting dolphins and grated walkways.
- Placement of 290, 24-inch concrete piles, 12, 12-inch steel piles and 4, 18-inch steel piles.
- Installation of a fender system using ultra-high molecular weight polyethylene face panels.

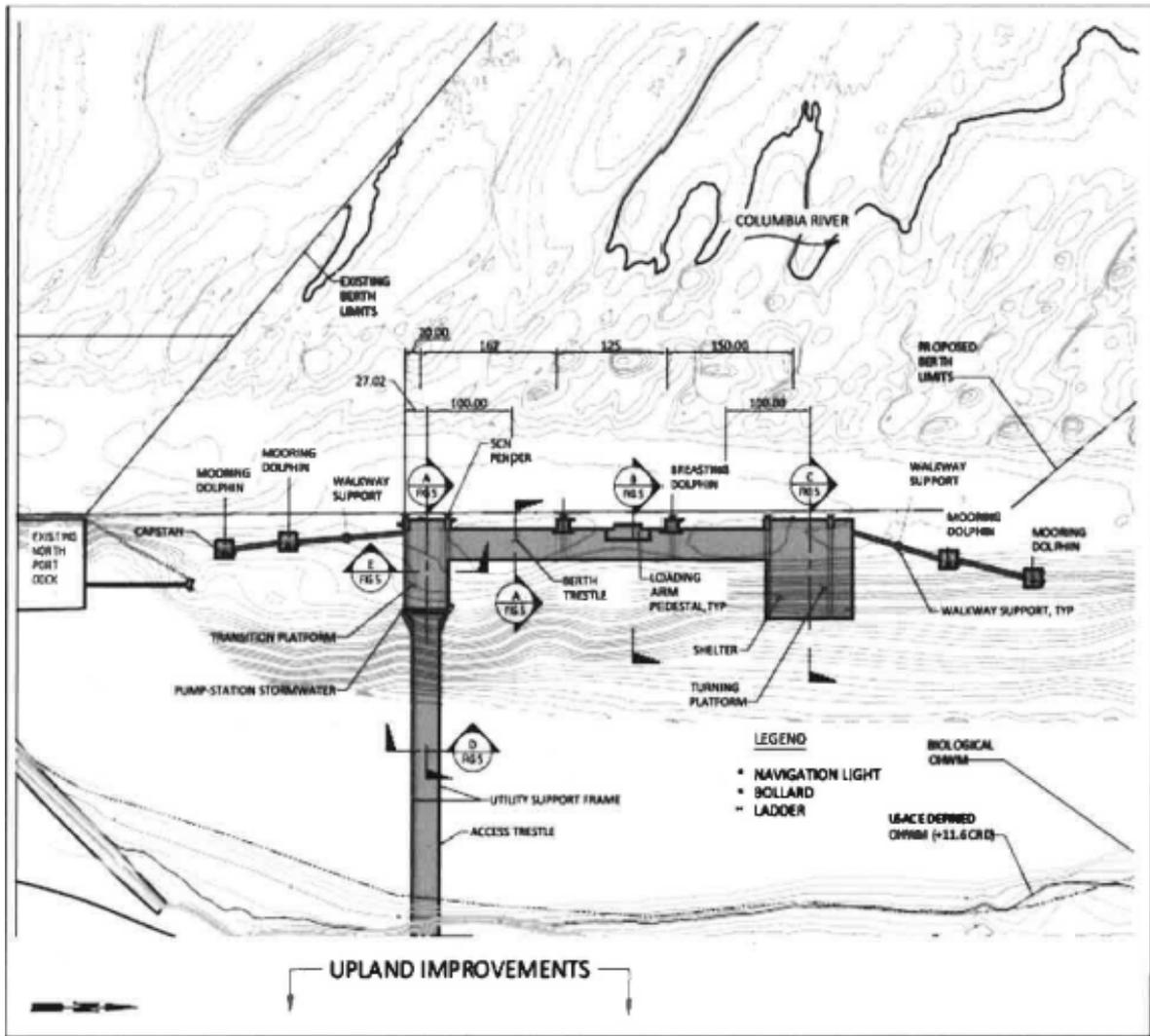


Figure 2. Proposed dock construction.

Since pile layout is conceptual, a 10 percent contingency was added by the applicant for the estimated number of concrete piles. This will accommodate potential revisions to the pile layout and configuration as the structural design is finalized. In addition, the project may require the installation of temporary piles during construction. Temporary piles are typically steel pipe or h-piles and will be driven with a vibratory hammer. These are placed and removed as necessary during the pile driving and over-water construction process. With the addition of the contingency, the proposed terminal will require the installation of approximately 320, 24-inch concrete piles; 12, 12-inch steel pipe piles; and four, 18-inch steel pipe piles. It is anticipated that all steel piles will be driven with a vibratory hammer. If it does become necessary to impact-drive steel piles, a bubble curtain or similarly effective noise attenuation device will be employed to reduce the potential for effects from temporarily elevated underwater noise levels.

A total of approximately 1,079 square feet of benthic habitat will be occupied by the new pile footprints. In addition, the proposed terminal itself will result in a total of approximately 44,943 square feet of new solid overwater coverage. With the single exception of a portion of the access trestle, the design of the terminal locates the platforms, dolphins, and structures in water deeper than 20 feet below OHWM (11.6 feet CRD [Columbia River Datum]). Of the total new aquatic habitat impact, approximately 34,018 square feet of overwater coverage, and approximately 806 square feet of new benthic impact associated with new pile footprints, will be located in water deeper than 20 feet below OHWM.

Approximately 10,925 square feet of new overwater coverage associated with the access trestle, and a total of approximately 173 square feet of new benthic impact associated with new pile footprints for the access trestle, will occur in and over shallow water habitat (water shallower than 20 feet below OHWM). The requirements for vehicle access and safety dictate the design and configuration of the access trestle. The trestle has been designed to be the minimum width necessary to perform its function. The trestle is by necessity a solid structure, and cannot be grated.

Based on the typical vessel size and production of the plant, an estimated three to six OGV round trips per month or 36 to 72 OGV round trips per year will use the berth for loading and unloading methanol. This will represent an increase over existing OGV traffic on the Columbia River. Additional ships may use the berth, for vessel supply operations, as a lay berth, for short- and long-term vessel moorage, and for topside vessel maintenance activities. These additional ships will not increase OGV traffic on the Columbia River as they are presently operating within the river.

### **Berth Dredging**

To accommodate OGV arrivals, docking, undocking, and departure, the existing berth serving the Port's North Port Terminal will be extended and this area will be deepened to minus 48 feet CRD with a 2-foot overdredge<sup>1</sup> allowance consistent with the existing berth. The berth will extend at an angle from the edge of the Columbia River navigation channel to the berthing line at the face of the proposed dock. The footprint of the expanded berth will be approximately 18 acres, of which approximately 16 acres will require dredging to achieve the berth depth. Existing

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<sup>1</sup> Due to dredging inaccuracies that can occur with equipment and the environment, overdredge is an allowance that compensates for the variables.

water depths in the proposed berth area vary from minus 39 feet CRD to minus 50 CRD. The total volume to be dredged is approximately 126,000 cubic yards.

The COE's Portland Sediment Evaluation Team (PSET) characterized the sediments in accordance with the guidelines from the Regional Sediment Evaluation Framework for the Lower Columbia River Management Area. Results indicate that the sediment samples did not exceed the sediment quality guidelines and, as such, the material proposed for dredging and placement will be suitable for placement at any of the existing Port placement sites (including in-water and upland placement sites) and on the upland portion of the project site. (PSET 2015)

Dredged material may be placed upland at the project site to provide material for construction or for other uses, or it may be placed at existing authorized in-water and upland placement sites which NMFS has analyzed in a prior consultation (NMFS No. NWR-2013-10116, dated July 15, 2013). The existing authorized in-water placement location that may be used includes beach nourishment at the Port's shoreline park (Louis Rasmussen Park) at RM 76. Dredged material may also be transported to Ross Island Sand and Gravel in Portland, Oregon for its use (any in-water placement of dredged or fill material by Ross Island Sand and Gravel is subject to a separate evaluation). The Port proposes to utilize two upland disposal sites for disposal of dredged material: the upland portion of the project site itself (also referred to as the North Port site) and the South Port upland disposal site located north of the TEMCO grain terminal at approximately RM 77.

### **Water Supply**

The proposed project will require water for domestic uses (*e.g.*, drinking, sanitation, showers, etc.) by employees and visitors to the terminal. Water for domestic uses will be obtained from the City of Kalama's municipal water supply system. Water used in the industrial process at the facility ("process water") will be provided by a collector well (Ranney well) to be constructed by the Port near the Columbia River shoreline. The collector well is proposed to be 22 feet in diameter (inside dimensions) and approximately 100 feet deep. The collector casing will receive ground water that percolates from the river through the soil from 10 laterals radiating from the central casing, each approximately 200 feet long. The well will pull water out of deep alluvium in the river bottom, and will be constructed under a groundwater permit issued by the Washington State Department of Ecology (Ecology). The permit allows withdrawal of up to 10,640 acre feet per year and 6,600 gallons per minute (gpm) of water. It is estimated that the proposed project will use approximately 5 million gallons per day of process water, or approximately 5,700 acre feet or 3,440 gpm.

### **Wastewater Treatment and Disposal**

Sources of wastewater from the proposed project include domestic and process wastewater streams. Domestic wastewater will be generated from the restrooms, on-site wash basins, and breakrooms. Domestic wastewater from the proposed project will be discharged to the existing Port of Kalama Wastewater Treatment Plant, which discharges to the Columbia River through a common outfall shared with the Steelscape facility.

Industrial process wastewater includes reject streams from raw water treatment and polishing, treated discharge from the methanol production process, and blow down from on-site cooling,

power generation, and boiler systems. The methanol production process will produce a process wastewater stream of approximately 135 gpm that will be recycled and reused on-site. This process wastewater stream will be treated with a membrane bio-reactor (MBR). The MBR will be an aerobic biological treatment with ultrafiltration. Discharges from the MBR will be directed to the Reverse Osmosis and Electro Deionization for re-use on-site. NWIW has committed to utilizing a zero liquid discharge system so that no process waste water will be discharged to the Columbia River.

### **Stormwater Treatment**

Stormwater from the proposed marine terminal will be segregated into two streams depending on the potential for contact with industrial activities. Stormwater from areas of the project site which are physically separated from the production process and from on-site paved areas will be directed to an infiltration facility for infiltration. Stormwater from the production process and on-site paved areas of the facility will be directed to a first flush pond for treatment. The first flush pond will discharge to the infiltration facility.

Stormwater from the first flush pond may be re-used on-site as raw water. Stormwater being re-used from the first flush pond will be treated through a coalescing plate oil-water separator and a granulated activated carbon filter prior to discharge into a cold-lime softener for re-use. The first flush pond and infiltration facility will be sized to manage stormwater on-site consistent with Cowlitz County and state water quality standards.

### **Construction Schedule**

The proposed project will be developed in one or two phases. The construction duration for the entire facility, including upland structures, will be approximately 26 to 48 months depending on whether it is built in one or two phases. Construction was expected to begin in mid-2016 and be completed as early as mid-2018 and as late as mid-2020.

- Pile installation will be conducted between 1 September and 31 January over approximately 120 days and up to two construction seasons.
- Dredging will be conducted between 1 August and 31 December over one construction season.
- ELJ installation will be conducted year-round outside the wetted perimeter of the river (in the dry)
- Pile removal may be conducted year-round
- Work conducted below the OHWM, (such as riparian plantings, trestle construction) but in the dry may be conducted year-round

### **Conservation Measures**

#### ***Dredging***

- Dredging will be conducted in a manner to prevent impingement of juvenile salmonids by dredging equipment (clamshell or hydraulic dredge). Regular observation of sediment aboard the barge or at the placement areas will be conducted to ensure fish are not present during dredging.

- Sediment that is dredged by hydraulic dredge and placed in-water by hydraulic pipeline will be discharged at the riverbed to the extent practicable to minimize turbidity in the water column.
- Smooth closure of the bucket will be implemented when at the bottom of the river bed to minimize turbidity.
- No stockpiling of dredged material will be allowed on the riverbed to minimize turbidity.
- Maintain suction head of hydraulic dredge in the river bed to the extent practicable to prevent entrainment.
- Use a buffer plate or other means to reduce flow energy of the hydraulic dredge at the placement area to prevent erosion and or/turbidity.
- Material used as beach nourishment will be placed within the limits of the boundaries and below the OHWM.
- To prevent fish stranding, the slope for beach nourishment will be 3:1 horizontal to vertical (33 percent) without any swales (ENTRIX 2008).
- If sediment is placed on a barge for delivery to the placement area, it will be managed to prevent spills from the barge. The barge will be managed such that the dredged sediment load does not exceed the capacity of the barge. The load will be placed in the barge to maintain an even keel and avoid listing. Hay bales and/or filter fabric may be placed over the barge scuppers to help filter suspended sediment from the barge effluent, if needed, based on sediment testing results.

Additional BMPs may also be implemented should turbidity and suspended sediments become elevated (monitoring will occur through a WA State Department of Ecology water quality certification) and may include, but are not limited to, the following:

- Slowing the velocity (i.e., cycle time) of the ascending loaded clamshell bucket through the water column;
- Pausing the dredge bucket near the bottom while descending, and near the water line while ascending; and
- Placing filter material over the barge scuppers to clear return water.

#### ***Pile Driving***

- A vibratory hammer will be used to drive steel piles to the greatest extent possible to minimize underwater noise levels.
- As described above in the construction schedule, in-water pile driving will be conducted only during the in-water work window of 1 September through 31 January to minimize effects to ESA-listed species

#### ***General Best Management Practices***

Project construction will be completed in compliance with Washington State Water Quality Standards (WAC 173-201A), including those listed below:

- Petroleum products, fresh cement, lime, concrete, chemicals, or other toxic or deleterious materials will not be allowed to enter surface waters.
- There will be no discharge of oil, fuels, or chemicals to surface waters, or onto land where there is a potential for re-entry into surface waters.

- Fuel hoses, oil drums, oil or fuel transfer valves, fittings, etc., will be checked regularly for leaks, and materials will be maintained and stored properly to prevent spills.

The Applicant’s contractor will prepare a spill prevention, control, and countermeasures (SPCC) plan and use during all demolition and construction operations. A copy of the plan with any updates will be maintained at the work site.

- The SPCC plan will outline BMPs, responsive actions in the event of a spill or release, and notification and reporting procedures. The plan also will outline management elements such as personnel responsibilities, project site security, site inspections, and training.
- The SPCC plan will outline the measures to prevent the release or spread of hazardous materials found on site or encountered during construction but not identified in contract documents including any hazardous materials that are stored, used, or generated on site during construction activities. These items include, but are not limited to, gasoline, diesel fuel, oils, and chemicals.
- Applicable spill response equipment and material designated in the SPCC plan will be maintained at the job site.

### **Kalama Lateral Pipeline**

The 3.1-mile linear project will cross seven water bodies during construction. Five of the seven waterbodies are intermittent and are expected to be dry during construction. According to Washington State Department of Fish and Wildlife, the remaining two waterbodies could support anadromous salmonids.

### **Interrelated and Interdependent Activities**

“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 C.F.R. § 402.02). In this opinion the proposed methanol facility and proposed mitigation is considered and interrelated and interdependent activity, the effects of which are outlined below and described more fully in Section 2.4, Effects of the Action on Species and Designated Critical Habitat.

### **Shipping from Port of Kalama into the Pacific Ocean**

Approximately 36 to 72 new methanol OGV round trips per year will travel the Columbia River as a result of construction and operation of the marine terminal.

The marine terminal will be designed to load methanol onto oceangoing vessels OGVs owned and/or operated by third parties that can that can handle methanol as cargo. OGVs will arrive at the terminal from the Pacific Ocean via the Columbia River navigation channel. The proposed dock will be designed to accommodate OGVs ranging in size from 45,000 deadweight tonnage (DWT) to 127,000 DWT, which will include OGV measuring from approximately 600 feet to 900 feet in length and 106 feet to 152 feet in width.

The typical speed of the types of OGVs that will serve the proposed project is 15 knots in the ocean and 10 knots in the Columbia River. OGVs will be piloted across the Columbia River Bar

and up the river to the terminal as required by state and federal regulations. Assist tugs will help OGV arriving at and leaving the berth. Based on the typical OGV size and production of the plant, an estimated three to six ships per month or 36 to 72 methanol OGV round trips per year will use the berth for loading methanol. These ships will represent new OGV traffic in the Columbia River. Additional ships may use the berth for other cargo loading and unloading, for OGV supply operations, as a lay berth, for short- and long-term OGV moorage, and for topside OGV maintenance activities. These additional ships are presently using the Columbia River and will not add any additional traffic from what presently exists.

### Mitigation

The Applicant has incorporated mitigation activities to address aquatic habitat impacts as part of the proposed action. The Applicant proposes four categories of activity: (1) pile removal; (2) engineered log jam (ELJ) installation; and, (3) riparian restoration and wetland buffer enhancement. Outside of the COE permit process, the applicant has agreed to preserve 90 to 95 acres of land immediately north of the project site.

### Pile Removal

The Applicant will remove approximately 157, 12- to 14-inch diameter treated timber piles associated with a deteriorated timber pile structure in the freshwater tidal backwater channel adjacent to the project site (Figure 3).



Figure 3. Proposed pile removal.

### Engineered Log Jam Installation

The applicant will install ten ELJs within the nearshore habitat along the Columbia River shoreline adjacent to the site (Figure 4). Each ELJ will measure approximately 20 x 20 feet and be composed of large-diameter untreated logs, logs with rootwads attached, small wood debris, and boulders. They will be anchored to untreated wood piles driven a minimum of 20 feet into the river stream bed and will be fastened to the piles by drilling holes in the wood and inserting 1-inch through-bolts for attaching chains to secure the wood to the piles. The structures will be installed at or near the mean lower low water mark, so that the structures are regularly inundated. Each ELJ will be a minimum of approximately 4000 square feet in size, and the eight structures will represent a total of 4,000 square feet of new large woody material, installed along approximately 1,000 linear feet of Columbia River shoreline.

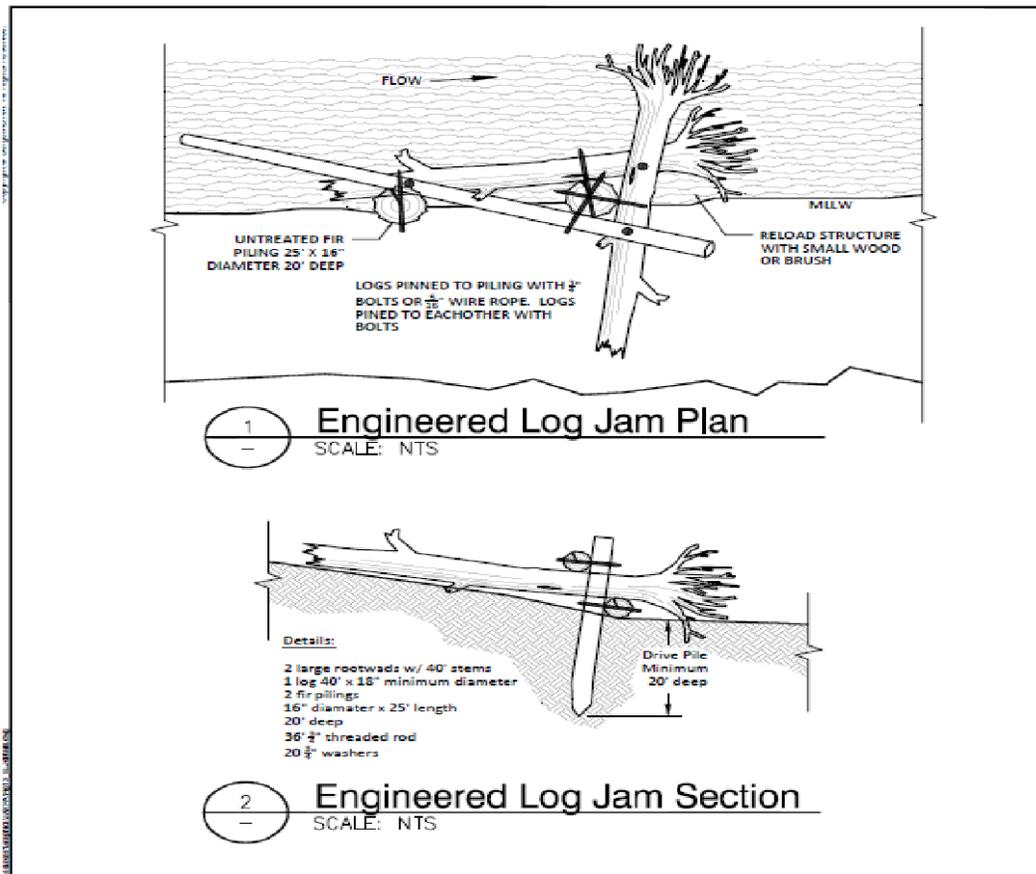


Figure 4. Engineered log jam construction.

***Riparian Restoration and Wetland Buffer Enhancement***

To further enhance riparian and shoreline habitat at the project site, the Applicant also proposes to conduct riparian enhancement and invasive species management within an area approximately 2.42 acres in size along approximately 2,300 linear feet of the Columbia River shoreline at the site (Figure 5). Similarly, the Applicant proposes to enhance approximately 0.58 acres of wetland buffer at the north end of the site to offset unavoidable wetland buffer impacts. The riparian and wetland buffer habitats will be enhanced by removing invasive species and installing native trees and shrubs that are common to this reach of the Columbia River shoreline and adjacent wetlands. The restoration site will be monitored and maintained for the life of the project to ensure the site remains functioning as designed.

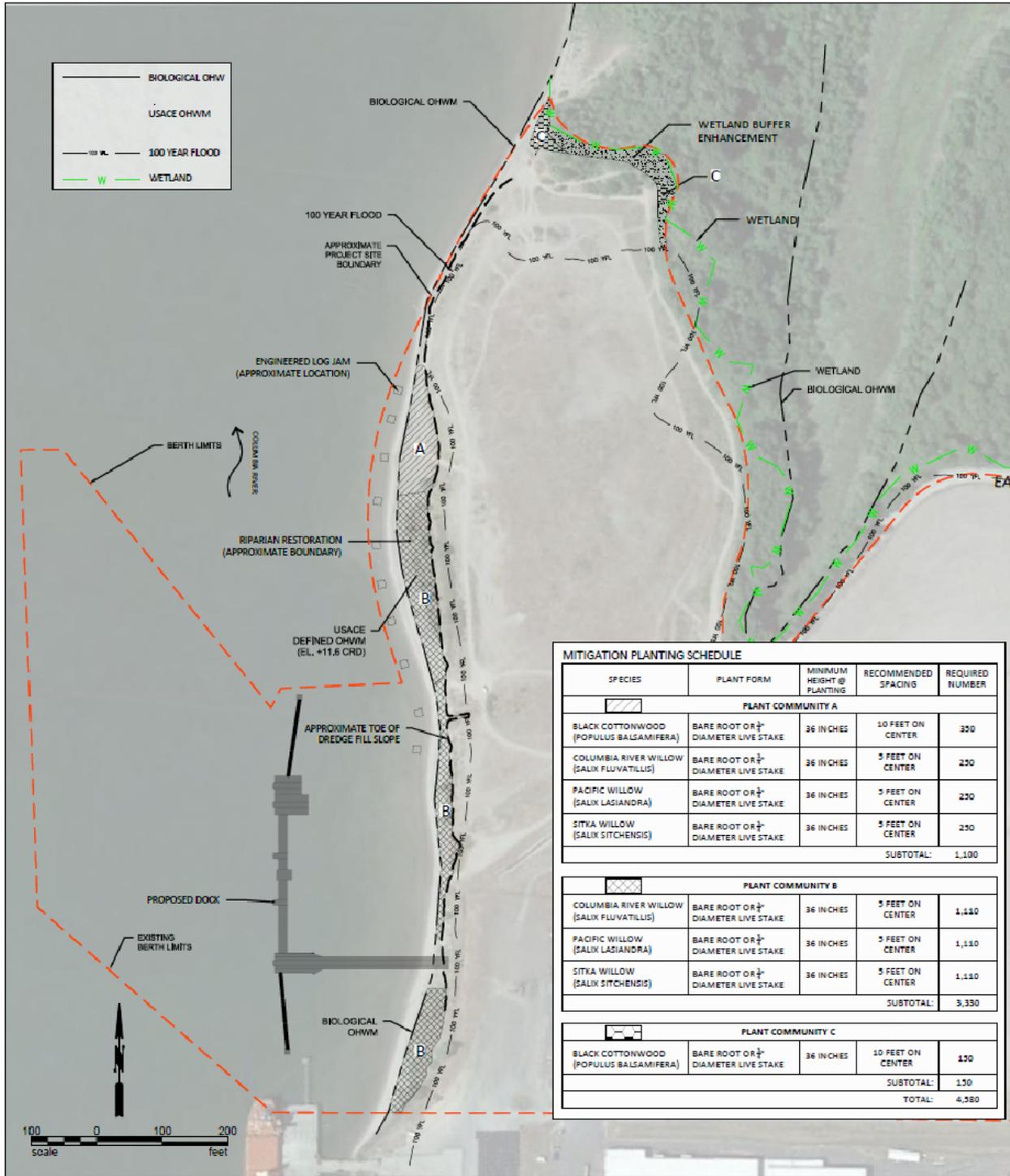


Figure 5. Proposed riparian planting design.

### ***Habitat Preservation***

The Port has agreed to place a restrictive conservation covenant preventing development on approximately 90 to 95 acres of land immediately north of the project site (Figure 6). The area proposed for the restrictive conservation covenant contains high quality habitat, including critical habitat for several populations of Endangered Species Act listed salmonids. Imposition of a restrictive conservation covenant will ensure that this area remains undeveloped and provides valuable habitat in perpetuity. To ensure the property is protected, a restrictive conservation covenant will be filed with Cowlitz County Auditor.



**Figure 6.** Proposed Area for Preservation.

### **1.4 Action Area**

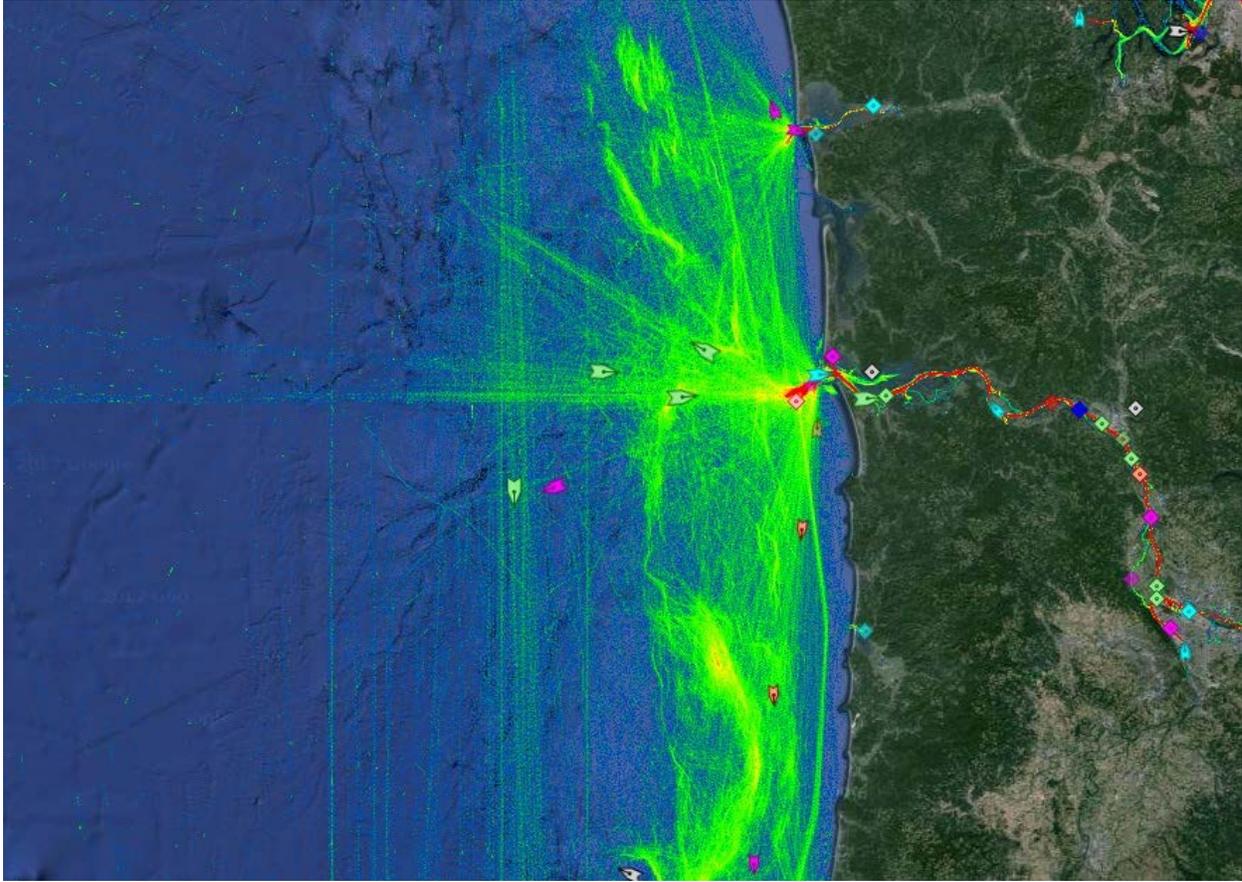
“Action area” means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 C.F.R. § 402.02).

For the proposed action and the interrelated and interdependent activities related to methanol transport, the action area includes the proposed dock facility at Columbia River RM 72 and extends downstream through the Columbia River navigation channel and into the Pacific Ocean where effects from ship traffic will occur, and the inland area where construction and operation of the pipeline will occur.

First, the action area includes the area affected by the construction and operation of the marine terminal – this includes the project sites and 385 feet from construction activities in the Columbia River to account for elevated noise from pile driving. Second, the action area includes a corridor along the proposed pipeline extending 3.1 miles inland to account for construction and operation activities from the pipeline extension. Lastly, it includes all areas affected by OGV traffic as explained below.

The portion of the Pacific Ocean included in the action area is a fan shape beginning at the mouth of the Columbia River and defined by OGV travel routes. It extends until it reaches the continental shelf approximately 40 miles offshore. The northern border of this fan is N 46° 57', W 125° 18' and the southern border is approximately N 45° 01', W 125° 18' (Figure 7). Within this fan area, encounters, OGV collisions, and impact from ship noise, are reasonably certain to occur between OGVs and marine mammals and leatherback sea turtles. The OGVs that travel through this area will continue on to destination ports primarily in Asia, with the density of marine mammals and leatherback sea turtles being substantially lower beyond the continental shelf. Beyond this area in the Pacific Ocean, the risk of a ship strike with a marine mammal or sea turtle becomes unlikely as density of ship traffic becomes lower. The action area extends landward 3.1 miles from the proposed methanol facility to encompass the construction and operation of the NW Pipeline that will supply the facility with methane. This will encompass the area where the pipeline will be placed which encompasses where construction activities will take place. This action area delimits the geographic location where the proposed action is likely to result in effects on listed species and critical habitat.

The action area includes aquatic habitats identified by the Pacific Fisheries Management Council (PFMC) as EFH for Pacific salmon (PFMC 2014), and groundfish (PFMC 2005).



**Figure 7.** Action area for OGV traffic from the NWIW methanol facility and out through the Pacific Ocean (Data/Image from [www.marinetraffic.com](http://www.marinetraffic.com), last semester of 2013).

**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.

The COE determined the proposed action is not likely to adversely affect green sturgeon and we agree with that determination. We also determined the project is NLAA for Southern Resident killer whales, sei whales, North Pacific right whales, Western North Pacific gray whales, green

turtles, loggerhead turtles, Guadalupe fur seal, and olive ridley turtles. Our concurrence is documented in the "Not Likely to Adversely Affect" Determinations Section (2.12).2.1 Analytical Approach.

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

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.

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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; Mote et al. 2013; Mote et al. 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases

in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

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 1.0-3.7°C 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.

Climate change also affects the rangewide status of blue whales, fin whales, humpback whales, and sperm whales, and marine habitat at large. Some of the effects of climate change on the Pacific Ocean are discussed above. In addition, evidence suggests that the productivity in the North Pacific (Mackas *et al.* 1989; Quinn and Niebauer 1995) and other oceans could be affected by changes in the environment. Increases in global temperatures are expected to have profound impacts on arctic and sub-arctic ecosystems, and these impacts are projected to accelerate during this century (ACIA 2004; Anisimov *et al.* 2007). The potential impacts of climate and oceanographic change on large whales will likely affect habitat availability and food availability. Large whale migration, feeding, and breeding locations may be influenced by factors such as ocean currents and water temperature. Any changes in these factors could render currently used habitat areas unsuitable and promote use of previously unutilized or previously not existing habitats may be a necessity for displaced individuals. Changes to climate and oceanographic processes may also lead to decreased productivity in different patterns of prey distribution and availability. Such changes could affect large whales that are dependent on those affected prey. The feeding range of large whales is wide and consequently, it is likely that whales may be more resilient to climate change, should it affect prey, than a species with a narrower range.

Based upon available information, it is likely that leatherback sea turtles are being affected and will be further affected by climate change. Similar to other sea turtle species, leatherbacks are likely affected by rising temperatures that may affect nesting success and skew sex ratios, and rising sea surface temperatures that may affect available nesting beach areas as well as ocean productivity. Leatherbacks are known to travel within specific isotherms and these could be affected by climate change and cause changes in their migration and prey availability (Robinson *et al.* 2008). Unlike other sea turtle species which may be prey limited due to climate changes to their forage base, leatherbacks feed primarily on jellyfish and some species are expected to

increase in abundance due to ocean warming (Brodeur *et al.* 1999; Attrill *et al.* 2007; Purcell *et al.* 2007; Richardson *et al.* 2009).

### **2.2.1 Status of the Species**

For Pacific salmon, steelhead, eulachon, and certain other species, NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: spatial structure, diversity, abundance, and productivity (McElhany *et al.* 2000). These “viable salmonid population” (VSP) criteria therefore encompass the species’ “reproduction, numbers, or distribution” as described in 50 C.F.R. § 402.02.<sup>2</sup> When these parameters are collectively at appropriate levels, they maintain a population’s capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment. These attributes are influenced by survival, behavior, and experiences throughout a species’ entire life cycle, and these characteristics, in turn, are influenced by habitat and other environmental conditions.

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

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

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

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

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

The summaries that follow describe the status of the 20 ESA-listed species, and their designated critical habitats, that occur within the geographic area of this proposed action and are considered in this opinion. More detailed information on the status and trends of these listed resources, and

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<sup>2</sup> VSP criteria do not pertain to marine mammals or sea turtles.

their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register (Table 1).

**Table 1.** Listing status, status of critical habitat designations and protective regulations, and relevant Federal Register (FR) decision notices for ESA-listed species considered in this opinion. Listing status: ‘T’ means listed as threatened under the ESA; ‘E’ means listed as endangered; ‘P’ means proposed for listing or designation.

Species	Listing Status	Critical Habitat	Protective Regulations
<b>Marine and Anadromous Fish</b>			
<b>Chinook salmon (<i>Oncorhynchus tshawytscha</i>)</b>			
Lower Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River spring-run	E 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	ESA section 9 applies
Snake River spring/summer-run	T 6/28/05; 70 FR 37160	10/25/99; 64 FR 57399	6/28/05; 70 FR 37160
Snake River fall-run	T 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	6/28/05; 70 FR 37160
<b>Chum salmon (<i>O. keta</i>)</b>			
Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
<b>Coho salmon (<i>O. kisutch</i>)</b>			
Lower Columbia River	T 6/28/05; 70 FR 37160	P 3/25/16; 81FR 9251; 78 FR 2726	6/28/05; 70 FR 37160
<b>Sockeye salmon (<i>O. nerka</i>)</b>			
Snake River	E 8/15/11; 70 FR 37160	12/28/93; 58 FR 68543	ESA section 9 applies
<b>Steelhead (<i>O. mykiss</i>)</b>			
Lower Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Middle Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	2/1/06; 71 FR 5178
Snake River Basin	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
<b>Eulachon (<i>Thaleichthys pacificus</i>)</b>			
Southern DPS	T 3/18/10; 75FR 13012	10/20/11; FR65324	Not applicable
<b>Marine Mammals</b>			
<b>Blue Whale (<i>Balaenoptera musculus</i>)</b>	E 12/02/1970; 35 FR 18319	Not applicable	ESA section 9 applies
<b>Fin whale (<i>B. physalus</i>)</b>	E 12/02/1970; 35 FR 18319	Not applicable	ESA section 9 applies
<b>Humpback whale (<i>Megaptera novaeangliae</i>)</b>	E 12/02/1970; 35 FR 18319	Not applicable	ESA section 9 applies
<b>Sperm whale (<i>Physeter macrocephalus</i>)</b>	E 12/02/1970	Not applicable	ESA section 9 applies
<b>Marine Turtles</b>			
<b>Leatherback turtle (<i>Dermochelys coriacea</i>)</b>	E 6/02/70 ; 39 FR 19320	3/23/79; 44 FR 17710 1/26/2012 77 FR 4170	ESA section 9 applies

## Salmon, Steelhead, and Eulachon

The status of species and critical habitat sections below are organized under two recovery domains (Table 2) to better integrate recovery planning information that NMFS is developing on the conservation status of the species and critical habitats considered in this consultation. Recovery domains are the geographically-based areas that NMFS is using to prepare multi-species recovery plans for anadromous species on the West Coast. Although eulachon are part of more than one recovery domain structure, they are presented below for convenience as part of the WLC recovery domain.

**Table 2.** Relevant recovery planning domains identified by NMFS and their ESA-listed salmon and steelhead species.

Recovery Domain	Species
Willamette-Lower Columbia (WLC)	LCR Chinook salmon UWR Chinook salmon CR chum salmon LCR coho salmon LCR steelhead UWR steelhead
Interior Columbia (IC)	UCR spring-run Chinook salmon SR spring/summer-run Chinook salmon SR fall-run Chinook salmon SR sockeye salmon UCR steelhead MCR steelhead SRB steelhead

For each recovery domain, a technical review team (TRT) appointed by NMFS has developed, or is developing, criteria necessary to identify independent populations within each species, recommended viability criteria for those species, and descriptions of factors that limit species survival. Viability criteria are prescriptions of the biological conditions for populations, biogeographic strata, and evolutionarily significant units (ESU) that, if met, would indicate that an ESU will have a negligible risk of extinction over a 100-year time frame (McElhany et al. 2000).<sup>3</sup>

Although the TRTs operated from the common set of biological principals described in McElhany *et al.* (2000), they worked semi-independently from each other and developed criteria suitable to the species and conditions found in their specific recovery domains. All of the criteria

<sup>3</sup> For Pacific salmon, NMFS uses its 1991 ESU policy, which states that a population or group of populations will be considered a distinct population segment if it is an evolutionarily significant unit. An evolutionarily significant unit represents a distinct population segment of Pacific salmon under the Endangered Species Act that (1) is substantially reproductively isolated from conspecific populations and (2) represents an important component of the evolutionary legacy of the species. The species *O. mykiss* is under the joint jurisdiction of NMFS and the Fish and Wildlife Service, so in making its January, 2006, ESA listing determinations, NMFS elected to use the 1996 joint FWS—NMFS DPS policy for this species.

have qualitative as well as quantitative aspects. The diversity of salmonid species and populations makes it impossible to set narrow quantitative guidelines that will fit all populations in all situations. For this and other reasons, viability criteria vary among species, mainly in the number and type of metrics and the scales at which the metrics apply (i.e., population, major population group (MPG), or ESU/DPS) (Busch *et al.* 2008).

The abundance and productivity (A&P) score considers the TRT's estimate of a population's minimum threshold population, natural spawning abundance, and the productivity of the population. Productivity over the entire life cycle and factors that affect population growth rate provide information on how well a population is "performing" in the habitats it occupies during the life cycle. Estimates of population growth rate that indicate a population is consistently failing to replace itself are an indicator of increased extinction risk. The four metrics (abundance, productivity, spatial structure, and diversity) are not independent of one another and their relationship to sustainability depends on a variety of interdependent ecological processes (Wainwright *et al.* 2008).

Integrated spatial structure and diversity (SS/D) risk combines risk for likely, future environmental conditions, and diversity (McElhany *et al.* 2000; McElhany *et al.* 2007; NW Fisheries Science Center 2015). Diversity factors include:

- Life history traits: Distribution of major life history strategies within a population, variability of traits, mean value of traits, and loss of traits.
- Effective population size: One of the indirect measures of diversity is effective population size. A population at chronic low abundance or experiencing even a single episode of low abundance is at a higher extinction risk because of loss of genetic variability, inbreeding and the expression of inbreeding depression, or the effects of mutation accumulation.
- Impact of hatchery fish: Interbreeding of wild populations and hatchery origin fish is a significant risk factor to the diversity of wild populations if the proportion of hatchery fish in the spawning population is high and their genetic similarity to the wild population is low.
- Anthropogenic mortality: The susceptibility to mortality from harvest or habitat alterations will differ depending on size, age, run timing, disease resistance or other traits.
- Habitat diversity: Habitat characteristics have clear selective effects on populations, and changes in habitat characteristics are likely to eventually lead to genetic changes through selection for locally adapted traits. In assessing risk associated with altered habitat diversity, historical diversity is used as a reference point.

Overall viability risk scores (high to low) and population persistence scores are based on combined ratings for the A&P and SS/D<sup>4</sup> metrics (Table 3) (McElhany *et al.* 2006). Persistence probabilities, which are provided here for Lower Columbia River salmon and steelhead, are the complement of a population's extinction risk (i.e., persistence probability = 1 – extinction risk) (NMFS 2013a). The IC-TRT has provided viability criteria that are based on McElhany *et al.* (2000) and McElhany (2006), as well as the results of previous applications in other TRTs and a

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<sup>4</sup> The WLC-TRT provided ratings for diversity and spatial structure risks. The IC-TRT provided spatial structure and diversity ratings combined as an integrated SS/D risk.

review of specific information available relative to listed IC ESU populations (IC-TRT 2007; NW Fisheries Science Center 2015).

**Table 3.** Population persistence categories from McElhany *et al.* (2006). A low or negligible risk of extinction is considered “viable” (NW Fisheries Science Center 2015). Population persistence categories correspond to: 4 = very low (VL), 3 = low (L), 2 = moderate (M), 1 = high (H), and 0 = very high (VH) in Oregon populations, which corresponds to “extirpated or nearly so” (E) in Washington populations (NW Fisheries Science Center 2015).

Population Persistence Category	Probability of population persistence in 100 years	Probability of population extinction in 100 years	Description
0	0-40 percent	60-100 percent	Either extinct or “high” risk of extinction
1	40-75 percent	25-60 percent	Relatively “high” risk of extinction in 100 years
2	75-95 percent	5-25 percent	“Moderate” risk of extinction in 100 years
3	95-99 percent	1-5 percent	“Low” (negligible) risk of extinction in 100 years
4	>99 percent	<1 percent	“Very low” risk of extinction in 100 years

The boundaries of each population were defined using a combination of genetic information, geography, life-history traits, morphological traits, and population dynamics that indicate the extent of reproductive isolation among spawning groups. The overall viability of a species is a function of the VSP attributes of its constituent populations. Until a viability analysis of a species is completed, the VSP guidelines recommend that all populations should be managed to retain the potential to achieve viable status to ensure a rapid start along the road to recovery, and that no significant parts of the species are lost before a full recovery plan is implemented (McElhany *et al.* 2000).

The size and distribution of the populations considered in this opinion generally have declined over the last few decades due to natural phenomena and human activity, including climate change (as described in Section 2.2), the operation of hydropower systems, over-harvest, effects of hatcheries, and habitat degradation. Enlarged populations of terns, harbor seals, Steller sea lions, California sea lions, and other aquatic predators in the Pacific Northwest may be limiting the productivity of some Pacific salmon and steelhead populations (NW Fisheries Science Center 2015, NMFS 2016).

Viability status or probability or population persistence is described below for each of the populations considered in this opinion.

**Willamette-Lower Columbia Recovery Domain.** Species in the Willamette-Lower Columbia (WLC) recovery domain include LCR Chinook salmon, UWR Chinook salmon, CR chum salmon, LCR coho salmon, LCR steelhead, UWR steelhead, southern DPS green sturgeon, and eulachon. The WLC-TRT has identified 107 demographically independent populations of Pacific salmon and steelhead (Table 4). These populations were further aggregated into “strata,” i.e.,

groupings above the population level that are connected by some degree of migration, based on ecological subregions. All 107 populations use parts of the mainstem of the Columbia River and the Columbia River estuary for migration, rearing, and smoltification.

**Table 4.** Populations of ESA-listed salmon and steelhead in the WLC recovery domain.

Species	Populations
LCR Chinook salmon	32
UWR Chinook salmon	7
CR chum salmon	17
LCR coho salmon	24
LCR steelhead	23
UWR steelhead	4

### *Status of LCR Chinook Salmon*

The ESU includes all naturally spawned populations of Chinook salmon originating from the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon east of the Hood River and the White Salmon River, and includes the Willamette River to Willamette Falls, Oregon. There are thirty-two demographically-independent populations in this ESU: 9 spring-run, 21 fall-run, and 2 late-fall run. These 32 populations are organized into six MPGs: Spring-run Cascade, Spring-run Gorge, Fall-run Coastal, Fall-run Cascade, Fall-run Gorge, and Late-Fall-run Cascade. Similar to the 2010 review, the BRT notes little change for overall biological status for all populations in this ESU in the 2015 review (NMFS 2016).

Recovery plan targets for this species are tailored for each life history type, and within each type, specific population targets are identified (NMFS 2013). For spring Chinook salmon, all populations are affected by aspects of habitat loss and degradation. The recovery plan calls for significant reductions in every threat category for four of the nine populations. Protection and improvement of tributary and estuarine habitat are specifically noted as critical to recovery.

For fall Chinook salmon, the Coast and Cascade strata must reach a high probability of persistence to meet recovery criteria, and this would be achieved primarily by ensuring habitat protection and restoration. Very large improvements are needed for most fall Chinook salmon populations to improve their probability of persistence.

For late fall Chinook salmon, recovery criteria call for maintenance of the North Fork Lewis and Sandy populations which are comparatively healthy, together with improving the probability of persistence of the Sandy population from its current status of “high” to “very high.” Improving the status of the Sandy population depends largely on harvest and hatchery changes. Habitat improvements to the Columbia River estuary and tributary spawning areas are also necessary. Of the 32 DIPs in this ESU, only the 2 late-fall run populations (Lewis River and Sandy River) could be considered viable or nearly so (NWFSC 2015).

**Spatial Structure and Diversity.** The WLC-TRT identified 32 historical populations of LCR Chinook salmon—seven in the coastal subregion, six in the Columbia Gorge, and 19 in the Cascade Range (Table 5). Spatial structure has been substantially reduced in several populations. Low abundance, past broodstock transfers and other legacy hatchery effects, and ongoing hatchery straying may have reduced genetic diversity within and among LCR Chinook salmon populations. Hatchery-origin fish spawning naturally may also have reduced population productivity (Lower Columbia Fish Recovery Board 2010; ODFW 2010; NMFS 2013a). Out of the 32 populations that make up this ESU, only the two late-fall runs, the North Fork Lewis and Sandy, are considered viable. Most populations (26 out of 32) have a very low probability of persistence over the next 100 years (and some are extirpated or nearly so) (Lower Columbia Fish Recovery Board 2010; ODFW 2010; NW Fisheries Science Center 2015; NMFS 2013a, NMFS 2016). Five of the six strata fall significantly short of the WLC-TRT criteria for viability; one stratum, Cascade late-fall, meets the WLC TRT criteria (NMFS 2013a).

**Table 5.** LCR Chinook salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine overall net persistence probability of the population (NMFS 2013a). Persistence probability ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Stratum		Spawning Population (Watershed)	A&P	Spatial Structure	Diversity	Overall Persistence Probability
Ecological Subregion	Run Timing					
Cascade Range	Spring	Upper Cowlitz River (WA)	VL	L	M	VL
		Cispus River (WA)	VL	L	M	VL
		Tilton River (WA)	VL	VL	VL	VL
		Toutle River (WA)	VL	H	L	VL
		Kalama River (WA)	VL	H	L	VL
		North Fork Lewis (WA)	VL	L	M	VL
		Sandy River (OR)	M	M	M	M
	Fall	Lower Cowlitz River (WA)	VL	H	M	VL
		Upper Cowlitz River (WA)	VL	VL	M	VL
		Toutle River (WA)	VL	H	M	VL
		Coweeman River (WA)	L	H	H	L
		Kalama River (WA)	VL	H	M	VL
		Lewis River (WA)	VL	H	H	VL

Stratum		Spawning Population (Watershed)	A&P	Spatial Structure	Diversity	Overall Persistence Probability
Ecological Subregion	Run Timing					
		Salmon Creek (WA)	VL	H	M	VL
		Clackamas River (OR)	VL	VH	L	VL
		Sandy River (OR)	VL	M	L	VL
		Washougal River (WA)	VL	H	M	VL
	Late Fall	North Fork Lewis (WA)	VH	H	H	VH
		Sandy River (OR)	VH	M	M	VH
Columbia Gorge	Spring	White Salmon River (WA)	VL	VL	VL	VL
		Hood River (OR)	VL	VH	VL	VL
	Fall	Lower Gorge (WA & OR)	VL	M	L	VL
		Upper Gorge (WA & OR)	VL	M	L	VL
		White Salmon River (WA)	VL	L	L	VL
		Hood River (OR)	VL	VH	L	VL
Coast Range	Fall	Young Bay (OR)	L	VH	L	L
		Grays/Chinook rivers (WA)	VL	H	VL	VL
		Big Creek (OR)	VL	H	L	VL
		Elochoman/Skamokawa creeks (WA)	VL	H	L	VL
		Clatskanie River (OR)	VL	VH	L	VL
		Mill, Germany, and Abernathy creeks (WA)	VL	H	L	VL
		Scappoose River (OR)	L	H	L	L

Abundance and Productivity. Of the seven spring-run DIPs in this MPG only the Sandy River spring-run population appears to be a currently self-sustaining population. Both of the two spring-run historical DIPs in the Spring-run Gorge MPG are extirpated or nearly so. In general, the DIPs in the Coastal Fall-run MPG are dominated by hatchery-origin spawners. In surveys conduct in both 2012 and 2013, no Chinook salmon were observed in Scappoose Creek. Overall, the Fall-run Cascade MPG exhibits stable population trends, but at low abundance levels, and most populations have hatchery contribution exceeding the target of 10% identified in the NMFS

Lower Columbia River recovery plan (Dornbush and Sihler 2013). Many of the populations in the Fall-run Gorge MPG have limited spawning habitat available. Additionally, the prevalence of returning hatchery-origin fish to spawning grounds presents a considerable threat to diversity. Natural-origin returns for most populations are in the hundreds of fish. The two populations in the Late-Fall-run MPG the most viable of the ESU. The Lewis River late-fall DIP has the largest natural abundance in the ESU and has a strong short-term positive trend and a stable long term trend, suggesting a population near capacity (Dornbush and Sihler 2013). The Sandy River late-fall run has not been directly monitored in a number of years; the most recent estimate was 373 spawners in 2010 (Takata 2011).

Limiting Factors include (NOAA Fisheries 2011; NMFS 2013a, NWFSC 2015):

- 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
- Contaminants

### ***Status of UWR Chinook Salmon***

Upper Willamette River (UWR) Chinook salmon were listed as threatened on June 28, 2005 (70 FR 37160). A recovery plan is available for this species (ODFW and NMFS 2011). There are a number of general considerations that affect some or all of the UWR Chinook populations, including high levels of prespawning mortality, lack of access to historical habitat, high levels of total dissolved gases (TDG), and a reduction in returning adult abundance between Willamette Falls and census points in the main tributaries (NWFSC 2015). Prespawning mortality levels are generally high in the lower tributary reaches where water temperatures and fish densities are the highest. Access to historical spawning and rearing areas is restricted by large dams in the four historically most productive tributaries, and in the absence of effective passage programs will continue to confine spawning to more lowland reaches where land development, water temperatures, and water quality may be limiting. Areas immediately downstream of high head dams may also be subject to high levels of total dissolved gas (TDG), which could affect a significant portion of the incubating embryos, in-stream juveniles, and adults in the basin (NMFS 2015). Shortfalls in counts of returning adults between Willamette Falls and upper tributary reaches also indicate additional prespawning mortality or spawning in lower quality habitat in lower tributary reaches could be limiting the recovery of these populations (Jepson et al. 2013; Jepson et al. 2014).

Spatial Structure and Diversity. This ESU includes naturally spawned spring-run Chinook salmon originating from the Clackamas River; in the Willamette River and its tributaries above Willamette Falls, Oregon; and progeny of six artificial propagation programs. All seven historical populations of UWR Chinook salmon identified by the WLC-TRT occur within the action area and are contained within a single ecological subregion, the western Cascade Range (Table 6). The McKenzie River population is currently characterized as at a

“low” risk of extinction and the Clackamas population has a “moderate” risk. Consideration of data collected since the 2005 status review has confirmed the high fraction of hatchery origin fish in all of the populations of this species (even the Clackamas and McKenzie rivers have hatchery fractions above WLC-TRT viability thresholds). All of the UWR Chinook salmon populations have “moderate” or “high” risk ratings for diversity. Clackamas River Chinook salmon have a “low” risk rating for spatial structure (Ford *et al.* 2010, NWFSC 2015).

**Table 6.** Scores for the key elements (A&P, diversity, and spatial structure) used to determine current overall viability risk for UWR Chinook salmon (ODFW and NMFS 2011). All populations are in the Western Cascade Range ecological subregion. Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

<b>Population (Watershed)</b>	<b>A&amp;P</b>	<b>Diversity</b>	<b>Spatial Structure</b>	<b>Overall Extinction Risk</b>
Clackamas River	M	M	L	M
Molalla River	VH	H	H	VH
North Santiam River	VH	H	H	VH
South Santiam River	VH	M	M	VH
Calapooia River	VH	H	VH	VH
McKenzie River	VL	M	M	L
Middle Fork Willamette River	VH	H	H	VH

Abundance and Productivity. The Clackamas and McKenzie River populations currently have the best risk ratings for A&P, spatial structure, and diversity. Both the Clackamas and McKenzie populations, considered the strongholds of natural production in this ESU, experienced a declining trend in abundance between the 2010 and the 2015 status review (NWFSC 2015). In contrast, North and South Santiam both experienced some improvement in abundance, but are still well below recovery goals, as are the other three populations in this ESU (NWFSC 2015). Data collected since the status update in 2005 (Good *et al.* 2005) highlighted the substantial risks associated with pre-spawning mortality. Although recovery plans are targeting key limiting factors for future actions, there have been no significant on-the-ground actions since the 2005 status review to resolve the lack of access to historical habitat above dams nor have there been substantial actions removing hatchery fish from the spawning grounds.

Limiting Factors include (NOAA Fisheries 2011; ODFW and NMFS 2011, NWFSC 2015):

- 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

### *Status of CR Chum Salmon*

Columbia River chum salmon are included in the Lower Columbia River Recovery Plan (NMFS 2013). Recovery targets described in the Plan for this species focus on improving tributary and estuarine habitat conditions, and re-establishing populations where they may have been extirpated, in order to increase all four viability parameters. Specific recovery goals are to restore Coast and Cascade chum salmon strata to a high probability of persistence, and to improve persistence probability of the two Gorge populations by protecting and restoring spawning habitat, side channel, and off channel habitats alcoves, wetlands, floodplains, *etc.*

Spatial Structure and Diversity. This ESU includes naturally-spawned chum salmon originating from the Columbia River (CR) and its tributaries in Washington and Oregon, and progeny of two artificial propagation programs. The WLC-TRT identified 17 historical populations of CR chum salmon and aggregated these into four strata (Myers *et al.* 2006) (Table 7). CR chum salmon spawning aggregations identified in the mainstem Columbia River were included in the population associated with the nearest river basin.

The very low persistence probabilities or possible extirpations of most chum salmon populations are due to low abundance, productivity, spatial structure, and diversity. Although hatchery production of chum salmon has been limited and hatchery effects on diversity are thought to have been relatively small, diversity has been greatly reduced at the ESU level because of presumed extirpations and the low abundance in the remaining populations (fewer than 100 spawners per year for most populations) (Lower Columbia Fish Recovery Board 2010; NMFS 2013a). The Lower Gorge population meets abundance and productivity criteria for very high levels of viability, but the distribution of spawning habitat (*i.e.*, spatial structure) for the population has been significantly reduced (Lower Columbia Fish Recovery Board 2010); spatial structure may need to be improved, at least in part, through better performance from the Oregon portion of the population (NMFS 2013a). 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 (NWFSC 2015).

**Table 7.** CR chum salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2013a). Persistence probability ratings are very low (VL), low (L), moderate (M), high (H), to very high (VH).

Stratum		Spawning Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Persistence Probability
Ecological Subregion	Run Timing					
Coast Range	Fall	Young's Bay (OR)	*	*	*	VL
		Grays/Chinook rivers (WA)	VH	M	H	M
		Big Creek (OR)	*	*	*	VL
		Elochoman/Skamakowa rivers (WA)	VL	H	L	VL
		Clatskanie River (OR)	*	*	*	VL
		Mill, Abernathy and Germany creeks (WA)	VL	H	L	VL
		Scappoose Creek (OR)	*	*	*	VL
Cascade Range	Summer	Cowlitz River (WA)	VL	L	L	VL
	Fall	Cowlitz River (WA)	VL	H	L	VL
		Kalama River (WA)	VL	H	L	VL
		Lewis River (WA)	VL	H	L	VL
		Salmon Creek (WA)	VL	L	L	VL
		Clackamas River (OR)	*	*	*	VL
		Sandy River (OR)	*	*	*	VL
		Washougal River (WA)	VL	H	L	VL
Columbia Gorge	Fall	Lower Gorge (WA & OR)	VH	H	VH	H
		Upper Gorge (WA & OR)	VL	L	L	VL

\* No data are available to make a quantitative assessment.

Of the 17 populations that historically made up this ESU, 15 of them (six in Oregon and nine in Washington) are so depleted that either their baseline probability of persistence is very low or they are extirpated or nearly so (Lower Columbia Fish Recovery Board 2010; ODFW 2010; NW Fisheries Science Center 2015; NMFS 2013a). All three strata in the ESU fall significantly short of the WLC-TRT criteria for viability. Currently almost all natural production occurs in just two populations: the Grays/Chinook and the Lower Gorge. The Grays/Chinook population has a

moderate persistence probability, and the Lower Gorge population has a high probability of persistence (Lower Columbia Fish Recovery Board 2010; NMFS 2013a). Since the 2010 review (Ford *et al.* 2010), likely improvements include the Big Creek demographically independent population, the Washougal River (positive abundance trend over 10-year period), and the Grays River (may be at or near viable status). The Lower Gorge has experienced population abundance declines (NMFS 2016)

Limiting Factors include (NOAA Fisheries 2011; NMFS 2013a; NWFSC 2015):

- 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

### ***Status of LCR Coho Salmon***

This species is included in the Lower Columbia River Recovery Plan (NMFS 2013). Specific recovery goals of the Plan are to improve all four viability parameters to the point that the Coast, Cascade, and Gorge strata achieve high probability of persistence. Protection of existing high-functioning habitat and restoration of tributary habitat are noted needs, along with reduction of hatchery and harvest impacts. Large improvements are needed in the persistence probability of most populations of this ESU.

Spatial Structure and Diversity. This ESU includes naturally-spawned coho salmon originating from the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia up to and including the Big White Salmon and Hood rivers; in the Willamette River to Willamette Falls, Oregon; and progeny of 21 artificial propagation programs.<sup>5</sup> Spatial diversity is rated “moderate” to “very high” for all the populations, except the North Fork Lewis River, which has a “low” rating for spatial structure.

Out of the 24 populations that make up this ESU (Table 8), 21 are considered to have a very low probability of persisting for the next 100 years, and none is considered viable (Lower Columbia Fish Recovery Board 2010; ODFW 2010; NMFS 2013a).

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<sup>5</sup> The Elochoman Hatchery Type-S and Type-N coho salmon programs were eliminated in 2008. The last adults from these two programs returned to the Elochoman in 2010. NMFS has recommended that these two programs be removed from the ESU (NMFS 2011a).

**Table 8.** LCR coho salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2013a). Persistence probability ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Ecological Subregions	Population (Watershed)	A&P	Spatial Structure	Diversity	Overall Persistence Probability
<b>Coast Range</b>	Young's Bay (OR)	VL	VH	VL	VL
	Grays/Chinook rivers (WA)	VL	H	VL	VL
	Big Creek (OR)	VL	H	L	VL
	Elochoman/Skamokawa creeks (WA)	VL	H	VL	VL
	Clatskanie River (OR)	L	VH	M	L
	Mill, Germany, and Abernathy creeks (WA)	VL	H	L	VL
	Scappoose River (OR)	M	H	M	M
<b>Cascade Range</b>	Lower Cowlitz River (WA)	VL	M	M	VL
	Upper Cowlitz River (WA)	VL	M	L	VL
	Cispus River (WA)	VL	M	L	VL
	Tilton River (WA)	VL	M	L	VL
	South Fork Toutle River (WA)	VL	H	M	VL
	North Fork Toutle River (WA)	VL	M	L	VL
	Coweeman River (WA)	VL	H	M	VL
	Kalama River (WA)	VL	H	L	VL
	North Fork Lewis River (WA)	VL	L	L	VL
	East Fork Lewis River (WA)	VL	H	M	VL
	Salmon Creek (WA)	VL	M	VL	VL
	Clackamas River (OR)	M	VH	H	M
	Sandy River (OR)	VL	H	M	VL
	Washougal River (WA)	VL	H	L	VL
<b>Columbia Gorge</b>	Lower Gorge Tributaries (WA & OR)	VL	M	VL	VL
	Upper Gorge/White Salmon (WA)	VL	M	VL	VL
	Upper Gorge Tributaries/Hood (OR)	VL	VH	L	VL

Abundance and Productivity. In Oregon, the Clatskanie Creek and Clackamas River populations have “low” and “moderate” persistence probability ratings for A&P, while the rest are rated “very low.” All of the Washington populations have “very low” A&P ratings. The persistence probability for diversity is “high” in the Clackamas population, “moderate” in the Clatskanie, Scappoose, Lower Cowlitz, South Fork Toutle, Coweeman, East Fork Lewis, and Sandy populations, and “low” to “very low” in the rest (NMFS 2013a). Uncertainty is high because of a lack of adult spawner surveys. Smolt traps indicate some natural production in Washington populations, though given the high fraction of hatchery origin spawners suspected to occur in these populations it is not clear that any are self-sustaining.

The 2015 Status Review (NWFSC) indicates most populations may have experienced improvements in abundance, diversity, and spatial structure since the last status review. New data from improved Washington State Fish and Wildlife Department surveys have demonstrated greater abundance and natural production for coho in many Washington populations than was

previously known. Despite these improvements, abundance remains relatively low and none of the MPGs meet criteria for viability (NWFSC 2015). 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 (NWFSC 2015).

Limiting Factors include (NOAA Fisheries 2011; NMFS 2013a; NWFSC 2015):

- 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

### *Status of LCR Steelhead*

This species is included in the Lower Columbia River recovery plan (NMFS 2013a). For this species, threats in all categories must be reduced, but the most crucial elements are protecting favorable tributary habitat and restoring habitat in the Upper Cowlitz, Cispus, North Fork Toutle, Kalama and Sandy subbasins (for winter steelhead), and the East Fork Lewis, and Hood, subbasins (for summer steelhead). Protection and improvement is also need among the South Fork Toutle and Clackamas winter steelhead populations.

Spatial Structure and Diversity. This DPS includes naturally spawned anadromous steelhead originating below natural and manmade impassable barriers from rivers between the Cowlitz and Wind Rivers (inclusive) and the Willamette and Hood Rivers (inclusive); excludes such fish originating from the upper Willamette River basin above Willamette Falls. This DPS does include steelhead from seven artificial propagation programs. Four strata and 23 historical populations of LCR steelhead occur within the DPS: 17 winter-run populations and six summer-run populations, within the Cascade and Gorge ecological subregions (Table 9).<sup>6</sup> Summer steelhead return to freshwater long before spawning. Winter steelhead, in contrast, return from the ocean much closer to maturity and spawn within a few weeks. Summer steelhead spawning areas in the Lower Columbia River are found above waterfalls and other features that create seasonal barriers to migration. Where no temporal barriers exist, the winter-run life history dominates (NWFSC 2015).

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<sup>6</sup> The White Salmon and Little White Salmon steelhead populations are part of the Middle Columbia steelhead DPS and are addressed in a separate species-level recovery plan, the Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan (NMFS 2009a).

**Table 9.** LCR steelhead strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2013a). Persistence probability ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Stratum		Population (Watershed)	A&P	Spatial Structure	Diversity	Overall Persistence Probability
Ecological Subregion	Run Timing					
Cascade Range	Summer	Kalama River (WA)	H	VH	M	M
		North Fork Lewis River (WA)	VL	VL	VL	VL
		East Fork Lewis River (WA)	VL	VH	M	VL
		Washougal River (WA)	M	VH	M	M
	Winter	Lower Cowlitz River (WA)	L	M	M	L
		Upper Cowlitz River (WA)	VL	M	M	VL
		Cispus River (WA)	VL	M	M	VL
		Tilton river (WA)	VL	M	M	VL
		South Fork Toutle River (WA)	M	VH	H	M
		North Fork Toutle River (WA)	VL	H	H	VL
		Coweeman River (WA)	L	VH	VH	L
		Kalama River (WA)	L	VH	H	L
		North Fork Lewis River (WA)	VL	M	M	VL
		East Fork Lewis River (WA)	M	VH	M	M
		Salmon Creek (WA)	VL	H	M	VL
		Clackamas River (OR)	M	VH	M	M
		Sandy River (OR)	L	M	M	L
		Washougal River (WA)	L	VH	M	L
Columbia Gorge	Summer	Wind River (WA)	VH	VH	H	H
		Hood River (OR)	VL	VH	L	VL
	Winter	Lower Gorge (WA & OR)	L	VH	M	L
		Upper Gorge (OR & WA)	L	M	M	L
		Hood River (OR)	M	VH	M	M

It is likely that genetic and life history diversity has been reduced as a result of pervasive hatchery effects and population bottlenecks. Spatial structure remains relatively high for most populations. Out of the 23 populations, 16 are considered to have a “low” or “very low” probability of persisting over the next 100 years, and six populations have a “moderate” probability of persistence (Lower Columbia Fish Recovery Board 2010; ODFW 2010; NW Fisheries Science Center 2015; NMFS 2013a). All four strata in the DPS fall short of the WLC-TRT criteria for viability (NMFS 2013a).

Baseline persistence probabilities were estimated to be “low” or “very low” for three out of the six summer steelhead populations that are part of the LCR DPS, moderate for two, and high for one, the Wind, which is considered viable. Thirteen of the 17 LCR winter steelhead populations have “low” or “very low” baseline probabilities of persistence, and the remaining four are at “moderate” probability of persistence (Table 9, above) (Lower Columbia Fish Recovery Board 2010; ODFW 2010; NMFS 2013a).

Abundance and Productivity. The “low” to “very low” baseline persistence probabilities of most Lower Columbia River steelhead populations reflects low abundance and productivity (NMFS 2013a, NWFSC 2015). All of the populations increased in abundance during the early 2000s, generally peaking in 2004. Most populations have since declined back to levels within one standard deviation of the long term mean. Exceptions are the Washougal summer-run and North Fork Toutle winter-run, which are still higher than the long term average, and the Sandy, which is lower. In general, the populations do not show any sustained dramatic changes in abundance or fraction of hatchery origin spawners since the 2010 status review (NW Fisheries Science Center 2015). Although current LCR steelhead populations are depressed compared to historical levels and long-term trends show declines, many populations are substantially healthier than their salmon counterparts, typically because of better habitat conditions in core steelhead production areas (Lower Columbia Fish Recovery Board 2010; NMFS 2013a; NWFSC 2015).

Limiting Factors include (NOAA Fisheries 2011; NMFS 2013a):

- 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

### ***Status of UWR Steelhead***

This species includes all naturally spawned anadromous winter-run *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Willamette River and its tributaries upstream of Willamette Falls to and including the Calapooia River (NMFS 2016).

**Spatial Structure and Diversity.** This DPS includes all naturally-spawned anadromous winter-run steelhead populations below natural and manmade impassable barriers in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to and including the Calapooia River (USDC 2014). Four DIPs of UWR steelhead occur within the DPS (Table 10). Historical observations, hatchery records, and genetics suggest that the presence of UWR steelhead in many tributaries on the west side of the upper basin is the result of recent introductions. Nevertheless, the WLC-TRT recognized that although west side UWR steelhead does not represent a historical population, those tributaries may provide juvenile rearing habitat or may be temporarily (for one or more generations) colonized during periods of high abundance (McClure *et al.* 2005). Hatchery summer-run steelhead that are released in the subbasins are from an out-of-basin stock, and are not part of the DPS, nor are stocked summer steelhead that have become established in the McKenzie River (ODFW and NMFS 2011).

**Table 10.** Scores for the key elements (A&P, diversity, and spatial structure) used to determine current overall viability risk for UWR steelhead (ODFW and NMFS 2011). All populations are in the Western Cascade Range ecological subregion. Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

<b>Population (Watershed)</b>	<b>A&amp;P</b>	<b>Diversity</b>	<b>Spatial Structure</b>	<b>Overall Extinction Risk</b>
Molalla River	VL	M	M	L
North Santiam River	VL	M	H	L
South Santiam River	VL	M	M	L
Calapooia River	M	M	VH	M

**Abundance and Productivity.** 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 steelhead in the basin reduced 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 (NWFSC 2015).

**Limiting Factors** include (NOAA Fisheries 2011; ODFW and NMFS 2011; NWFSC 2015):

- 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

### *Status of Eulachon*

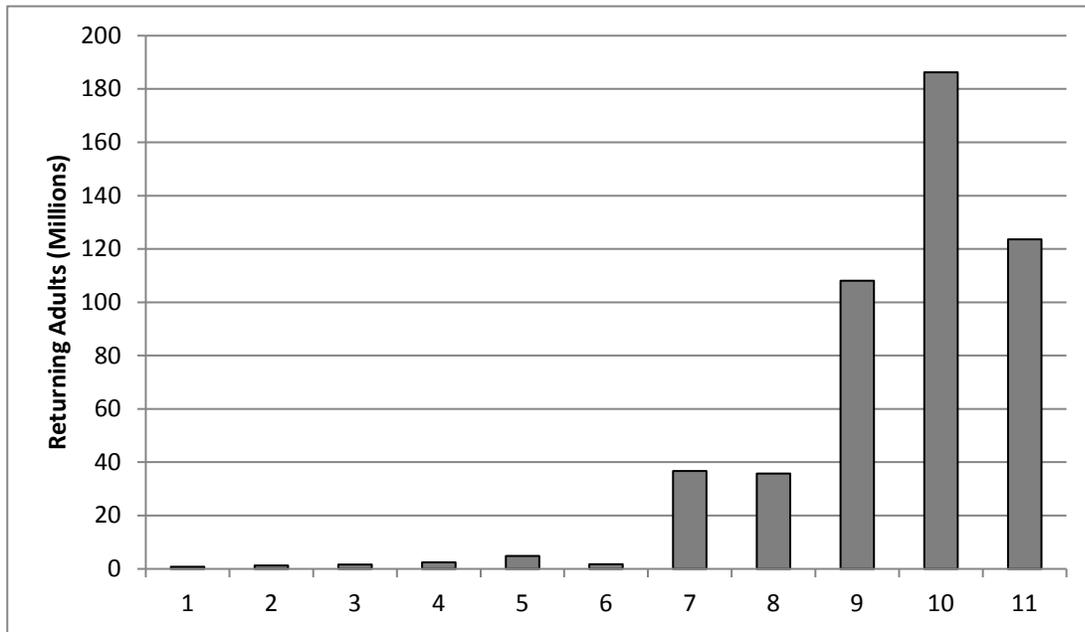
On October 20, 2016, NMFS completed a draft Federal recovery plan, which is to serve as guidance for recovery efforts (NMFS 2016). The major threats to eulachon are impacts of climate change on oceanic and freshwater habitats (species-wide), fishery by-catch (species-wide), dams and water diversions (Klamath and Columbia subpopulations) and elevated predation (Fraser River and British Columbia sub-populations) (NMFS 2016). Preliminary key recovery actions in the recovery outline include maintaining conservative harvest, reducing by-catch, restoring more natural flows and water quality in the Columbia River, maintaining dredging BMPs, removing Klamath River dams, and completing research on life history and genetics, climate effects, and habitat effects (NMFS 2016b).

Spatial Structure and Diversity. Listed eulachon occur in three salmon recovery domains in Oregon: the Willamette and Lower Columbia, Oregon Coast, and Southern Oregon/Northern California Coast. The listed population of eulachon includes all naturally-spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. Core populations for this species include the Fraser River, Columbia River and (historically) the Klamath River. Eulachon leave saltwater to spawn in their natal streams late winter through early summer, and typically spawn at night in the lower reaches of larger rivers fed by snowmelt. After hatching, larvae are carried downstream and widely dispersed by estuarine and ocean currents. Eulachon movements in the ocean are poorly known, although the amount of eulachon by-catch in the pink shrimp fishery seems to indicate that the distribution of these organisms overlap in the ocean (NMFS 2016b).

Abundance and Productivity. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River (Drake *et al.* 2008). Persistent low returns and landings of eulachon in the Columbia River from 1993 to 2000 prompted the states of Oregon and Washington to adopt a Joint State Eulachon Management Plan in 2001 that provides for restricted harvest management when parental run strength, juvenile production, and ocean productivity forecast a poor return (WDFW and ODFW 2001). Despite a brief period of improved returns in 2001 to 2003, the returns and associated commercial landings eventually declined to the low levels observed in the mid-1990s (Joint Columbia River Management Staff 2009). Starting in 2005, the fishery has operated at the most conservative level allowed in the management plan (Joint Columbia River Management Staff 2009). Large commercial and recreational fisheries have occurred in the Sandy River in the past. The most recent commercial harvest in the Sandy River was in 2003. No commercial harvest has been recorded for the Grays River from 1990 to the present, but larval sampling has confirmed successful spawning in recent years (USDC 2011). Starting in 2011, returns in the Columbia River have rebounded by up to two orders of magnitude (Figure 8). We have not identified an abundance or productivity target for eulachon recovery, as sufficient data does not exist to parameterize a population viability analysis.<sup>7</sup>

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<sup>7</sup> September 1, 2015 email from Robert Anderson, Eulachon Recovery Coordinator, NMFS, to Jeffrey Lockwood, Fishery Biologist, NMFS, regarding a eulachon recovery question from EPA.



**Figure 8.** Annual Columbia River eulachon run size from 2000 to 2015 (mean of bootstrap estimates; pounds converted to numbers of fish at 11.16 fish per pound; [WDFW 2015]). The estimates were calculated based on methods developed by Parker (1985), Jackson and Cheng (2001), and Hay *et al.* (2002) to estimate spawning biomass of pelagic fishes. For 2000 through 2010, estimates were back-calculated using historical larval density data.

Threats. We have not identified limiting factors for this species. However, our status review for this species (NMFS 2016b) listed threats to this species (Table 11).

**Table 11.** Threats to eulachon populations with the most severe threat ranked number 1. Statutory listing factors (ESA section 4(a)(1)(A)–(C), and (E)) include (A): the present or threatened destruction, modification, or curtailment of its habitat or range; (B): overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; and (E) other natural or man-made factors affecting its continued existence. Source: Gustafson *et al.* (2010), p. 160-170.

Threat	Klamath River	Columbia River	Fraser River	British Columbia	Listing Factor
	Ranking				
Climate change impacts on ocean conditions	1	1	1	1	A
Dams/water diversions	2	4	8	11	A
Eulachon by-catch	3	2	2	2	E
Climate change impacts on freshwater habitats	4	3	4	4	A
Predation	5	7	3	3	C
Water quality	6	5	5	8	A
Catastrophic events	7	8	10	5	A
Disease	8	11	11	7	C
Competition	9	12	12	9	E
Shoreline construction	10	10	9	6	A
Tribal/First Nation fisheries	11	14	13	10	B
Nonindigenous species	12	15	15	13	E
Recreational harvest	13	13	14	14	B
Scientific monitoring	-	16	16	15	B
Commercial harvest	-	9	6	-	A
Dredging	-	6	7	12	A

(-) = no ranking due to insufficient data.

The likely effects of climate change on eulachon were summarized by Gustafson et al. (2010). Many populations of eulachon spawn in rivers fed by snowmelt or glacial runoff well before the peak of water inputs so that their eggs will have time to incubate before hatching during the peak spring discharge of the rivers. If peak runoff and river flows occur earlier due to warmer air temperatures, eulachon may spawn earlier or be flushed out to the ocean at an earlier date. Earlier emigration of eulachon from spawning areas, together with an anticipated delay in the onset of coastal upwelling, may result in a mismatch between entry of larval eulachon into the ocean and the peak of coastal upwelling, which could reduce marine survival of the larvae. Gustafson et al. (2010) also summarized anecdotal and quantitative data suggesting that, perhaps due to warming conditions or altered stream flow timing, adult eulachon are returning earlier in the season to several rivers within the southern DPS.

**Interior Columbia Recovery Domain.** Species in the Interior Columbia (IC) recovery domain include UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, UCR steelhead, MCR steelhead, and SRB steelhead. The IC-TRT identified 82 populations of those species based on genetic, geographic (hydrographic), and habitat characteristics (Table 12). In some cases, the IC-TRT further aggregated populations into “major groupings” based on dispersal distance and rate, and

drainage structure, primarily the location and distribution of large tributaries (IC-TRT 2003). All 82 populations identified use the lower mainstem of the Snake River, the mainstem of the Columbia River, and the Columbia River estuary, or part thereof, for migration, rearing, and smoltification.

**Table 12.** Populations of ESA-listed salmon and steelhead in the IC recovery domain.

Species	Populations
UCR spring-run Chinook salmon	3
SR spring/summer-run Chinook salmon	31
SR fall-run Chinook salmon	1
SR sockeye salmon	1
MCR steelhead	17
UCR steelhead	4
SRB steelhead	24

The IC-TRT also recommended viability criteria that follow the VSP framework (McElhany *et al.* 2006) and described biological or physical performance conditions that, when met, indicate a population or species has a 5 percent or less risk of extinction over a 100-year period (NRC 1995; IC-TRT 2007).

#### ***Status of UCR Spring-run Chinook Salmon***

A recovery plan is available for this species (UCSRB 2007). Achieving recovery (i.e., delisting the species) of each ESU via sufficient improvement in the abundance, productivity, spatial structure, and diversity is the longer-term goal of the Upper Columbia Salmon Recovery Board (UCSRB) Plan. The plan calls for meeting or exceeding the same basic spatial structure and diversity criteria adopted from the ICTRT viability report for recovery (NWFSC 2015). None of the three populations are viable with respect to abundance and productivity, and they all have a greater than 25 % chance of extinction in 100 years (UCSRB 2007).

Spatial Structure and Diversity. This ESU includes naturally spawned spring-run Chinook salmon originating from Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam (excluding the Okanogan River subbasin). This ESU does include Chinook salmon from six artificial propagation programs. This species includes all naturally-spawned populations of Chinook salmon in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam (excluding the Okanogan River), the Columbia River upstream to Chief Joseph Dam, and progeny of six artificial propagation programs. The IC-TRT identified four independent populations of UCR spring-run Chinook salmon in the upriver tributaries of Wenatchee, Entiat, Methow, and Okanogan (extirpated), but no major groups due to the relatively small geographic area affected (IC-TRT 2003; NW Fisheries Science Center 2015) (Table 13).

The composite SS/D risks for all three of the extant populations in this MPG are at “high” risk. The spatial processes component of the SS/D risk is “low” for the Wenatchee River and Methow

River populations and “moderate” for the Entiat River (loss of production in lower section increases effective distance to other populations). All three of the extant populations in this MPG are at “high” risk for diversity, driven primarily by chronically high proportions of hatchery-origin spawners in natural spawning areas and lack of genetic diversity among the natural-origin spawners (NW Fisheries Science Center 2015, NMFS 2016).

Increases in natural origin abundance relative to the extremely low spawning levels observed in the mid-1990s are encouraging; however, average productivity levels remain extremely low. Overall, the viability of the Upper Columbia Spring Chinook salmon ESU has likely improved somewhat since the 2005 status review, but the ESU is still clearly at “moderate-to-high” risk of extinction (NWFSC 2015).

**Table 13** Scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for spring-run UCR Chinook salmon (NW Fisheries Science Center 2015). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH) and extirpated (E).

Population	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Wenatchee River	H	H	H	H
Entiat River	H	H	H	H
Methow River	H	H	H	H
Okanogan River				E

Abundance and Productivity. UCR spring-run Chinook salmon is not currently meeting the viability criteria (adapted from the IC-TRT) in the Upper Columbia Recovery Plan. A&P remains at “high” risk for each of the three extant populations in this MPG/ESU (Table 13). The 10-year geometric mean abundance of adult natural origin spawners has increased for each population relative to the levels for the 1981-2003 series, but the estimates remain below the corresponding IC-TRT thresholds. 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 percent 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 (NWFSC 2015).

Limiting Factors include (Upper Columbia Salmon Recovery Board 2007; NOAA Fisheries 2011; NWFSC 2015):

- 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

***Status of SR Spring/summer-run Chinook Salmon***

Spatial Structure and Diversity. This ESU includes all naturally-spawned spring/summer-run Chinook salmon originating from the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins; and progeny of eleven artificial propagation programs. The IC-TRT currently believes there are 28 extant and four extirpated populations of SR spring/summer-run Chinook salmon, and aggregated these into major population groups (IC-TRT 2007; NW Fisheries Science Center 2015). All except one extant population (Chamberlin Creek) are at high risk of extinction (NWFSC 2015) (Table 14).

**Table 14.** SR spring/summer-run Chinook salmon ecological subregions, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for SR spring/summer-run Chinook salmon. Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E).

Ecological Subregions	Spawning Populations (Watershed)	A&P	Diversity	Integrated SS/D*	Overall Viability Risk
Lower Snake River	Tucannon River	H	M	M	H
	Asotin River	----	----	----	E
Grande Ronde and Imnaha rivers	Wenaha River	H	M	M	H
	Lostine/Wallowa River	H	M	M	H
	Minam River	H	M	M	H
	Catherine Creek	H	M	M	H
	Upper Grande Ronde R.	H	M	H	H
	Imnaha River	H	M	M	H
	Big Sheep Creek	----	----	----	E
	Lookingglass Creek	----	----	----	E
South Fork Salmon River	Little Salmon River	*	*	*	H
	South Fork mainstem	H	M	M	H
	Secesh River	H	L	L	H
	EF/Johnson Creek	H	L	L	H
Middle Fork Salmon River	Chamberlin Creek	H	L	L	H
	Big Creek	H	M	M	H
	Lower MF Salmon	H	M	M	H
	Camas Creek	H	M	M	H
	Loon Creek	H	M	M	H
	Upper MF Salmon	H	M	M	H
	Sulphur Creek	H	M	M	H
	Bear Valley Creek	H	L	L	H
	Marsh Creek	H	L	L	H
Upper Mainstem Salmon	N. Fork Salmon River	H	L	L	H
	Lemhi River	H	H	H	H
	Pahsimeroi River	H	H	H	H
	Upper Salmon-lower mainstem	H	L	L	H
	East Fork Salmon River	H	H	H	H
	Yankee Fork	H	H	H	H
	Valley Creek	H	M	M	H
	Upper Salmon main	H	M	M	H
	Panther Creek	----	----	----	E

\* Insufficient data.

Abundance and Productivity. Population level status ratings remain at “high” risk across all MPGs within the ESU. 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 (NWFSC 2015).

The ability of SR spring/summer-run Chinook salmon populations to be self-sustaining through normal periods of relatively low ocean survival remains uncertain. Factors cited by Good *et al.* (2005) remain as concerns or key uncertainties for several populations.

Limiting Factors include (NOAA Fisheries 2011):

- Effects related to the hydropower system in the mainstem Columbia River,
- Altered flows and degraded water quality
- Harvest-related effects
- Elevated predation

### ***Status of SR Fall-run Chinook Salmon***

Spatial Structure and Diversity. This ESU includes all naturally-spawned fall-run Chinook salmon originating from the mainstem Snake River below Hells Canyon Dam, and in the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River, and progeny of four artificial propagation programs. The IC-TRT identified three populations of this species, although only the lower mainstem population exists at present, and it spawns in the lower main stem of the Clearwater, Imnaha, Grande Ronde, Salmon and Tucannon rivers. The extant population of Snake River fall-run Chinook salmon is the only remaining population from an historical ESU that also included large mainstem populations upstream of the current location of the Hells Canyon Dam complex (IC-TRT 2003; NWFSC 2015, NMFS 2016). The population is at moderate risk for diversity and spatial structure.

Abundance and Productivity. 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 (NWFSC 2015).

Limiting Factors include (NOAA Fisheries 2011; NWFSC 2015, NMFS 2016):

- 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.

### ***Status of SR Sockeye Salmon***

Best available information indicates that the species, in this case the Snake River Sockeye Salmon ESU, is at high risk and remains at endangered status. We released a final recovery plan for this species on June 8, 2015 (NMFS 2015). Overall, the recovery strategy aims to reintroduce and support adaptation of naturally self-sustaining sockeye salmon populations in the Sawtooth Valley lakes.

Spatial Structure and Diversity. This ESU includes all naturally spawned anadromous and residual sockeye salmon originating from the Snake River basin, Idaho, and artificially-propagated sockeye salmon from the Redfish Lake captive propagation program. The IC-TRT identified historical sockeye salmon production in at least five Stanley Basin and Sawtooth Valley lakes and in lake systems associated with Snake River tributaries currently cut off to anadromous access (*e.g.*, Wallowa and Payette Lakes), although current returns of SR sockeye salmon are extremely low and limited to Redfish Lake (IC-TRT 2007).

Abundance and Productivity. This single population ESU is at very high risk due 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. Although the captive brood program has been successful in providing substantial numbers of hatchery produced *O. nerka* for use in supplementation efforts, substantial increases in survival rates across life history stages must occur to re-establish sustainable natural production (Hebdon *et al.* 2004; Keefer *et al.* 2008, NWFSC 2015).

Limiting Factors include (NOAA Fisheries 2011; NWFSC 2015):

- Effects related to the hydropower system in the mainstem Columbia River
- Reduced water quality and elevated temperatures in the Salmon River
- Water quantity
- Elevated predation

### ***Status of MCR Steelhead***

Spatial Structure and Diversity. This DPS includes all naturally-spawned anadromous steelhead originating below natural and artificial impassable barriers in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington, excluding steelhead from the Snake River basin; and progeny of seven artificial propagation programs. The IC-TRT identified 17 extant populations in this DPS (IC-TRT 2003). The populations fall into four major population groups: the Yakima River Basin (four extant populations), the Umatilla/Walla-Walla drainages (three extant and one extirpated populations); the John Day River drainage (five extant populations) and the Eastern Cascades group (five extant and two extirpated populations) (Table 15) (NMFS 2009a; NWFSC 2015).

**Table 15.** Ecological subregions, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for MCR steelhead (NMFS 2009a; NW Fisheries Science Center 2015). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the DPS.

Ecological Subregions	Population (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Cascade Eastern Slope Tributaries	Fifteenmile Creek	L	L	L	Viable
	Klickitat River	M	M	M	MT
	Eastside Deschutes River	L	M	M	Viable
	Westside Deschutes River	H	M	M	H*
	Rock Creek	H	M	M	H?
	White Salmon				E*
	Crooked River				E*
John Day River	Upper Mainstem	M	M	M	MT
	North Fork	VL	L	L	Highly Viable
	Middle Fork	M	M	M	MT
	South Fork	M	M	M	MT
	Lower Mainstem	M	M	M	MT
Walla Walla and Umatilla rivers	Umatilla River	M	M	M	MT
	Touchet River	M	M	M	H
	Walla Walla River	M	M	M	MT
Yakima River	Satus Creek	M	M	M	Viable (MT)
	Toppenish Creek	M	M	M	Viable (MT)
	Naches River	H	M	M	H
	Upper Yakima	H	H	H	H

\* Re-introduction efforts underway (NMFS 2009a).

Straying frequencies into at least the Lower John Day River population are high. Out-of-basin hatchery stray proportions, although reduced, remain very high in the Deschutes River basin.

Abundance and Productivity. The following is a summary from the status review update. More detailed information on the status and trends of these listed resources, and their biology and ecology are in the status update (NWFSC 2015).

There have been improvements in the viability ratings for some of the component populations, but the Mid-Columbia River Steelhead DPS is not currently meeting the viability criteria described in the Mid-Columbia Steelhead Recovery Plan. Natural origin returns to the majority of populations in two of the four MPGs in this DPS increased modestly relative to the levels reported in the previous five year review. Abundance estimates for 2 of 3 populations with sufficient data in the remaining two MPGs (Eastside Cascades and Umatilla/Walla-Walla) were

marginally lower. Natural-origin spawning estimates are highly variable relative to minimum abundance thresholds across the populations in the DPS. Three of the four MPGs in this DPS include at least one population rated at low risk for abundance and productivity (Table 37 in NWFSC 2015). The survival gaps for the remaining populations are generally smaller than those for the other Interior Columbia Basin listed DPSs (Figure 52 in NWFSC 2015). Updated information indicates that stray levels into the John Day River populations have decreased in recent years. Out of basin hatchery stray proportions, although reduced, remain high in spawning reaches within the Deschutes River basin populations. In general, the majority of population level viability ratings remained unchanged from prior reviews for each MPG within the DPS.

Limiting Factors include (NMFS 2009a; NOAA Fisheries 2011):

- 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

### *Status of UCR Steelhead*

Spatial Structure and Diversity. This DPS includes all naturally-spawned anadromous steelhead originating below natural and manmade impassable barriers in streams in the Columbia River Basin upstream from the Yakima River, Washington, to the U.S.-Canada border, and progeny of six artificial propagation programs. Four independent populations of UCR steelhead were identified by the IC-TRT in the same upriver tributaries as for UC spring-run Chinook salmon (i.e., Wenatchee, Entiat, Methow, and Okanogan) and, similarly, no major population groupings were identified due to the relatively small geographic area involved (IC-TRT 2003; NWFSC 2015). Three populations are at high risk of extinction while 1 population is at moderate risk (NWFSC 2015).

Abundance and Productivity. Upper Columbia steelhead populations have increased in natural origin abundance in recent years, but productivity levels remain low. The modest improvements in natural returns in recent years are probably primarily the result of several years of relatively good natural survival in the ocean and tributary habitats (NWFSC 2015). The status of the Wenatchee River steelhead population continued to improve based on the additional years information available for the most recent review. The abundance and productivity viability rating for the Wenatchee River exceeds the minimum threshold for 5 percent 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.

Limiting Factors include (Upper Columbia Salmon Recovery Board 2007; NOAA Fisheries 2011; NWFSC 2015):

- 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
- Elevated predation and competition
- Harvest-related effects

***Status of SRB Steelhead***

Spatial Structure and Diversity. This DPS includes all naturally-spawned anadromous steelhead originating below natural and manmade impassable barriers in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho, and progeny of six artificial propagation programs. The IC-TRT identified 24 populations in five major groups (IC-TRT 2010; NW Fisheries Science Center 2015). 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 (NMFS 2016).

**Table 16.** Ecological subregions, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for SRB steelhead (NW Fisheries Science Center 2015; NMFS 2011b). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the DPS.

Ecological subregions	Spawning Populations (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk*
Lower Snake River	Tucannon River	**	M	M	H
	Asotin Creek	**	M	M	MT
Grande Ronde River	Lower Grande Ronde	**	M	M	Not rated
	Joseph Creek	VL	L	L	Highly viable
	Upper Grande Ronde	M	M	M	MT
	Wallowa River	**	L	L	H
Clearwater River	Lower Clearwater	M	L	L	MT
	South Fork Clearwater	H	M	M	H
	Lolo Creek	H	M	M	H
	Selway River	H	L	L	H
	Lochsa River	H	L	L	H
Salmon River	Little Salmon River	**	M	M	MT
	South Fork Salmon	**	L	L	H
	Secesh River	**	L	L	H
	Chamberlain Creek	**	L	L	H
	Lower MF Salmon	**	L	L	H
	Upper MF Salmon	**	L	L	H
	Panther Creek	**	M	H	H
	North Fork Salmon	**	M	M	MT
	Lemhi River	**	M	M	MT
	Pahsimeroi River	**	M	M	MT
	East Fork Salmon	**	M	M	MT
Upper Main Salmon	**	M	M	MT	
Imnaha	Imnaha River	M	M	M	MT

\* There is uncertainty in these ratings due to a lack of population-specific data.

\*\* Insufficient data.

Abundance and Productivity. The level of natural production in the two populations with full data series and the Asotin Creek index reaches is encouraging, but the status of most populations in this DPS remains highly 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 (NWFSC 2015).

Limiting Factors include (IC-TRT 2010; NMFS 2011b; NWFSC 2015):

- 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
- Elevated predation

### ***Marine Mammals***

Recovery plans are in place for all of the species considered in this Opinion and they can be found at: <http://www.nmfs.noaa.gov/pr/recovery/plans.htm#mammals>.

NMFS recognizes geographic stocks of whales under the Marine Mammal Protection Act (MMPA) (section 117, 16 U.S.C. § 1386),<sup>8</sup> and requires the monitoring and management of marine mammals on a stock-by-stock basis, rather than entire species, populations, or DPSs. Although the stock identification is not recognized as part of the ESA-listing, it does provide a meaningful framework for analyzing the impacts of the proposed action on whale populations as a whole.

***Status of Blue Whales.*** The blue whale, *Balaenoptera musculus*, was listed as endangered worldwide under the precursor to the ESA, the Endangered Species Conservation Act of 1969, and remained on the list of threatened and endangered species after the passage of the ESA in 1973 (35 Fed. Reg. 8491) (June 2, 1970)) (codified at 50 C.F.R. §§ 17). The entire species remains endangered under the ESA. There is no designated critical habitat for blue whales. NMFS recognizes four different stocks of Blue Whales under the MMPA. See 16 USC §

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<sup>8</sup> Section 117. Stock Assessments 16 U.S.C. 1386: Each draft stock assessment, based on the best scientific information available shall (1) Describe the geographic range of the affected stock, including any seasonal or temporal variation in such range; (2) provide for such stock the minimum population estimate, current and maximum net productivity rates, and current population trend, including a description of the information upon which these are based; (3) estimate the annual human-caused mortality and serious injury of the stock by source and, for a strategic stock, other factors that may be causing a decline or impeding recovery of the stock, including effects on marine mammal habitat and prey; (4) describe commercial fisheries that interact with the stock, including the approximate number of tanker actively participating in each such fishery, the estimated level of incidental mortality and serious injury of the stock by each such fishery on an annual basis, seasonal or area differences in such incidental mortality or serious injury; and the rate, based on the appropriate standard unit of fishing effort, of such incidental mortality and serious injury, and an analysis stating whether such level is insignificant and is approaching a zero mortality and serious injury rate; (5) categorize the status of the stock as one that either has a level of human-caused mortality and serious injury that is not likely to cause the stock to be reduced below its optimum sustainable population, or is a strategic stock, with a description of the reasons therefor; and (6) estimate the potential biological removal level for the stock, describing the information used to calculate it, including the recovery factor.

1386. The blue whales most likely to be observed within the action area are identified as the Eastern North Pacific stock.

Spatial Structure and Diversity. Blue whales may be found in all oceans of the world. They mate and calve in tropical-to-temperate waters during winter months and feed in polar waters during summer months. In the northern hemisphere, blue whales move north to Arctic waters to feed, while in the southern hemisphere, blue whales move south to the Antarctic to feed. Blue whales migrate long distances between equatorial wintering grounds and high latitude feeding areas. In the eastern North Pacific, they feed in California waters in summer/fall (from June to November) and migrate south to areas off Mexico and as far south as the Costa Rica Dome (10°N) in winter and spring. During the summer, they may be found across the Gulf of Alaska, but they seldom enter the eastern Bering Sea. Historical areas of concentration include the eastern Gulf of Alaska, the eastern Aleutians, and the far western Aleutians. Blue whales spend most of their time along the edges of continental shelves and are seldom seen in coastal waters. Although visual detections of blue whales are rare off Washington and Oregon, there have been a few acoustic detections of blue whales (McDonald *et al.* 1994, Stafford *et al.* 1998, VonSaunders and Barlow 1999). Satellite tracking data shows that blue whales are concentrated in regions of high summer productivity along the upper continental slope from central to southern California. The two areas of highest use were near the Gulf of the Farallones and the western part of the Channel Islands. Blue whales that were tagged off California traveled to the Gulf of Alaska and to the southern tip of Baja, Mexico (Irvine *et al.* 2014).

Abundance and Productivity. The size of the Eastern North Pacific stock of blue whales off the U.S. West Coast has been estimated using a combination of line-transect and mark-recapture methods. The mark-recapture estimates are likely to be negatively biased by individual heterogeneity in sighting probabilities (Hammond 1986); however, Calambokidis *et al.* 2009, 2010 minimized such effects by selecting one sample that was taken randomly with respect to distance from the coast. The line-transect estimates from summer/autumn between 2001 and 2008 in the California Current ranged between 400 and 800 animals (Barlow and Forney 2007, Barlow 2010) and may also be negatively biased, as some of the blue whales in this stock were likely to be off of Baja California, and as a result, out of the study area at the time of the survey (Wade and Gerrodette 1993; Barlow and Forney 2007, Calambokidis *et al.* 2009). Therefore, the line-transect method only reflects the average estimated density of blue whales in the study area (California Current) at a specific season, whereas the mark-recapture methods provide an estimated total population size (Carretta *et al.* 2014, 2017). The best estimate of blue whale abundance in the North Pacific is from recent photographic mark-recapture estimates for the period 2008 to 2011, or 1,647 whales (Calambokidis and Barlow 2013). The minimum population estimates of Eastern North Pacific blue whales is 1,551 with a calculated potential biological removal (PBR, which is defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population) allocation for U.S. waters of 2.3 whales per year (Carretta *et al.* 2017)

Based on these mark-recapture estimates, which likely provide the best indication of population growth, there is no evidence of growth in the blue whale population since the early 1990s (Carretta *et al.* 2017).

**Threats.** Blue whales experienced intensive whaling throughout the 20th century. Vessel interactions and fishery interactions, in addition to reduced prey abundance due to overfishing or other factors (including climate change), habitat degradation, and disturbance from low-frequency noise, constitute the most obvious threats to blue whales identified in the blue whale recovery plan (NMFS 1998). Because little evidence of entanglement in fishing gear exists, and large whales such as the blue whale may often die later and drift far enough not to strand on land after such incidents, it is difficult to estimate the numbers of blue whales possibly killed and injured by fishing gear. Ship strikes are also a threat to all large whales, including blue whales, although reports of ship struck whales are likely a minimum. The threat to blue whales due to underwater noise, pollutants, marine debris, and habitat degradation, are difficult to quantify. However, there is a growing concern that the increasing levels of anthropogenic noise in the ocean may be a habitat concern for whales, particularly for whales that use low frequency sound to communicate, such as baleen whales.

For the ENP stock, the observed annual incidental mortality and injury rate (0.9/year) from ship strikes is less than the calculated PBR (2.3) for this stock, but this rate does not include unidentified large whales struck by vessels, some of which may have been blue whales, nor does it include undetected and unreported ship strikes of blue whales (Carretta et al. 2017). The number of blue whales struck by ships in the California Current likely exceeds the PBR for this stock (Redfern et al. 2013). To date, no blue whale mortality has been associated with U.S. west coast fisheries; therefore, total fishery mortality is approaching a zero mortality and serious injury rate (a standard under the Marine Mammal Protection Act; Carretta et al. 2017). However, in 2015 and 2016, NMFS received the first confirmed reports of entangled blue whales along the U.S. west coast, although the ultimate fate of these animals is unknown, and these events have not yet been evaluated for potential mortality and serious injury (NMFS WCR stranding data).

**Status of Fin Whales.** Fin whales, like most large baleen whales, are currently listed as endangered under the ESA. Fin whales were listed as endangered worldwide under the precursor to the ESA, the Endangered Species Conservation Act of 1969, and remained on the list of threatened and endangered species after the passage of the ESA in 1973 (35 Fed. Reg. 8491) (June 2, 1970) (codified at 50 C.F.R. § 17.11(h)). There is no designated critical habitat for fin whales. The fin whales most likely to be observed within the proposed action area are identified as the CA/OR/WA stock.

**Spatial Structure and Diversity.** Fin whales are widely distributed throughout the world's oceans. The fin whale is a cosmopolitan species with a generally anti-tropical distribution centered in the temperate zones. Fin whales are known to associate with steep contours, perhaps due to abundance of prey. Fin whales feed on planktonic crustaceans, including *Thysanoessa* sp. euphausiids and *Calanus* sp. copepods, and schooling fish, including herring, capelin and mackerel (NMFS 2010a). Fin whale populations exhibit differing degrees of mobility, presumably depending on the stability of access to sufficient prey resources throughout the year. Most groups are thought to migrate seasonally, in some cases over distances of thousands of kilometers. They feed intensively at high latitudes in summer and fall, or at least greatly reduce their food intake, at lower latitudes in winter. Some groups apparently move over shorter distances and can be considered resident to areas with a year-round supply of adequate prey. Year-round residence has been observed in the Gulf of California, although higher abundances

are observed in the winter and spring. Fin whales have also been observed in the waters around Hawaii. In the Atlantic Ocean, fin whales have an extensive distribution from the Gulf of Mexico and Mediterranean Sea northward to the arctic. In general, the fin whale feeds on krill and various amounts of schooling fish, notably herring, capelin, walleye pollock, and sandlance (Reeves *et al.* 2002). In the Pacific Ocean, fin whales are found year-round off southern and central California, Oregon, and Washington, and in the summer and fall months in the Shelikof Strait and Gulf of Alaska. In the Pacific, fin whales prey mainly on euphausiids, copepods, herring, capelin, and walleye pollock.

Abundance and Productivity. Although reliable and recent estimates of fin whale abundance are available for large portions of the North Atlantic Ocean, this is not the case for most of the North Pacific Ocean and Southern Hemisphere. Status of populations in both of these ocean basins, stated in terms of present population size relative to “initial” (pre-whaling, or carrying capacity) level, is uncertain. Fin whales in the entire North Pacific are estimated to be less than 38 percent of historic carrying capacity of the region (Mizroch *et al.* 1984). The best estimate of fin whale abundance in California, Oregon, and Washington waters out to 300 nautical miles is 9,029 whales, generated from a trend-model analysis of line-transect data from 1991 through 2014 (Nadeem *et al.* 2016). The new trend estimates are based on similar to methods to those first applied to this population by Moore and Barlow (2011). However, the new abundance estimates are substantially higher than earlier estimates because the new analysis incorporates lower estimates of detection probability (Barlow 2015). The trend-model analysis incorporates information from the entire 1991-2014 time series for each annual estimate of abundance, and given the strong evidence of an increasing abundance trend over that time (Moore and Barlow 2011; Nadeem *et al.* 2016), the best estimate of abundance is represented by the estimate for the most recent year, or 2014. This is probably an underestimate because it excludes some fin whales which that could not be identified in the field and which were recorded as “unidentified rorqual” or “unidentified large whale”.18).

Threats. A comprehensive list of general threats to fin whales is detailed in the Recovery Plan (NMFS 2010a). The main direct threat to fin whale populations is the possibility that illegal whaling or resumed legal whaling will cause removals at biologically unsustainable rates. Additionally, reduced prey abundance due to overfishing or other factors (including climate change), habitat degradation, and disturbance from low-frequency noise, constitute the most obvious threats to fin whales besides vessel interactions and fishery entanglements. Because little evidence of entanglement in fishing gear exists, and large whales such as the fin whale may often die later and drift far enough not to strand on land after such incidents, it is difficult to estimate the numbers of fin whales killed and injured by gear entanglements. Documented ship strike deaths and serious injuries are derived from actual counts of fin whale carcasses and should be considered minimum values. The threats to fin whales due to underwater noise, pollutants, marine debris, and habitat degradation, are difficult to quantify. However, there is a growing concern that the increasing levels of anthropogenic noise in the ocean may be a habitat concern for fin whales that use low frequency sound to communicate.

For the CA/OR/WA stock of fin whales, the total quantified documented incidental mortality and serious injury (2.0/yr) due to fisheries (0.2/yr) and ship strikes (1.8/yr) is less than the calculated PBR of 81 (Carretta *et al.* 2017). Total fishery mortality is less than 10% of PBR and, therefore,

may be approaching zero mortality and serious injury rate (Carretta et al. 2017). However, in 2015 and 2016, there have been additional instances where fin whale whales were sighted at-sea with indications of injury resulting from interaction with unknown fishing gear and other debris (NMFS WCR stranding data).

***Status of Humpback Whales. , Mexico DPS and Central America DPS.*** Humpback whales were listed as endangered under the Endangered Species Conservation Act in June 1970 (35 FR 18319), and remained on the list of threatened and endangered species after the passage of the ESA in 1973 (35 FR 8491). A recovery plan for humpbacks was issued in November 1991 (NMFS 1991). On September 8, 2016, NMFS published a final rule to divide the globally listed endangered humpback whale into 14 DPSs and place four DPSs as endangered and one as threatened (81 FR 62259). NMFS has identified three DPSs of humpback whales that may be found off the coasts of Washington, Oregon and California. These are the Hawaiian DPS (found predominately off Washington and southern British Columbia), which is not listed under the ESA; the Mexico DPS (found all along the U.S. west coast), which is listed as threatened under the ESA; and the Central America DPS (found predominately off the coasts of Oregon and California), which is listed as endangered under the ESA.

Humpback whales are found in all oceans of the world and migrate from high latitude feeding grounds to low latitude calving areas. Humpbacks primarily occur near the edge of the continental slope and deep submarine canyons, where upwelling concentrates zooplankton near the surface for feeding. Humpback whales feed on euphausiids and various schooling fishes, including herring, capelin, sand lance, and mackerel (Clapham 2009).

Current MMPA stock assessment reports for humpback whales on the west coast of the United States do not reflect the new ESA listings, thus we will refer in part to the status of the populations that are found in the action area using the existing reports. The CA/OR/WA stock spends the winter primarily in coastal waters of Mexico and Central America, and the summer along the West Coast from California to British Columbia. As a result, both the endangered Central America DPS and the threatened Mexico DPS at times travel and feed off the U.S. west coast. The Central North Pacific stock primarily spends winters in Hawaii and summers in Alaska, and its distribution may partially overlap with that of the CA/OR/WA stock off the coast of Washington and British Columbia (Clapham 2009). There is some mixing between these populations, though they are still considered distinct stocks. In December, 2016, NMFS WCR released a memo outlining evaluation of the distribution and relative abundance of ESA-listed DPSs that occur in the waters off the United States West Coast (NMFS 2016c). In summary, the proportional approach breaks down as follows:

**Table 17.** Proportional estimates of each DPS that will be applied in waters off of California, Oregon, and Washington/SBC.

Feeding Areas	Central American DPS (E)	Mexico DPS (T)
California/Oregon	20%	90%
Washington/SBC)	15%	42%

Based on the December 2016 memo, this biological opinion evaluates impacts on both the Central American and Mexico DPSs of humpback whales as both are expected to occur in the action area in the relative proportions described above. To the extent that impacts are evaluated at an individual animal level, these proportions would be used as the likelihood that the affected animal is from either DPS.

Population Status and Trends. Current estimates of abundance for the Central America DPS range from approximately 400 to 600 individuals (Bettridge et al. 2015; Wade et al. 2016). The size of this population is relatively low compared to most other North Pacific breeding populations. The population trend for the Central America DPS is unknown (Bettridge et al. 2015). The Mexico DPS, which also occurs in the action area, is estimated to be 6,000 to 7,000 individuals based on the SPLASH project (Calambokidis et al. 2008) and the status review (Bettridge et al. 2015). The population growth of California/Oregon feeding population of the North Pacific humpback whales has been estimated as increasing about 8 percent annually (the population growth rate for the entire North Pacific population is approximately 4.9 percent) (Calambokidis et al. 2008). The estimate for the abundance of the CA/OR/WA stock, which combines members of several different humpback whale DPSs, is 1,918 animals (Carretta et al 2017).

Threats. A comprehensive list of general threats to humpback whales is detailed in the Recovery Plan (NMFS 1991). Similar to blue and fin whales, humpbacks globally are potentially affected by a resumption of commercial whaling, loss of habitat, loss of prey (for a variety of reasons including climate variability), underwater noise, and pollutants. Entanglement in fishing gear poses a threat to individual humpback whales throughout the Pacific. The estimated impact of fisheries on the CA/OR/WA humpback whale stock is likely underestimated, since the serious injury or mortality of large whales due to entanglement in gear may go unobserved because whales swim away with a portion of the net, line, buoys, or pots. Humpback whales, especially calves and juveniles, are highly vulnerable to ship strikes (Stevick 1999) and other interactions with non-fishing vessels. Off the U.S. west coast, humpback whale distribution overlaps significantly with the transit routes of large commercial vessels, including cruise ships, large tug and barge transport vessels, and oil tankers in the proposed action area. Whale watching boats and research activities directed toward whales and may have direct or indirect impacts on humpback whales as harassment may occur, preferred habitats may be abandoned, and fitness and survivability may be compromised if disturbance levels are too high.

Along the U.S. west coast, the estimated annual mortality and serious injury of the CA/OR/WA stock of humpback whales due to commercial fishery entanglements (5.3/yr), and non-fishery entanglements (0.2/yr), other anthropogenic sources (zero), plus ship strikes (1.0/yr), equals 6.5 animals, which is less than the PBR allocation of 11 for U.S. waters (Carretta et al. 2017). Most data on human-caused serious injury and mortality for this population is based on opportunistic stranding and at-sea sighting data and represents a minimum count of total impacts. There is currently no estimate of the fraction of anthropogenic injuries and deaths to humpback whales that are undocumented on the U.S. west coast. Based on strandings and at sea observations, annual humpback whale mortality and serious injury in commercial fisheries (5.3/yr) is greater than 10% of the PBR; therefore, total fishery mortality and serious injury is not approaching zero mortality and serious injury rate (Carretta et al. 2017). In 2015 (34 entanglements) and 2016 (54

entanglements), humpback whales were observed and reported entangled at record levels that will receive additional evaluation in upcoming stock assessment reports (NMFS WCR stranding data).

***Status of Sperm Whales.*** Sperm whales, as a species, were listed as endangered worldwide under the precursor to the ESA, the Endangered Species Conservation Act of 1969, and remained on the list of threatened and endangered species after the passage of the ESA in 1973 (35 FR 8491; June 2, 1970). The entire species of sperm whales are currently listed as endangered under the ESA. There is no designated critical habitat for sperm whales. We issued the final recovery plan for sperm whales in December 2010 (NMFS 2010). The sperm whales most likely to be observed within the action area are identified as the CA/OR/WA stock.

**Spatial Structure and Diversity.** As described by Carretta et al. (2017, and citations therein), sperm whales are found throughout the North Pacific and are distributed broadly from tropical and temperate waters to the Bering Sea as far north as Cape Navarin, Russia. Mature female and immature sperm whales of both sexes are found in more temperate and tropical waters from the equator to around 45°N throughout the year. These groups of adult females and immature sperm whales are rarely found at latitudes higher than 50°N and 50°S (Rice 1989; Reeves and Whitehead 1997). Sexually mature males join these groups throughout the winter. During the summer, mature male sperm whales are thought to move north into the Aleutian Islands, Gulf of Alaska, and the Bering Sea. They are often concentrated around oceanic islands in areas of upwelling, and along the outer continental shelf and mid-ocean waters. Sperm whales are found year-round in California waters (Dohl *et al.* 1983; Barlow 1995; Forney *et al.* 1995). They reach peak abundance from April through mid-June and from the end of August through mid-November (Rice 1974). They have been seen in every season except winter (Dec-Feb.) in Washington and Oregon (Green *et al.* 1992). Acoustic detections of sperm whales in the offshore waters of the outer Washington coast occurred in all months of the year, with peak occurrence April to August. Acoustic detection inshore from April to November were generally faint enough to suggest that the whales were offshore (Oleson et al. 2009).

**Abundance and Productivity.** Whitehead (2002) estimated current sperm whale abundance to be approximately 300,000–450,000 worldwide, growing at about 1 percent per year. Abundance in the Pacific is approximately 152,000–226,000 using Whitehead’s 2002 methods.

The most recent abundance estimates for sperm whales off California, Oregon, and Washington, out to 300 nm were derived from trend-model analysis of line-transect data collected during six surveys from 1991 to 2008. Using this method, estimates ranged from 2,000 to 3,000 animals (Moore and Barlow 2014). The best estimate for the California Current (2,106 sperm whales) is the trend-estimate that corresponds with the 2008 survey (Carretta et al. 2017). The minimum population estimate is 1,332 whales and the calculated PBR is 2.7 sperm whales per year (Carretta et al. 2017, Moore and Barlow 2014).

The mean annual estimated mortality and serious injury attributable to commercial fisheries interactions was 1.7 sperm whales per year, based on observer and stranding data from 2001 to 2012. There were no documented mortalities or serious injuries of sperm whales due to ship

strikes from 2008 to 2012. The annual fishery-related and ship strike mortality and serious-injury is less than PBR, but greater than ten percent of PBR, so cannot be considered insignificant and approaching a zero mortality and serious injury rate (Carretta et al. 2017).

Threats-Entrapment and Entanglement in Fishing Gear. Sperm whales have been observed interacting with fishing gear, specifically with the California thresher shark/swordfish drift gillnet fishery ( $\geq 14$ -inch mesh). Given the location the whales were likely from the California/Oregon/Washington sperm whale stock. With regard to other known fisheries interactions, one sperm whale was found dead in Marin County, California in 2004, with monofilament netting in its stomach (WCR Stranding Network Database 2014). It is not known if the marine debris was the cause of death. Similarly, in 2008, two sperm whales stranded dead: one was found in Crescent City, California with a stomach full of a variety of different nets; and the other in Point Reyes, California with a variety of different netting, a plastic tarp, and rope marks on its pectoral flipper. Also, in 2008, an animal stranded dead in North Cove, Washington, with apparent entanglement scars. For the sperm whales found stranded dead in 2008, investigators could not determine the animals' primary cause of death was interactions with gear; however, it seems possible entanglement could have been related to their death. We reviewed records from 1998 through 2013 and estimate that the total serious injury or mortality due to fisheries is 25 sperm whales total over that time period (WCR Stranding Network Database 2014).

Limiting Factors. Factors limiting sperm whale recovery are illegal whaling, ship strikes, entanglement in fish gear, marine pollution, contaminants, reduced prey abundance due to overfishing or other factors (including climate change), and disturbance from increasing anthropogenic ocean noise (NMFS 2010b).

**Other Threats (all whales).** NMFS issues scientific research permits to allow research actions that involve take of whales. Currently there are 12 permits that allow directed research on whales, typically involving either targeted capture or sampling of individuals that may have stranded or been incidentally taken in some other manner. These permits allow a suite of activities that include observation, tagging, tracking, and collection of biological data and samples. These activities are intended to be non-injurious, with only minimal short term affects. But the risks of a incurring an injury or mortality as a result of directed research cannot be eliminated.

## **Leatherback Sea Turtles**

*Status of Leatherback Turtles.* NMFS listed leatherback turtles as endangered under the ESA in June, 1970 (35 FR 8491). In 1979, NMFS designated critical habitat for leatherback turtles to include coastal waters adjacent to Sandy Point, St. Croix, U.S. Virgin Island (44 Fed. Reg. 17710) (March 23, 1979). We designated additional critical habitat along the U.S. West Coast in January, 2012 (77 Fed. Reg. 4170) (January 26, 2012). We issued the final recovery plan for leatherback turtles in January 1998 (NMFS and USFWS 1998a).

Spatial Structure and Diversity. Leatherback turtles are widely distributed throughout the oceans of the world. The species nests in three main regions of the world: the Pacific, Atlantic

(including the Caribbean Sea), and Indian Oceans. Leatherbacks also occur in the Mediterranean Sea, although they are not known to nest there. The main regional areas may further be divided into nesting populations. In the Pacific, leatherback nesting aggregations are found in the eastern and western Pacific. In the eastern Pacific, major nesting sites are located in Mexico, Costa Rica, and Nicaragua. Nesting in the western Pacific occurs at numerous beaches in Indonesia, the Solomon Islands, Papua New Guinea, and Vanuatu, with a few nesters reported in Malaysia and only occasional reports of nesting in Thailand and Australia (Eckert *et al.* 2012). In the Atlantic Ocean, leatherbacks are divided into seven groups or nesting populations that are genetically distinct: Florida, Northern Caribbean, Western Caribbean, Southern Caribbean/Guianas, West Africa, South Africa, and Brazil (TEWG 2007). In the Indian Ocean, leatherback nesting aggregations are reported in the Andaman and Nicobar Islands, India, Sri Lanka, and South Africa.

Leatherback turtles lead a completely pelagic existence, foraging widely in temperate and tropical waters except during the nesting season, when gravid females return to tropical beaches to lay eggs. Leatherbacks are highly migratory, exploiting convergence zones and upwelling areas for foraging in the open ocean, along continental margins, and in archipelagic waters (Morreale *et al.* 1994; Eckert 1998, 1999; Benson *et al.* 2007a, 2011). Aerial surveys of coastal California, Oregon, and Washington indicate leatherbacks are most likely to occur along the continental slope as opposed to the continental shelf (NMFS and USFWS 1998a). Recent work by NMFS have tracked leatherbacks across the Pacific and confirmed that leatherbacks utilize zones of upwelling relaxation with central California and the waters off the Columbia River being two primary feeding areas (Benson *et al.* 2007b, 2011, and NMFS 2012a).

Abundance and Productivity. Leatherbacks are found throughout the world and populations and trends vary in different regions and nesting beaches. In 1980, the global estimate of breeding female leatherbacks was approximately 115,000 (Pritchard 1982). By 1995, one estimate claimed this global population of adult females had declined to 34,500 (Spotila *et al.* 1996). A current global population estimate is not available at this time, but details on what is known of populations are provided below.

For the Indian Ocean and Southeast Asia, there is generally insufficient information to determine trends at nesting beaches; however, these regions have nesting numbers that are quite low with a total for all known nesting beaches in the low hundreds (TEWG 2007).

NMFS and the USFWS conducted an extensive review of the status of leatherbacks throughout the Atlantic in 2007. The analysis showed that six out of seven nesting populations are stable or increasing at all beaches except the Western Caribbean (TEWG 2007). The most recent population estimate for the North Atlantic ranges from 34,000 to 94,000 adult leatherbacks (TEWG 2007).

In the Pacific, leatherback populations are declining at all major Pacific basin nesting beaches, particularly in the last two decades (Spotila *et al.* 1996; Spotila *et al.* 2000; NMFS and USFWS 2007). In the eastern Pacific, nesting counts indicate that the population has continued to decline since the mid-1990s leading some researchers to conclude that this leatherback is on the verge of extirpation (*e.g.*, Spotila *et al.* 1996; Spotila *et al.*, 2000). Steep declines have been documented

in Mexico and Costa Rica, the two major nesting sites for eastern Pacific leatherbacks (Mast *et al.* 2017). Recent estimates of the number of nesting females/year in Mexico and for Costa Rica is approximately 200 animals or less for each country per year (NMFS and USFWS 2013). Estimates presented at international conferences show the numbers declining even more in all of the major nesting sites in the eastern Pacific.

Based on satellite tracking data from leatherbacks nesting on western Pacific beaches or foraging off California, some leatherbacks will move into U.S. coastal waters as early as the spring, often coming directly from foraging areas in the eastern equatorial Pacific (Benson *et al.* 2011). Leatherbacks will move into areas of high abundance and density of gelatinous prey, *e.g.*, *Chrysaora fuscescens* and *Aurelia spp.*, along the West Coast when upwelling relaxes and sea surface temperatures increase and retention areas develop (Benson *et al.* 2011). These coastal foraging areas are primarily upwelling “shadows,” regions where larval fish, crabs, and jellyfish are retained in the upper water column during relaxation of upwelling. Three main areas of foraging have been documented on the U.S. West Coast: in California over the coastal shelf in waters of 14-16° C, particularly off of central CA; along the continental shelf and slope off of Oregon and Washington, particularly off the Columbia River plume; and offshore of central and northern California at sea surface temperature fronts in deep offshore areas, although this area was not regularly used (Benson *et al.* 2011). Researchers estimated an average of 178 leatherbacks were present between the coast and roughly the 50 fathom isobath off California (Benson *et al.* 2007b). Abundance over the study period was variable between years, ranging from an estimated 20 leatherbacks (1995) to 366 leatherbacks (1990) (Benson *et al.* 2007b).

The western Pacific leatherback metapopulation that nests in Indonesia, Papua New Guinea (PNG), Solomon Islands, and Vanuatu harbors the last remaining nesting aggregation of significant size in the Pacific with approximately 2700–4500 breeding females (Dutton *et al.* 2007; Hitipeuw *et al.* 2007). This number is substantially higher than the population estimate of 1,775 to 1,900 Western Pacific breeding females published in 2000 and used to predict possible extinction in the Pacific (Spotila *et al.* 2000). The larger population estimate is due to the addition of a number of nesting females from beaches that were not included in previous population estimates. Therefore, this is not indicative of a positive growth trend in the population. The current overall estimate for Papua Barat, Indonesia, Papua New Guinea, and Solomon Islands is 5,000 to 10,000 nests per year (Nel 2012). Although there is generally insufficient long term data to calculate population trends, in all of these areas, the number of nesting females is substantially lower than historical records (Nel 2012).

The most recently available information on nesting numbers in northwest Papua reflects a disturbing decline. Collectively, Tapilatu *et al.* (2013) estimated that since 1984, these primary western Pacific beaches have experienced a long-term decline in nesting of 5.9 percent per year. With a mean clutch frequency of  $5.5 \pm 1.6$ , approximately 489 females nested on Pacific beaches in 2011.

A small number of leatherbacks nest along the east coast of Papua New Guinea along the Huon Coast. Based on Pilcher (2012) nesting data between 2000 and 2012, it appears that this area has 240 to 500 nests per year. Post nesting females from Papua New Guinea were tracked to foraging

areas in the Southern Hemisphere, including the Coral Sea and the western south Pacific (Benson *et al.* 2011).

In the Solomon Islands, nesting 30 years ago occurred at more than 15 beaches (Vaughan 1981). Primary nesting beaches are now only found on Isabel Island (2 beaches), Sasakoloa and Litogarhira, with some additional nesting on Rendova and Tetepare (Dutton *et al.* 2007). There is no long-term data to assess trends in the Solomon Islands, but the total number of nesting females is estimated to be around 100 per year (Petro *et al.* 2007).

Leatherback nesting in Vanuatu has only recently been reported (Dutton *et al.* 2007). There are low levels of nesting at four to five beaches with a total of about 50 nests laid per year (Petro 2007).

There is limited sporadic leatherback nesting activity in Vietnam and Thailand.(Hamann *et al.* 2006, Eckert *et al.* 2012). In Australia, nesting was sporadic and the last observed nesting event occurred in 1996 (Limpus 2009). The collapse of the nesting population in Malaysia has been documented through systematic beach counts or surveys in Rantau Abang, Terengganu. Malaysia was once the site of an enormous leatherback nesting population which is now considered functionally extinct with only 2-3 females returning annually to nest each year (Chan and Liew 1996).

Limiting Factors. Threats to leatherbacks are detailed in the most recent 5-year status review (NMFS and USFWS 2013). The primary threats identified are fishery bycatch and impacts at nesting beaches. Other threats include direct harvest, predation, marine debris, climate change (NMFS and USFWS 2013), and ship strikes (Hazel *et al.* 2007).

### **2.2.2 Status of the Critical Habitats**

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

This section examines the current status of designated critical habitat by examining the condition and trends of PBFs throughout the designated areas. These features are essential to the conservation of the listed species because they support one or more of the species’ life stages (*e.g.*, sites with conditions that support spawning, rearing, migration, and/or foraging).

### **Salmon and Steelhead**

Because the PBF’s for the salmon and steelhead ESUs and DPSs addressed in this opinion are the same, the status of critical habitat for these species is described together in this section. For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of

the fifth-field hydrologic unit code (HUC<sub>5</sub>)<sup>9</sup> in terms of the conservation value they provide to each listed species they support.<sup>10</sup> The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water conditions, side channels), 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 (NOAA Fisheries 2005). Thus, even a location that has poor quality habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (*e.g.*, one of a very few spawning areas), a unique contribution to the population it served (*e.g.*, a population at the extreme end of geographic distribution), or the fact that it serves another important role (*e.g.*, obligate area for migration to upstream spawning areas).

The physical or biological features (PBFs) of freshwater spawning and incubation sites for the salmon and steelhead addressed in this opinion include water flow, quality, and temperature conditions and suitable substrate for spawning and incubation, as well as migratory access for adults and juveniles (Table 18-19). These features are essential to conservation because without them the species cannot successfully spawn and produce offspring.

The physical or biological features of freshwater migration corridors associated with spawning and incubation sites include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

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<sup>9</sup> A hydrological code or hydrologic unit code is a sequence of numbers or letters that identify a hydrological feature like a river, river reach, lake, or area like a drainage basin (also called watershed (in North America)) or catchment.

<sup>10</sup> The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" (NOAA Fisheries 2005).

**Table 18.** Physical or biological features (PBFs) of critical habitats designated for ESA-listed salmon and steelhead species considered in the opinion (except SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, and SR sockeye salmon), and corresponding species life history events.

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

**Table 19.** Essential features of critical habitats designated for SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, SONCC coho salmon, and corresponding species life history events.

Essential Features		Species Life History Event
Site	Site Attribute	
Spawning and juvenile rearing areas	Access (sockeye) Cover/shelter Food (juvenile rearing) Riparian vegetation Space (Chinook, coho) Spawning gravel Water quality Water temp (sockeye) Water quantity	Adult spawning Embryo incubation Alevin growth and development Fry emergence from gravel Fry/parr/smolt growth and development
Adult and juvenile migration corridors	Cover/shelter Food (juvenile) Riparian vegetation Safe passage Space 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
Areas for growth and development to adulthood	Ocean areas – not identified	Nearshore juvenile rearing Subadult rearing Adult growth and sexual maturation Adult spawning migration

**CHART Salmon and Steelhead Critical Habitat Assessments.** During the process of designating critical habitat, the CHART for each recovery domain assessed biological information pertaining to areas under consideration for designation as critical habitat to identify the areas occupied by listed salmon, determine whether those areas contained PBFs essential for the conservation of those species, and whether unoccupied areas existed within the historical range of the listed salmon and steelhead that are also essential for conservation. The CHARTs assigned a 0 to 3 point score for the PBFs in each HUC<sub>5</sub> watershed for:

- Factor 1. Quantity
- Factor 2. Quality—Current Condition
- Factor 3. Quality—Potential Condition
- Factor 4. Support of Rarity Importance
- Factor 5. Support of Abundant Populations
- Factor 6. Support of Spawning/Rearing

Thus, the overall quality of habitat in a given watershed was characterized by the scores for Factor 2 (quality—current condition), which considers the existing condition of the quality of

PBFs in the HUC<sub>5</sub> watershed; and Factor 3 (quality—potential condition), which considers the likelihood of achieving PBF potential in the HUC<sub>5</sub> watershed, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility.

**Willamette-Lower Columbia Recovery Domain.** Critical habitat was designated in the WLC recovery domain for UWR spring-run Chinook salmon, LCR Chinook salmon, LCR steelhead, UWR steelhead, CR chum salmon, southern green sturgeon, and eulachon, and proposed for LCR coho salmon. In addition to the Willamette and Columbia River mainstems, important tributaries on the Oregon side of the WLC include Youngs Bay, Big Creek, Clatskanie River, and Scappoose River in the Oregon Coast subbasin; Hood River in the Gorge; and the Sandy, Clackamas, Molalla, North and South Santiam, Calapooia, McKenzie, and Middle Fork Willamette rivers in the West Cascades subbasin.

Land management activities have severely degraded stream habitat conditions in the Willamette River mainstem above Willamette Falls and associated subbasins. In the Willamette River mainstem and lower sub-basin mainstem reaches, high density urban development and widespread agricultural effects have reduced aquatic and riparian habitat quality and complexity, and altered sediment and water quality and quantity, and watershed processes. The Willamette River, once a highly braided river system, has been dramatically simplified through channelization, dredging, and other activities that have reduced rearing habitat by as much as 75 percent. In addition, the construction of 37 dams in the basin blocked access to more than 435 miles of stream and river spawning habitat. The dams alter the temperature regime of the Willamette River and its tributaries, affecting the timing and development of naturally-spawned eggs and fry. Logging in the Cascade and Coast Ranges, and agriculture, urbanization, and gravel mining on valley floors, have contributed to increased erosion and sediment loads throughout the WLC domain (ODFW 2011).

The mainstem Willamette River has been channelized and stripped of large wood which provides important refuge habitat for juvenile salmon. Development began to encroach on the riparian forest beginning in the 1870s (Sedell and Froggatt 1984). Gregory *et al.* (2002a) calculated that the total mainstem Willamette River channel area decreased from 41,000 to 23,000 acres between 1895 and 1995. They noted that the lower reach, from the mouth of the river to Newberg (RM 50), is confined within a basaltic trench, and that due to this geomorphic constraint, less channel area has been lost than in upstream areas. The middle reach from Newberg to Albany (RM 50 to 120) incurred losses of 12percent primary channel area, 16percent side channels, 33percent alcoves, and 9percent islands. Even greater changes occurred in the upper reach, from Albany to Eugene (RM 187). There, approximately 40 percent of both channel length and channel area were lost, along with 21 percent of the primary channel, 41 percent of side channels, 74 percent of alcoves, and 80 percent of island areas (ODFW 2011).

The banks of the Willamette River have more than 96 miles of revetments; approximately half were constructed by the Corps. Generally, the revetments were placed in the vicinity of roads or on the outside bank of river bends, so that while only 26 percent of the total length is revetted, 65 percent of the meander bends are revetted (Gregory *et al.* 2002b). The majority of dynamic sections have been armored, reducing adjustments in channel bed and sediment storage by the

river, and thereby diminishing both the complexity and productivity of aquatic habitats (Gregory *et al.* 2002b).

The once expansive forests of the Willamette River floodplain provided valuable nutrients and organic matter during flood pulses, food sources for macroinvertebrates, and slow-water refugia for fish during flood events. These forests also cooled river temperatures as the river flowed through its many channels. However, riparian forests have diminished considerably in the lower reaches of the Willamette River (Gregory *et al.* 2002c). Extensive changes began before the major dams were built, with navigational and agricultural demands dominating the early use of the river. Sedell and Froggatt (1984) noted that agriculture and cutting of streamside trees were major agents of change for riparian vegetation, along with snagging of large wood in the channel. The reduced shoreline, fewer and smaller snags, and reduced riparian forest have resulted in large functional losses to the river, including reduced structural features, organic inputs from litter fall, entrained allochthonous materials, and flood flow filtering capacity.

Gregory *et al.* (2002c) described the changes in riparian vegetation in river reaches from the mouth to Newberg, from Newberg to Albany, and from Albany to Eugene. They noted that the riparian forests were formerly a mosaic of brush, marsh, and ash tree openings maintained by annual flood inundation. Below the City of Newberg, the most noticeable change was that conifers were almost eliminated. Above Newberg, the formerly hardwood-dominated riparian forests along with mixed forest made up less than half of the riparian vegetation by 1990, while agriculture dominated. This conversion has reduced river shading and the potential for recruitment of wood to the river, reducing channel complexity and the quality of rearing, migration and spawning habitats.

Hyporheic flow in the Willamette River has been examined through discharge measurements and found to be significant in some areas, particularly those with gravel deposits (Wentz *et al.* 1998; Fernald *et al.* 2001). Hyporheic flow processes water and affects its quality on reemerging into the main channel, stabilizing variations in physical and chemical water characteristics. Hyporheic flow is important for ecological functions, some aspects of water quality (such as temperature and dissolved oxygen), and some benthic invertebrate life stages. Alcove habitat, which has been limited by channelization, combines low hydraulic stress and high food availability with the potential for hyporheic flows across the steep hydraulic gradients in the gravel separating them from the main channel (Fernald *et al.* 2001). The loss of channel complexity and meandering that fosters creations of gravel deposits decreases the potential for hyporheic flows, as does gravel mining.

On the mainstem of the Columbia River, hydropower projects, including the Federal Columbia River Hydropower System (FCRPS), have significantly degraded salmon and steelhead habitats (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011c; NMFS 2013a). The series of dams and reservoirs that make up the FCRPS block an estimated 12 million cubic yards of debris and sediment that would otherwise naturally flow down the Columbia River and replenish shorelines along the Washington and Oregon coasts. Hydroelectric development modified natural flow regimes, resulting in higher water temperatures, changes in fish community structure leading to increased rates of piscivorous and avian predation on juvenile salmon and steelhead, and delayed migration for both adult and juveniles. Physical features of dams such as turbines also kill

migrating fish. In-river survival is inversely related to the number of hydropower projects encountered by emigrating juveniles.

Industrial harbor and port development are also significant influences on the Lower Willamette and Lower Columbia rivers (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011c; NMFS 2013a). Since 1878, the COE has dredged 100 miles of river channel within the mainstem Columbia River, its estuary, and Oregon's Willamette River as a navigation channel. Originally dredged to a 20-foot minimum depth, the Federal navigation channel of the Lower Columbia River is now maintained at a depth of 43 feet and a width of 600 feet. The Lower Columbia River supports five ports on the Washington State side: Kalama, Longview, Skamania County, Woodland, and Vancouver. In addition to loss of riparian habitat, and disruption of benthic habitat due to dredging, high levels of several sediment chemicals that are harmful to fish at certain concentrations, such as arsenic and polycyclic aromatic hydrocarbons (PAHs), have been identified in Lower Columbia River watersheds in the vicinity of the ports and associated industrial facilities.

The most extensive urban development in the Lower Columbia River subbasin has occurred in the Portland/Vancouver area. Outside of this major urban area, the majority of residences and businesses rely on septic systems. Common water quality issues with urban development and residential septic systems include higher water temperatures, lowered dissolved oxygen, increased fecal coliform bacteria, and increased chemicals associated with pesticides and urban runoff. Under these environmental conditions, fish in the action area are stressed. Stress may lead to reductions in biological reserves, altered biological processes, increased disease susceptibility, and altered performance of individual fish (*e.g.* growth, osmoregulation, and survival).

The Columbia River estuary has lost a significant amount of the tidal marsh and tidal swamp habitats that are critical to juvenile salmon and steelhead, particularly small or ocean-type species (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011c; NMFS 2013a). Edges of marsh areas provide sheltered habitats for juvenile salmon and steelhead where food, in the form of amphipods or other small invertebrates which feed on marsh detritus, is plentiful, and larger predatory fish can be avoided. Historically, floodwaters of the Columbia River inundated the margins and floodplains along the estuary, allowing juvenile salmon and steelhead access to a wide expanse of low-velocity marshland and tidal channel habitats. In general, the riverbanks were gently sloping, with riparian and wetland vegetation at the higher elevations of the river floodplain becoming habitat for salmon and steelhead during flooding river discharges or flood tides. Sherwood *et al.* (1990) estimated that the Columbia River estuary lost 20,000 acres of tidal swamps, 10,000 acres of tidal marshes, and 3,000 acres of tidal flats between 1870 and 1970. This study further estimated an 80percent reduction in emergent vegetation production and a 15 percent decline in benthic algal production.

Habitat and food-web changes within the estuary, and other factors affecting salmon population structure and life histories, have altered the Columbia River estuary's capacity to support juvenile salmon (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011c; NMFS 2013a). Diking and filling activities have reduced the tidal prism and eliminate emergent and forested wetlands and floodplain habitats. These changes have likely reduced the estuary's salmon-rearing capacity.

Moreover, water and sediment in the Lower Columbia River and its tributaries have toxic contaminants that are harmful to aquatic resources (Lower Columbia River Estuary Partnership 2007). Contaminants of concern include dioxins and furans, heavy metals, polychlorinated biphenyls (PCBs) and organochlorine pesticides such as DDT. Restoration of estuarine habitats, particularly diked emergent and forested wetlands, reduction of avian predation by terns, and flow manipulations to restore historical flow patterns have likely begun to enhance the estuary’s productive capacity for salmon.

The WLC recovery domain CHART determined that most HUC<sub>5</sub> watersheds with PBFs for salmon or steelhead are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or a high potential for improvement. Only watersheds in the upper McKenzie River and its tributaries are in good to excellent condition with no potential for improvement (Table 20).

**Table 20. Willamette-Lower Columbia Recovery Domain:** Current and potential quality of HUC<sub>5</sub> watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK), chum salmon (CM), and steelhead (ST) (NOAA Fisheries 2005).<sup>11</sup> Watersheds are ranked primarily by “current quality” and secondly by their “potential for restoration.”

Current PBF Condition	Potential PBF Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC <sub>5</sub> Code(s)	Listed Species	Current Quality	Restoration Potential
<b>Columbia Gorge #1707010xxx</b>			
Wind River (511)	CK/ST	2/2	2/2
East Fork Hood (506), & Upper (404) & Lower Cispus (405) rivers	CK/ST	2/2	2/2
Plympton Creek (306)	CK	2	2
Little White Salmon River (510)	CK	2	0
Grays Creek (512) & Eagle Creek (513)	CK/CM/ST	2/1/2	1/1/2
White Salmon River (509)	CK/CM	2/1	1/2
West Fork Hood River (507)	CK/ST	1/2	2/2
Hood River (508)	CK/ST	1/1	2/2
Unoccupied habitat: Wind River (511)	Chum conservation value “Possibly High”		
<b>Cascade and Coast Range #1708000xxx</b>			
Lower Gorge Tributaries (107)	CK/CM/ST	2/2/2	2/3/2
Lower Lewis (206) & North Fork Toutle (504) rivers	CK/CM/ST	1/3/1	2/1/2
Salmon (101), Zigzag (102), & Upper Sandy (103) rivers	CK/ST	2/2	2/2
Big Creek (602)	CK/CM	2/2	2/2
Coweeman River (508)	CK/CM/ST	2/2/1	2/1/2
Kalama River (301)	CK/CM/ST	1/2/2	2/1/2
Cowlitz Headwaters (401)	CK/ST	2/2	1/1
Skamokawa/Elochoman (305)	CK/CM	2/1	2

<sup>11</sup> On January 14, 2013, NMFS published a proposed rule for the designation of critical habitat for LCR coho salmon and Puget Sound steelhead (USDC 2013). A draft biological report, which includes a CHART assessment for PS steelhead, was also completed (NMFS 2012b).

**Current PBF Condition**

**Potential PBF Condition**

3 = good to excellent  
 2 = fair to good  
 1 = fair to poor  
 0 = poor

3 = highly functioning, at historical potential  
 2 = high potential for improvement  
 1 = some potential for improvement  
 0 = little or no potential for improvement

<b>Watershed Name(s) and HUC<sub>5</sub> Code(s)</b>	<b>Listed Species</b>	<b>Current Quality</b>	<b>Restoration Potential</b>
Salmon Creek (109)	CK/CM/ST	1/2/1	2/3/2
Green (505) & South Fork Toutle (506) rivers	CK/CM/ST	1/1/2	2/1/2
Jackson Prairie (503) & East Willapa (507)	CK/CM/ST	1/2/1	1/1/2
Grays Bay (603)	CK/CM	1/2	2/3
Upper Middle Fork Willamette River (101)	CK	2	1
Germany/Abernathy creeks (304)	CK/CM	1/2	2
Mid-Sandy (104), Bull Run (105), & Lower Sandy (108) rivers	CK/ST	1/1	2/2
Washougal (106) & East Fork Lewis (205) rivers	CK/CM/ST	1/1/1	2/1/2
Upper Cowlitz (402) & Tilton rivers (501) & Cowlitz Valley Frontal (403)	CK/ST	1/1	2/1
Clatskanie (303) & Young rivers (601)	CK	1	2
Rifle Reservoir (502)	CK/ST	1	1
Beaver Creek (302)	CK	0	1
Unoccupied Habitat: Upper Lewis (201) & Muddy (202) rivers; Swift (203) & Yale (204) reservoirs	CK & ST Conservation Value "Possibly High"		
Unoccupied Habitat: Upper Lewis (201) & Muddy (202) rivers; Swift (203) & Yale (204) reservoirs	CK & ST Conservation Value "Possibly High"		
<b>Willamette River #1709000xxx</b>			
Upper (401) & South Fork (403) McKenzie rivers; Horse Creek (402); & McKenzie River/Quartz Creek (405)	CK	3	3
Lower McKenzie River (407)	CK	2	3
South Santiam River (606)	CK/ST	2/2	1/3
South Santiam River/Foster Reservoir (607)	CK/ST	2/2	1/2
North Fork of Middle Fork Willamette (106) & Blue (404) rivers	CK	2	1
Upper South Yamhill River (801)	ST	2	1
Little North Santiam River (505)	CK/ST	1/2	3/3
Upper Molalla River (905)	CK/ST	1/2	1/1
Abernathy Creek (704)	CK/ST	1/1	1/2
Luckiamute River (306) & Yamhill (807) Lower Molalla (906) rivers; Middle (504) & Lower (506) North Santiam rivers; Hamilton Creek/South Santiam River (601); Wiley Creek (608); Mill Creek/Willamette River (701); & Willamette River/Chehalem Creek (703); Lower South (804) & North (806) Yamhill rivers; & Salt Creek/South Yamhill River (805)	CK/ST	1	1
Hills (102) & Salmon (104) creeks; Salt Creek/Willamette River (103), Hills Creek Reservoir (105), Middle Fork Willamette/Lookout Point (107); Little Fall (108) & Fall (109) creeks; Lower Middle Fork of Willamette (110), Long Tom (301), Marys (305) & Mohawk (406) rivers	CK	1	1
Willamina Creek (802) & Mill Creek/South Yamhill River (803)	ST	1	1
Calapooia River (303); Oak (304) Crabtree (602), Thomas (603) & Rickreall (702) creeks; Abiqua (901), Butte (902) & Rock (903) creeks/Pudding River; & Senecal Creek/Mill Creek (904)	CK/ST	1/1	0/1
Row River (201), Mosby (202) & Muddy (302) creeks, Upper (203) & Lower (205) Coast Fork Willamette River	CK	1	0
Unoccupied habitat in North Santiam (501) & North Fork Breitenbush (502) rivers; Quartzville Creek (604) and Middle Santiam River (605)	CK & ST Conservation Value "Possibly High"		
Unoccupied habitat in Detroit Reservoir/Blowout Divide Creek (503)	Conservation Value: CK "Possibly Medium"; ST Possibly High"		
<b>Lower Willamette #1709001xxx</b>			
Collawash (101), Upper Clackamas (102), & Oak Grove Fork (103)	CK/ST	2/2	3/2

**Current PBF Condition**

3 = good to excellent  
 2 = fair to good  
 1 = fair to poor  
 0 = poor

**Potential PBF Condition**

3 = highly functioning, at historical potential  
 2 = high potential for improvement  
 1 = some potential for improvement  
 0 = little or no potential for improvement

Watershed Name(s) and HUC <sub>5</sub> Code(s)	Listed Species	Current Quality	Restoration Potential
Clackamas rivers			
Middle Clackamas River (104)	CK/ST	2/1	3/2
Eagle Creek (105)	CK/ST	2/2	1/2
Gales Creek (002)	ST	2	1
Lower Clackamas River (106) & Scappoose Creek (202)	CK/ST	1	2
Dairy (001) & Scoggins (003) creeks; Rock Creek/Tualatin River (004); & Tualatin River (005)	ST	1	1
Johnson Creek (201)	CK/ST	0/1	2/2
Lower Willamette/Columbia Slough (203)	CK/ST	0	2

**Interior Columbia Recovery Domain.** NMFS has designated critical habitat in the IC recovery domain, which includes the Snake River Basin, for SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, UCR spring-run Chinook salmon, SR sockeye salmon, MCR steelhead, UCR steelhead, and SRB steelhead. Major tributaries in the Oregon portion of the IC recovery domain include the Deschutes, John Day, Umatilla, Walla Walla, Grande Ronde, and Imnaha rivers. See table above for citations.

Habitat quality in tributary streams in the IC recovery domain varies from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban development (Wissmar *et al.* 1994; NMFS 2009a). Critical habitat throughout much of the IC recovery domain has been degraded by intense agriculture, alteration of stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, logging, mining, and urbanization. Reduced summer stream flows, impaired water quality, and reduction of habitat complexity are common problems for critical habitat in developed areas.

Migratory habitat quality in this area has been severely affected by the development and operation of the FCRPS dams and reservoirs in the mainstem Columbia River, Bureau of Reclamation tributary projects, and privately owned dams in the Snake and Upper Columbia River Basins. For example, construction of Hells Canyon Dam eliminated access to several likely production areas in Oregon and Idaho, including the Burnt, Powder, Weiser, Payette, Malheur, Owyhee, and Boise river basins (Good *et al.* 2005), and Grand Coulee and Chief Joseph dams completely block anadromous fish passage on the upper mainstem Columbia River. Hydroelectric development modified natural flow regimes, resulting in higher water temperatures, changes in fish community structure leading to increased rates of piscivorous and avian predation on juvenile salmon and steelhead, and delayed migration for both adult and juveniles. Physical features of dams such as turbines also kill migrating fish. In-river survival is inversely related to the number of hydropower projects encountered by emigrating juveniles.

Similarly, development and operation of extensive irrigation systems and dams for water withdrawal and storage in tributaries have altered hydrological cycles. A series of large

regulating dams on the middle and upper Deschutes River affect flow and block access to upstream habitat, and have extirpated one or more populations from the Cascades Eastern Slope major population (IC-TRT 2003). Similarly, operation and maintenance of large water reclamation systems such as the Umatilla Basin and Yakima Projects have significantly reduced flows and degraded water quality and physical habitat in this domain.

Many stream reaches designated as critical habitat in the IC recovery domain are over-allocated, with more allocated water rights granted by the state than existing streamflow. Withdrawal of water, particularly during low-flow periods that commonly overlap with agricultural withdrawals, often increases summer stream temperatures, blocks fish migration, strands fish, and alters sediment transport (Spence *et al.* 1996). Reduced tributary stream flow has been identified as a major limiting factor for all listed salmon and steelhead species in this recovery domain except SR fall-run Chinook salmon and SR sockeye salmon (NMFS 2007; NOAA Fisheries 2011).

Many stream reaches designated as critical habitat are listed on the state of Oregon's Clean Water Act section 303(d) list for water temperature. Many areas that were historically suitable rearing and spawning habitat are now unsuitable due to high summer stream temperatures. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water for agricultural or municipal use all contribute to elevated stream temperatures. Contaminants such as insecticides and herbicides from agricultural runoff and heavy metals from mine waste are common in some areas of critical habitat.

The IC recovery domain is a very large and diverse area. The CHART determined that few watersheds with PBFs for Chinook salmon or steelhead are in good to excellent condition with no potential for improvement. Overall, most IC recovery domain watersheds are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or high potential for improvement. In Washington, the Upper Methow, Lost, White, and Chiwawa watersheds are in good-to-excellent condition with no potential for improvement. In Oregon, only the Lower Deschutes, Minam, Wenaha, and Upper and Lower Imnaha Rivers HUC<sub>5</sub> watersheds are in good-to-excellent condition with no potential for improvement. In Idaho, a number of watersheds with PBFs for steelhead (Upper Middle Salmon, Upper Salmon/Pahsimeroi, Middle Fork Salmon, Little Salmon, Selway, and Lochsa rivers) are in good-to-excellent condition with no potential for improvement. Additionally, several Lower Snake River HUC<sub>5</sub> watersheds in the Hells Canyon area, straddling Oregon and Idaho, are in good-to-excellent condition with no potential for improvement (Table 21).

**Table 21.** Interior Columbia Recovery Domain: Current and potential quality of HUC5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and steelhead (ST) (NOAA Fisheries 2005). Watersheds are ranked primarily by “current quality” and secondly by their “potential for restoration.”

Current PBF Condition	Potential PBF Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC <sub>5</sub> Code(s)	Listed Species	Current Quality	Restoration Potential
<b>Upper Columbia #1702000xxx</b>			
White (101), Chiwawa (102), Lost (801) & Upper Methow (802) rivers	CK/ST	3	3
Upper Chewuch (803) & Twisp rivers (805)	CK/ST	3	2
Lower Chewuch River (804); Middle (806) & Lower (807) Methow rivers	CK/ST	2	2
Salmon Creek (603) & Okanogan River/Omak Creek (604)	ST	2	2
Upper Columbia/Swamp Creek (505)	CK/ST	2	1
Foster Creek (503) & Jordan/Tumwater (504)	CK/ST	1	1
Upper (601) & Lower (602) Okanogan River; Okanogan River/Bonaparte Creek (605); Lower Similkameen River (704); & Lower Lake Chelan (903)	ST	1	1
Unoccupied habitat in Sinlahekin Creek (703)	ST Conservation Value “Possibly High”		
<b>Upper Columbia #1702001xxx</b>			
Entiat River (001); Nason/Tumwater (103); & Lower Wenatchee River (105)	CK/ST	2	2
Lake Entiat (002)	CK/ST	2	1
Columbia River/Lynch Coulee (003); Sand Hollow (004); Yakima/Hansen Creek (604), Middle Columbia/Priest Rapids (605), & Columbia River/Zintel Canyon (606)	ST	2	1
Icicle/Chumstick (104)	CK/ST	1	2
Lower Crab Creek (509)	ST	1	2
Rattlesnake Creek (204)	ST	0	1
<b>Yakima #1703000xxx</b>			
Upper (101) & Middle (102) Yakima rivers; Teanaway (103) & Little Naches (201) rivers; Naches River/Rattlesnake Creek (202); & Ahtanum (301) & Upper Toppenish (303) & Satus (305) creeks	ST	2	2
Umtanum/Wenas (104); Naches River/Tieton River (203); Upper Lower Yakima River (302); & Lower Toppenish Creek (304)	ST	1	2
Yakima River/Spring Creek (306)	ST	1	1
<b>Lower Snake River #1706010xxx</b>			
Snake River/Granite (101), Getta (102), & Divide (104) creeks; Upper (201) & Lower (205) Imnaha River; Snake River/Rogersburg (301); Minam (505) & Wenaha (603) rivers	ST	3	3
Grande Ronde River/Rondowa (601)	ST	3	2
Big (203) & Little (204) Sheep creeks; Asotin River (302); Catherine Creek (405); Lostine River (502); Bear Creek (504); & Upper (706) & Lower (707) Tucannon River	ST	2	3
Middle Imnaha River (202); Snake River/Captain John Creek (303);	ST	2	2

**Current PBF Condition**

**Potential PBF Condition**

3 = good to excellent  
 2 = fair to good  
 1 = fair to poor  
 0 = poor

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 2 = high potential for improvement  
 1 = some potential for improvement  
 0 = little or no potential for improvement

<b>Watershed Name and HUC<sub>5</sub> Code(s)</b>	<b>Listed Species</b>	<b>Current Quality</b>	<b>Restoration Potential</b>
Upper Grande Ronde River (401); Meadow (402); Beaver (403); Indian (409), Lookingglass (410) & Cabin (411) creeks; Lower Wallowa River (506); Mud (602), Chesnimnus (604) & Upper Joseph (605) creeks			
Ladd Creek (406); Phillips/Willow Creek (408); Upper (501) & Middle (503) Wallowa rivers; & Lower Grande Ronde River/Menatche Creek (607)	ST	1	3
Five Points (404); Lower Joseph (606) & Deadman (703) creeks	ST	1	2
Tucannon/Alpowa Creek (701)	ST	1	1
Mill Creek (407)	ST	0	3
Pataha Creek (705)	ST	0	2
Snake River/Steptoe Canyon (702) & Penawawa Creek (708)	ST	0	1
Flat Creek (704) & Lower Palouse River (808)	ST	0	0
<b>Upper Salmon and Pahsimeroi #1706020xxx</b>			
Germania (111) & Warm Springs (114) creeks; Lower Pahsimeroi River (201); Alturas Lake (120), Redfish Lake (121), Upper Valley (123) & West Fork Yankee (126) creeks	ST	3	3
Basin Creek (124)	ST	3	2
Salmon River/Challis (101); East Fork Salmon River/McDonald Creek (105); Herd Creek (108); Upper East Fork Salmon River (110); Salmon River/Big Casino (115), Fisher (117) & Fourth of July (118) creeks; Upper Salmon River (119); Valley Creek/Iron Creek (122); & Morgan Creek (132)	ST	2	3
Salmon River/Bayhorse Creek (104); Salmon River/Slate Creek (113); Upper Yankee Fork (127) & Squaw Creek (128); Pahsimeroi River/Falls Creek (202)	ST	2	2
Yankee Fork/Jordan Creek (125)	ST	1	3
Salmon River/Kinnikinnick Creek (112); Garden Creek (129); Challis Creek/Mill Creek (130); & Patterson Creek (203)	ST	1	2
Road Creek (107)	ST	1	1
Unoccupied habitat in Hawley (410), Eighteenmile (411) & Big Timber (413) creeks	Conservation Value for ST "Possibly High"		
<b>Middle Salmon, Panther and Lemhi #1706020xxx</b>			
Salmon River/Colson (301), Pine (303) & Moose (305) creeks; Indian (304) & Carmen (308) creeks, North Fork Salmon River (306); & Texas Creek (412)	ST	3	3
Deep Creek (318)	ST	3	2
Salmon River/Cow Creek (312) & Hat (313), Iron (314), Upper Panther (315), Moyer (316) & Woodtick (317) creeks; Lemhi River/Whimpey Creek (402); Hayden (414), Big Eight Mile (408), & Canyon (408) creeks	ST	2	3
Salmon River/Tower (307) & Twelvemile (311) creeks; Lemhi River/Kenney Creek (403); Lemhi River/McDevitt (405), Lemhi River/Yearian Creek (406); & Peterson Creek (407)	ST	2	2
Owl (302) & Napias (319) creeks	ST	2	1
Salmon River/Jesse Creek (309); Panther Creek/Trail Creek (322); & Lemhi River/Bohannon Creek (401)	ST	1	3

**Current PBF Condition**

**Potential PBF Condition**

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 0 = poor

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 1 = some potential for improvement  
 0 = little or no potential for improvement

<b>Watershed Name and HUC<sub>5</sub> Code(s)</b>	<b>Listed Species</b>	<b>Current Quality</b>	<b>Restoration Potential</b>
Salmon River/Williams Creek (310)	ST	1	2
Agency Creek (404)	ST	1	1
Panther Creek/Spring Creek (320) & Clear Creek (323)	ST	0	3
Big Deer Creek (321)	ST	0	1
<b>Mid-Salmon-Chamberlain, South Fork, Lower, and Middle Fork Salmon #1706020xxx</b>			
Lower (501), Upper (503) & Little (504) Loon creeks; Warm Springs (502); Rapid River (505); Middle Fork Salmon River/Soldier (507) & Lower Marble Creek (513); & Sulphur (509), Pistol (510), Indian (511) & Upper Marble (512) creeks; Lower Middle Fork Salmon River (601); Wilson (602), Upper Camas (604), Rush (610), Monumental (611), Beaver (614), Big Ramey (615) & Lower Big (617) creeks; Middle Fork Salmon River/Brush (603) & Sheep (609) creeks; Big Creek/Little Marble (612); Crooked (616), Sheep (704), Bargamin (709), Sabe (711), Horse (714), Cottonwood (716) & Upper Chamberlain Creek (718); Salmon River/Hot Springs (712); Salmon River/Kitchen Creek (715); Lower Chamberlain/McCalla Creek (717); & Slate Creek (911)	ST	3	3
Marsh (506); Bear Valley (508) Yellow Jacket (604); West Fork Camas (607) & Lower Camas (608) creeks; & Salmon River/Disappointment Creek (713) & White Bird Creek (908)	ST	2	3
Upper Big Creek (613); Salmon River/Fall (701), California (703), Trout (708), Crooked (705) & Warren (719) creeks; Lower South Fork Salmon River (801); South Fork Salmon River/Cabin (809), Blackmare (810) & Fitsum (812) creeks; Lower Johnson Creek (805); & Lower (813), Middle (814) & Upper Secesh (815) rivers; Salmon River/China (901), Cottonwood (904), McKenzie (909), John Day (912) & Lake (913) creeks; Eagle (902), Deer (903), Skookumchuck (910), French (915) & Partridge (916) creeks	ST	2	2
Wind River (702), Salmon River/Rabbit (706) & Rattlesnake (710) creeks; & Big Mallard Creek (707); Burnt Log (806), Upper Johnson (807) & Buckhorn (811) creeks; Salmon River/Deep (905), Hammer (907) & Van (914) creeks	ST	2	1
Silver Creek (605)	ST	1	3
Lower (803) & Upper (804) East Fork South Fork Salmon River; Rock (906) & Rice (917) creeks	ST	1	2
<b>Little Salmon #176021xxx</b>			
Rapid River (005)	ST	3	3
Hazard Creek (003)	ST	3	2
Boulder Creek (004)	ST	2	3
Lower Little Salmon River (001) & Little Salmon River/Hard Creek (002)	ST	2	2
<b>Selway, Lochsa and Clearwater #1706030xxx</b>			
Selway River/Pettibone (101) & Gardner (103) creeks; Bear (102), White Cap (104), Indian (105), Burnt Knob (107), Running (108) & Goat (109) creeks; & Upper Selway River (106); Gedney (202), Upper Three Links (204), Rhoda (205), North Fork Moose (207), Upper East	ST	3	3

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 1 = fair to poor  
 0 = poor

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 1 = some potential for improvement  
 0 = little or no potential for improvement

<b>Watershed Name and HUC<sub>5</sub> Code(s)</b>	<b>Listed Species</b>	<b>Current Quality</b>	<b>Restoration Potential</b>
Fork Moose (209) & Martin (210) creeks; Upper (211), Middle (212) & Lower Meadow (213) creeks; Selway River/Three Links Creek (203); & East Fork Moose Creek/Trout Creek (208); Fish (302), Storm (309), Warm Springs (311), Fish Lake (312), Boulder (313) & Old Man (314) creeks; Lochsa River/Stanley (303) & Squaw (304) creeks; Lower Crooked (305), Upper Crooked (306) & Brushy (307) forks; Lower (308), Upper (310) White Sands, Ten Mile (509) & John's (510) creeks			
Selway River/Goddard Creek (201); O'Hara Creek (214) Newsome (505) creeks; American (506), Red (507) & Crooked (508) rivers	ST	2	3
Lower Lochsa River (301); Middle Fork Clearwater River/Maggie Creek (401); South Fork Clearwater River/Meadow (502) & Leggett creeks; Mill (511), Big Bear (604), Upper Big Bear (605), Musselshell (617), Eldorado (619) & Mission (629) creeks, Potlatch River/Pine Creek (606); & Upper Potlatch River (607); Lower (615), Middle (616) & Upper (618) Lolo creeks	ST	2	2
South Fork Clearwater River/Peasley Creek (502)	ST	2	1
Upper Orofino Creek (613)	ST	2	0
Clear Creek (402)	ST	1	3
Three Mile (512), Cottonwood (513), Big Canyon (610), Little Canyon (611) & Jim Ford (614) creeks; Potlatch River/Middle Potlatch Creek (603); Clearwater River/Bedrock (608), Jack's (609) Lower Lawyer (623), Middle Lawyer (624), Cottonwood (627) & Upper Lapwai (628) creeks; & Upper (630) & Lower (631) Sweetwater creeks	ST	1	2
Lower Clearwater River (601) & Clearwater River/Lower Potlatch River (602), Fivemile Creek (620), Sixmile Creek (621) and Tom Taha (622) creeks	ST	1	1
<b>Mid-Columbia #1707010xxx</b>			
Wood Gulch (112); Rock Creek (113); Upper Walla Walla (201), Upper Touchet (203), & Upper Umatilla (301) rivers; Meacham (302) & Birch (306) creeks; Upper (601) & Middle (602) Klickitat River	ST	2	2
Glade (105) & Mill (202) creeks; Lower Klickitat River (604); Mosier Creek (505); White Salmon River (509); Middle Columbia/Grays Creek (512)	ST	2	1
Little White Salmon River (510)	ST	2	0
Middle Touchet River (204); McKay Creek (305); Little Klickitat River (603);Fifteenmile (502) & Fivemile (503) creeks	ST	1	2
Alder (110) & Pine (111) creeks; Lower Touchet River (207), Cottonwood (208), Pine (209) & Dry (210) creeks; Lower Walla Walla River (211); Umatilla River/Mission Creek (303) Wildhorse Creek (304); Umatilla River/Alkali Canyon (307); Lower Butter Creek (310); Upper Middle Columbia/Hood (501); Middle Columbia/Mill Creek (504)	ST	1	1
Stage Gulch (308) & Lower Umatilla River (313)	ST	0	1
<b>John Day #170702xxx</b>			
Middle (103) & Lower (105) South Fork John Day rivers; Murderers (104) & Canyon (107) creeks; Upper John Day (106) & Upper North	ST	2	2

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 1 = some potential for improvement  
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<b>Watershed Name and HUC<sub>5</sub> Code(s)</b>	<b>Listed Species</b>	<b>Current Quality</b>	<b>Restoration Potential</b>
Fork John Day (201) rivers; & Desolation Creek (204)			
North Fork John Day/Big Creek (203); Cottonwood Creek (209) & Lower NF John Day River (210)	ST	2	1
Strawberry (108), Beech (109), Laycock (110), Fields (111), Mountain (113) & Rock (114) creeks; Upper Middle John Day River (112); Granite (202) & Wall (208) creeks; Upper (205) & Lower (206) Camas creeks; North Fork John Day/Potamus Creek (207); Upper Middle Fork John Day River (301) & Camp (302), Big (303) & Long (304) creeks; Bridge (403) & Upper Rock (411) creeks; & Pine Hollow (407)	ST	1	2
John Day/Johnson Creek (115); Lower Middle Fork John Day River (305); Lower John Day River/Kahler Creek (401), Service (402) & Muddy (404) creeks; Lower John Day River/Clarno (405); Butte (406), Thirtymile (408) & Lower Rock (412) creeks; Lower John Day River/Ferry (409) & Scott (410) canyons; & Lower John Day River/McDonald Ferry (414)	ST	1	1
<b>Deschutes #1707030xxx</b>			
Lower Deschutes River (612)	ST	3	3
Middle Deschutes River (607)	ST	3	2
Upper Deschutes River (603)	ST	2	1
Mill Creek (605) & Warm Springs River (606)	ST	2	1
Bakeoven (608) & Buck Hollow (611) creeks; Upper (701) & Lower (705) Trout Creek	ST	1	2
Beaver (605) & Antelope (702) creeks	ST	1	1
White River (610) & Mud Springs Creek (704)	ST	1	0
Unoccupied habitat in Deschutes River/McKenzie Canyon (107) & Haystack (311); Squaw Creek (108); Lower Metolius River (110), Headwaters Deschutes River (601)	ST Conservation Value "Possibly High"		

**Eulachon**

Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington (FR65324, 10/20/2011). All of these areas are designated as migration and spawning habitat for this species. The 234-mile section of the Columbia River from the mouth to Bonneville Dam is designated as critical habitat. In Oregon, 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek have been designated. In Washington State, 49 miles of the lower Cowlitz River, 4 miles of the Elochoman River, 8 miles of the lower Elwha River, 10 miles of the Grays River, 19 miles of the Lewis River, 6 miles of the East Fork Lewis River, 3 miles of the Quinault River, 5 miles of Skamokawa Creek, 6 miles of the Toutle River (Figure 9). Table 22 details eulachon PBFs.



**Figure 9.** Final Critical Habitat for Southern DPS of Eulachon.

The range of eulachon in the Pacific Northwest completely overlaps with the range of several ESA-listed stocks of salmon and steelhead. Although the habitat requirements of these fishes differ somewhat from eulachon, efforts to protect habitat generally focus on the maintenance of watershed processes that would be expected to benefit eulachon. The BRT identified dams and water diversions as moderate threats to eulachon in the Columbia and Klamath rivers where hydropower generation and flood control are major activities. Degraded water quality is common in some areas occupied by southern DPS eulachon. In the Columbia and Klamath systems, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods.

**Table 22.** Physical or biological features of critical habitats designated for eulachon and corresponding species life history events.

Physical or biological features		Species Life History Event
Site Type	Site Attribute	
Freshwater spawning and incubation	Flow Water quality Water temperature Substrate	Adult spawning Incubation
Freshwater migration	Flow Water quality Water temperature Food	Adult and larval mobility Larval feeding

Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown (Gustafson et al. 2010). The BRT identified dredging as a low to moderate threat to eulachon in the Columbia River. Dredging during eulachon spawning would be particularly detrimental because eggs could be destroyed through entrainment. The lower Columbia River mainstem provides spawning and incubation sites, and a large migratory corridor to spawning areas in the tributaries. Prior to the construction of Bonneville Dam, eulachon ascended the Columbia River as far as Hood River, Oregon. Major tributaries that support spawning runs include the Grays, Skamokawa, Elochoman, Kalama, Lewis and Sandy rivers.

### 2.3 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 C.F.R. § 402.02).

#### Salmon, Steelhead, and Eulachon

Each fish species considered in this opinion resides in or migrates through the action area in the lower Columbia River and nearshore marine areas. The action area is used as rearing and migration habitat by juvenile and adult salmonids and for migration habitat for eulachon.

As described above in the Status of the Species and Critical Habitat sections, factors that limit the recovery of species considered in this opinion vary with the overall condition of aquatic habitats on private, state, and Federal lands. Within the action area, many stream and riparian areas have already been degraded by the effects of land and water use, including road construction, forest management, agriculture, mining, transportation, urbanization, and water development. Each of these economic activities has contributed to a myriad of interrelated

factors that have contributed to the decline of species considered in this opinion. Among the most important of these are changes in stream channel morphology, degradation of spawning substrates, reduced instream roughness and cover, loss and degradation of estuarine rearing habitats, loss of wetlands, loss and degradation of riparian areas, water quality degradation (*e.g.*, temperature, sediment, dissolved oxygen), blocked fish passage, direct take, and loss of habitat refugia.

Anadromous salmonids have been affected by the development and operation of dams. Dams and reservoirs, within the currently accessible migratory corridor, have greatly altered the river environment and have affected fish passage. Dams without adequate fish passage systems have extirpated anadromous fish from their pre-development spawning and rearing habitats. The operation of water storage projects has altered the natural hydrograph of many rivers. Water impoundment and dam operations also affect downstream water quality characteristics, vital components to anadromous fish survival. In recent years, high quality fish passage is being restored where it did not previously exist, either through improvements to existing fish passage facilities or through dam removal, *e.g.*, Marmot Dam on the Sandy River and Powerdale Dam on the Hood River.

Within the habitat in the action area currently accessible by species considered in this opinion, dams have negatively affected spawning and rearing habitat. Floodplains have been reduced, off-channel habitat features have been eliminated or disconnected from the main channel, and the amount of large woody debris in the mainstem has been greatly reduced. Remaining habitats often are affected by flow fluctuations associated with reservoir water management for power peaking, flood control, and other operations.

The development of hydropower and water storage projects within the Columbia River Basin have resulted in the inundation of many mainstem spawning and shallow-water rearing areas (loss of spawning gravels and access to spawning and rearing areas); altered water quality (reduced spring turbidity levels), water quantity (seasonal changes in flows and consumptive losses resulting from use of stored water for agricultural, industrial, or municipal purposes), water temperature (including generally warmer minimum winter temperatures and cooler maximum summer temperatures), water velocity (reduced spring flows and increased cross-sectional areas of the river channel), food (alteration of food webs, including the type and availability of prey species), and safe passage (increased mortality rates of migrating juveniles) (Ferguson *et al.* 2005; Williams *et al.* 2005).

Anadromous fish considered in this opinion are exposed to high rates of predation during all life stages. Fish, birds, and marine mammals, including harbor seals, sea lions, and killer whales all prey on juvenile and adult salmon in the action area. The Columbia River Basin has a diverse assemblage of native and introduced fish species, some of which prey on salmon, steelhead, and eulachon. The primary resident fish predators of salmonids in many areas of the Columbia River inhabited by anadromous salmon are northern pikeminnow (native), smallmouth bass (introduced), and walleye (introduced). Other predatory resident fish in the action area include channel catfish (introduced), Pacific lamprey (native), yellow perch (introduced), largemouth bass (introduced), and bull trout (native). Increased predation by non-native predators has and continues to decrease population abundance and productivity.

Avian predation is a factor limiting salmonid recovery in the Columbia River Basin. Throughout the basin, piscivorous birds congregate near hydroelectric dams and in the estuary near man-made islands and structures. Avian predation has been exacerbated by environmental changes associated with river developments. Water clarity caused by suspended sediments settling in impoundments increases the vulnerability of migrating smolts to avian predation. Delay in migration through project reservoirs due to slack water, particularly immediately upstream from the dams, increases smolt exposure to avian predators, and juvenile bypass systems at dams concentrate smolts, creating potential feeding stations for birds. Dredge spoil islands, associated with maintaining the Columbia River navigation channel, provide habitat for nesting Caspian terns and other piscivorous birds. Caspian terns, double-crested cormorants, glaucous-winged/western gull hybrids, California gulls, and ring-billed gulls are the principal avian predators in the basin. As with piscivorous predators, predation by birds has and continues to decrease population abundance and productivity.

In general, the aquatic habitat of the Columbia River at the project site (RM 72) provides habitat for a variety of benthic, epibenthic, and water column organisms. The shape, composition, and configuration of benthic topography are in a state of relatively constant change in the reach of the Columbia River in the action area, due to natural processes. Sand waves naturally form and propagate along the channel and the adjacent river bottom, with the estimated volume of sand in a single large sand wave in a range of between 100,000 to 200,000 cubic yards. Substrate within both subtidal and intertidal benthic environments consists largely of silts and medium-to-coarse alluvial sands. There is no submerged aquatic vegetation in this reach of the river, most likely due to the dynamic nature of the system and the high water velocities.

Water quality conditions (turbidity, pH, and dissolved oxygen) at the project site are generally within the range needed to support aquatic life. The majority of the river in the vicinity of the project site is not identified on the Washington State Department of Ecology 303(d) list for elevated water temperatures. However, two areas on the Columbia River, near the project site (one at RM 71.9 immediately downstream of the project site, and one approximately 2 miles upstream at RM 74) are listed for temperature exceedances. Data published by the U.S. Geological Survey in 2012 indicate that summer water temperatures downstream of Bonneville Dam routinely exceed 70°F (Tanner *et al.* 2012), compared to optimal 55°F for incubation of eggs to 68°F for adult migration.

Based on data from the Merchants Exchange of Portland, Oregon, the number of cargo ship arrivals in the Columbia River for 2014 was 1,644 ships. As many as 2,413 OGVs plied the lower Columbia River in 1995. In recent years, other terminals have been proposed and will require consultation and/or have been consulted upon in the LCR. These include the Tesoro Savage Terminal (RM 103.5), Millenium (RM 63), and the Columbia River Bio-Refinery (RM 53). Assuming these are constructed, all of these terminals will facilitate future increased OGV traffic and associated effects such as shoreline erosion, ship strikes, and ship wake stranding. The Tesoro Savage Terminal (365 OGV/year), the Millenium Terminal (840 OGV/year), and the Columbia River Bio-Refinery (108 OGV/year) combined with the NWIW represent 1,385 more sailings or an 84 percent increase in OGV traffic within the Columbia River action area.

In addition to development-related actions (e.g. marinas, moorage facilities) that have adversely affected salmon and steelhead in the action area, the environmental baseline also includes restoration actions that have improved habitat conditions for salmon and steelhead. Some restoration actions like the removal of the Hemlock and Condit tributary dams, removing and breaching dikes in portions of the estuary, and planting riparian and floodplain native woody vegetation allow for restoring habitat forming processes and should result in the eventual achievement of self-sustaining habitat. The preservation and restoration of other high quality habitats also are likely to contribute to the recovery of ESA-listed stocks. Other restoration actions including digging chum salmon spawning channels, developing side channels for rearing, and placing LWM largely focus on improving short-term to mid-term habitat conditions, though their ability to delay the decline of listed salmonids is equivocal (Roni *et al.* 2002).

### **Marine Mammals**

The environmental baseline described below refers to the past and present impacts of all Federal, State, or private actions and other human activities in the action area to the affected marine mammal stocks.

**Fisheries Interactions.** Entrapment and entanglement in fishing gear has been identified as a significant source of mortality to endangered whales (Caretta *et al.* 2013). In 2016, 71 whales were reported as entangled off the coasts of Washington, Oregon, and California (NOAA 2017). This is the highest annual total since NOAA Fisheries started keeping records in 1982. Humpback whales were the predominant species reported as entangled, confirmed in 42 separate cases. The majority of whale entanglements reported off California, Oregon, and Washington from 2000 to 2012 (46 percent) were identified as trap/pot gear (NMFS 2014). No consultations have been done for State managed Dungeness crab fisheries which have resulted in large numbers of entanglements. There are multiple types of federally-managed fisheries on the West Coast known to have been involved with entanglements and each has gone through section 7 consultation. The opinions found no jeopardy to marine mammals (NOAA 2017).<sup>12</sup>

**Ship Strikes.** The OGVs transiting the action area may interact with whales and leatherback sea turtles. Ship strikes have been identified as a significant source of mortality to endangered whales (Kraus 1990) and sea turtles (Hazel *et al.* 2007). The WCR maintains a stranding database and includes marine mammal death and injury records from ship strikes, which extends beyond the action area. Data specific to the action area is not available, thus we assume that the number of strikes occurring in the action area is a small portion of the total strikes along the United States West Coast. Based on data from the Merchants Exchange of Portland, Oregon (2016), the number of cargo ship arrivals in the Columbia River for 2014 was 1,644 ships. The

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<sup>12</sup> Continued management of the drift gillnet fishery under the Fishery Management Plan for U.S. West Coast Fisheries for Highly Migratory Species. NOAA #2012/03020, dated May 2, 2013

Adoption of (1) proposed Highly Migratory Species Fisheries Management Plan; (2) continued operation of Highly Migratory Species fishery vessels under permits pursuant to the High Seas Fishing Compliance Act; and (3) Endangered species Act regulation on the prohibition of shallow longline sets east of the 150-degree West longitude. Dated February 4, 2004

Continuing Operation of the Pacific Coast Groundfish Fishery NOAA # NWR-2012-876 Dated December 7, 2012

addition of 72 methanol OGV round trips per year represents an approximate 4 percent increase in yearly cargo ship large vessel traffic in the Columbia River. However, when compared with the total number of ocean going vessels that originated from West Coast ports in 2013 (18,550), the increase resulting from the proposed project represents a less than 0.4 percent increase for all large vessels on the west coast.

**Blue Whales.** From 1998-2013, the total estimated number of observed or assumed mortality and serious injury attributed to ship strikes off the U.S. West Coast is approximately 13 blue whales (WCR Stranding Database). Ship strikes were implicated in the deaths of nine blue whales, from 2007-2011 (Carretta *et al.* 2013). Five of these deaths occurred in 2007, the highest number recorded for any year. The other ship strike deaths occurred in 2009 (2 whales) and in 2010 (2 whales). During this time period, there were an additional four serious injuries (i.e., an injury that is more likely than not to result in mortality) of unidentified large whales attributed to ship strikes (Carretta *et al.* 2013). Several blue whales have been photographed in California with large gashes in their dorsal surface that appear to be from ship strikes (Carretta *et al.* 2014). Blue whale mortality and injuries attributed to ship strikes in California waters averaged 1.9 per year during 2007-2011. The high number of ship strikes observed in 2007 resulted in NOAA implementing a mitigation plan that includes NOAA weather radio and USCG advisory broadcasts to mariners entering the Santa Barbara Channel to be observant for whales, along with recommendations that mariners transit the channel at 10 knots or less. The Channel Islands National Marine Sanctuary also developed a blue whale ship strike response plan. Additional plan information can be found at <http://channelislands.noaa.gov/focus/alert.html>. Documented ship strike deaths and serious injuries are considered minimum values because they are derived from counts of whale carcasses which have consistently low detection rates. Because of this negative bias, Redfern *et al.* (2013) stress that the number of ship strike deaths of blue whales in the California current likely exceeds the potential biological removal (i.e., 2.3 whales per year; Carretta *et al.* 2014).

**Fin Whales.** Fin whales have been reported struck and killed by large OGVs along the entire West Coast. From 1998-2013, the total estimated number of observed or assumed mortality and serious injury attributed to ship strikes off the U.S. West Coast is approximately 19 fin whales (WCR Stranding Database). At least one, and probably more, fin whales were killed by collisions with ships off California in the early 1990s (Barlow *et al.* 1997). Ship strikes were implicated in the deaths of seven fin whales and serious injury of one fin whale between 2007 and 2011. In 2008, one fin whale was struck and brought into the port of Los Angeles on the bow of a ship. In 2009, a total of four fin whales were reported as struck: two were struck off of San Clemente Island in Southern California, one came in on the bow of a OGV into Los Angeles Harbor, and one came in on a bow of a OGV into Tacoma, Washington. In 2010, a fin whale came in on the bow of an OGV in the port of Oakland, near San Francisco, CA. The whale was towed out to sea and within a few days another fin whale washed ashore near San Francisco with injuries believed to have been caused by a ship strike. It is possible that this animal was the same animal as the one that came in on the OGV in Oakland; however, DNA evidence confirming the match was not available; thus both animals are counted as individual ship strikes. An adult female fin whale was also killed in 2011, and stranded in San Diego, CA, where it expelled a fetus, post-mortem. Additional mortality from ship strikes probably goes unreported because the whales do not strand, or if they do, they do not always have obvious signs of trauma (Carretta *et*

al. 2014). Between 2007 and 2011, the average observed annual mortality and serious injury due to ship strikes was 1.6 fin whales per year (Carretta *et al.* 2014).

**Humpback Whales.** From 1998-2013, the total estimated number of observed or assumed mortality and serious injury attributed to ship strikes off the U.S. West Coast is approximately 11 humpback whales (WCR Stranding Database). Ship strikes were implicated in the deaths of at least two humpback whales in 1993, one in 1995, and one in 2000 (J. Cordaro, NMFS unpublished data, *in* Carretta *et al.* 2006). In 2004, a humpback whale stranded dead in Washington with injuries consistent with those caused by a ship strike. In 2005, a free-swimming humpback whale was reported to have been hit by a USCG OGV in San Francisco Bay. No blood was visible in the water, but the final status of this animal remains unknown. In 2007, a humpback whale cow/calf pair swam into the Sacramento River with injuries consistent with a ship strike. The injuries appeared non-fatal as the animals eventually left the River and headed back into the Pacific Ocean. Also in 2007, a humpback whale stranded dead in Marin County, California, with a fractured skull, consistent with a ship strike. In 2008, in Washington, two humpback whales stranded dead with injuries consistent with those caused by a ship strike. In 2011, a humpback whale stranded dead with a large contusion near the dorsal fin, in Los Angeles County, California with injuries consistent with those caused by a ship strike. In 2013, one humpback whale was killed by a ship strike and stranded dead in Marin County, California. Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not have obvious signs of trauma. Several humpback whales have been photographed in California with large gashes in their dorsal surface that appear to be from ship strikes (Carretta *et al.*, 2012).

The 5-year average number of humpback whale deaths by ship strikes off the West Coast of the U.S. from 2007-2011 as reported in Carretta *et al.* (2014) is 1.1 humpback whales per year. The 5-year average number of humpback whale deaths by ship strikes off the West Coast of the U.S. considered in this analysis from 2009-2013 is 0.60 humpback whales per year, but this is considered a minimum since animals struck by ships may not be realized or reported.

**Sperm Whales.** From 1998-2013, the total estimated number of observed or assumed mortality and serious injury attributed to ship strikes off the U.S. West Coast is approximately 4 sperm whales (WCR Stranding Database). Sperm whales interactions with large OGV are rarely reported within the proposed action area, although they are likely vulnerable to ship strikes off the West Coast of the U.S. Carcasses that do not drift ashore may go unreported, and those that do strand may show no obvious signs of having been struck by a ship. Two whales described as “possibly sperm whales” are known to have died in U.S. waters in 1990, after being struck by OGV (Barlow *et al.* 1997). In 2007, in Florence, OR, a calf stranded dead with obvious signs of propeller trauma, a deep gash on its dorsal side, and the caudal end of the body cut off at the peduncle. In 2009, a sperm whale carcass washed ashore at Point Reyes, California with severe bruising and hemorrhaging along the dorsum, consistent with injuries likely to have been caused from a ship strike.

From 2001-13, the total number of observed or assumed mortality and serious injury (M/SI) attributed to ship strikes is 3.0, resulting in an annual average of 0.23 sperm whales. Again, this is considered a minimum since animals struck by ships may not be realized or reported.

**Acoustic Disturbance.** Increasing levels of anthropogenic sound in the world's oceans (Andrew *et al.* 2002), such as those produced by shipping traffic, Acoustic Thermometry of Ocean Climate or Low Frequency Active sonar, have been suggested to be a habitat concern for whales, particularly for baleen whales (fin, humpback, and blue) that may communicate using low frequency sound (Andrew *et al.* 2002). Based on vocalizations (Richardson *et al.* 1995; Au *et al.* 2006), reactions to sound sources (Lien *et al.* 1990, 1992; Maybaum 1993), and anatomical studies (Hauser *et al.* 2001), humpback whales also appear to be sensitive to mid-frequency sounds, including those used in active sonar military exercises (Navy 2007). We do not have specific information about what types of acoustic disturbance is in the action area; however, we expect noise from shipping, boating associated with commercial and recreational fishing, and Coast Guard operations.

### **Leatherback Sea Turtles**

As described above in the status section, leatherback sea turtles have been and continue to be affected by numerous activities within the proposed action area. Here we look at the past and present impacts of all Federal, State, or private actions and other human activities in the action area to leatherback sea turtles.

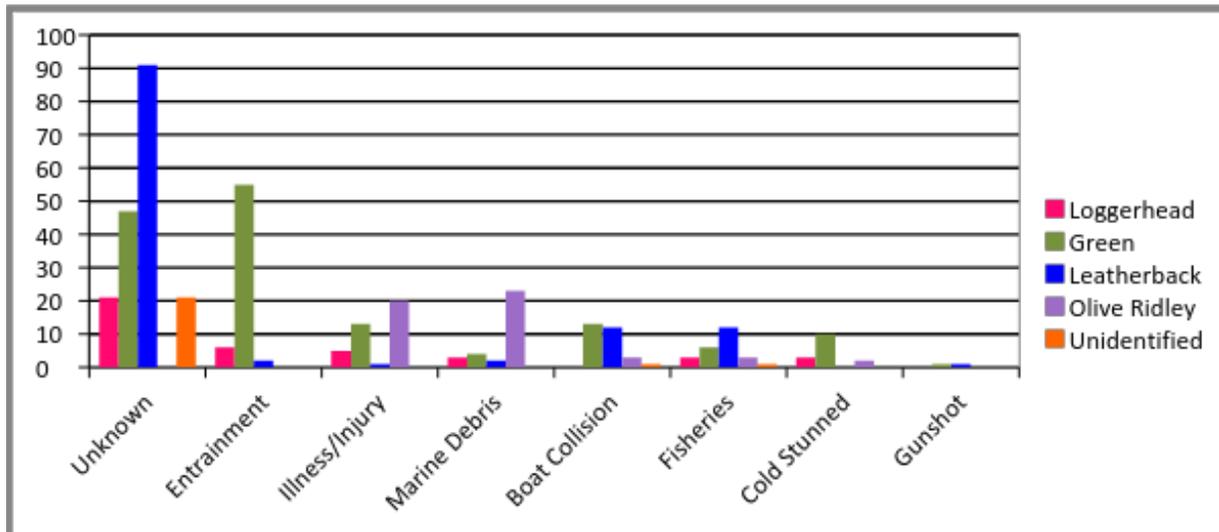
**Fisheries Interactions.** All sea turtle species are occasionally reported and observed interacting with fishing gear, including pot/trap gear, gillnets, and hook and line recreational gear, with leatherbacks interacting with gear the most. Sea turtles have not been observed entangled in the salmon or coastal pelagic species fishing gear. An interaction between gear used in the Federal groundfish fishery and a leatherback was recently observed when a dead leatherback was found entangled in sablefish trap gear fishing offshore of Fort Bragg in October, 2008. NMFS recently completed a section 7 consultation (NMFS 2013b) on the Federal groundfish fishery and issued an incidental take statement for leatherback sea turtles. The opinion found no jeopardy to leatherback sea turtles. No other sea turtle species have been observed entangled in the various components of the groundfish fishery.

**Ship Strikes.** Ship strikes are occasionally a source of injury and mortality to sea turtles along the West Coast. A review of the stranding data base indicates that leatherbacks are reported most often as stranded due to the impact by OGV strikes compared to other sea turtles along the West Coast. Confirmed stranding data related to ship strikes is not available for the action area. In this case, we looked at stranding data from California as a comparison. As with California, OGV strikes to leatherback sea turtles are likely to occur, as the Columbia River plume is a foraging area for leatherback sea turtles, which overlaps with current shipping routes. Between 2000 and 2005, there were three reported boat collisions with leatherbacks off the California coast, and fate of these turtles is unknown (SWR stranding data base). Two of the reports documented damage to the carapace, head, or flippers. In 2008, there was another boat collision reported off Cayucos Point, California and the turtle was observed dead (Caretta *et al.* 2013). Ship strikes likely go largely unreported, and may pose a threat to leatherbacks in foraging areas like the Gulf of the Farallones in Northern California (Benson *et al.* 2007b).

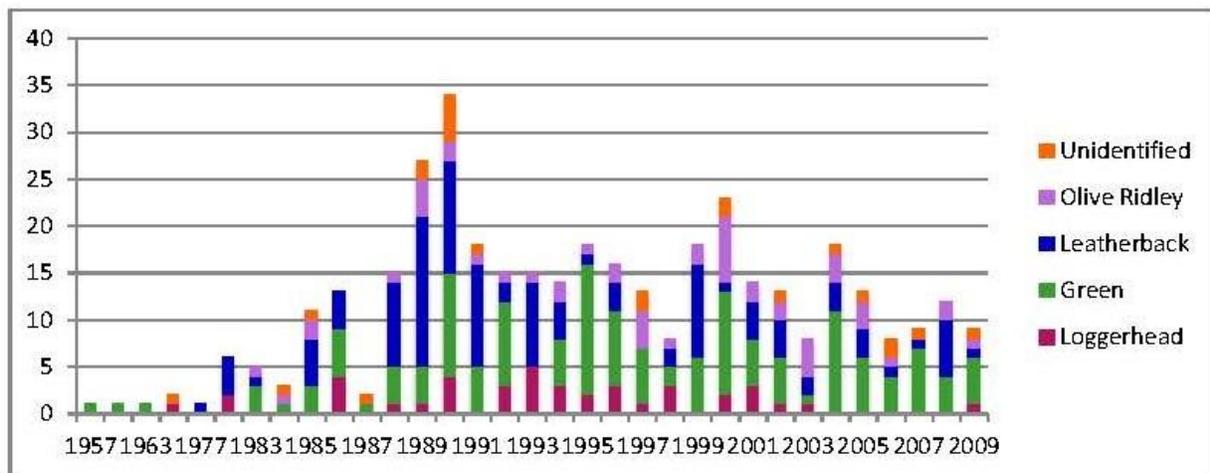
**Other Threats.** Sea turtles, particularly olive ridleys, have stranded off the West Coast through their encounters with marine debris, either through ingesting debris or becoming entangled in the

debris (NMFS 2009b). Other threats include unknown injuries, illness, and gunshot wounds (Figure 10). Because not all stranded sea turtles are necropsied, particularly leatherbacks, many threats are not documented, but all strandings are recorded in the stranding data base (Figure 11).

NMFS issues scientific research permits to allow research actions that involve take of sea turtles. Currently there are four permits that allow directed research on sea turtles, typically involving either targeted capture or sampling of individuals that may have stranded or incidentally taken in some other manner. These permits allow a suite of activities that include tagging, tracking, and collection of biological data and samples. These activities are intended to be non-injurious, with only minimal short-term effects. But the risks of a incurring an injury or mortality cannot be eliminated as a result of directed research.



**Figure 10.** Known causes of sea turtle strandings off the U.S. West Coast, 1957–2009.



**Figure 11.** Sea turtle strandings documented off the U.S. West Coast, 1957–2009.

## **2.4 Effects of the Action on Species and Designated Critical Habitat**

Under the ESA “effects of the action” means the direct and indirect effects of an action on the species 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 C.F.R. § 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 effects of the proposed action will affect all salmon and steelhead in this opinion in a similar manner. This is because all of these ESUs and DPSs have similar life history, biology, and behavior. Eulachon, like salmon and steelhead, are anadromous fish although their life history and biology is somewhat different than salmon and steelhead. Where the effects of the action may impact these species slightly differently, it is noted in our analysis below. Effects to marine mammals and turtle are discussed separately following this analysis.

For this consultation, we do not consider any impacts from greenhouse gases generated during plant operations to be indirect or direct effects of the action. This is because we cannot show a causal connection between the emissions of GHGs from the proposed agency action and specific localized climate change as it impacts listed species or critical habitat with reasonable certainty.<sup>13</sup>

### **2.4.1 Effects on Species**

#### **Salmon, Steelhead, and Eulachon**

The COE proposes to issue a permit to the Port of Kalama to construct a marine export facility in the Port at River Mile (RM) 72 on the Columbia River. The COE also proposes to permit Northwest Pipeline LLC to construct the Kalama Lateral Project to supply methane to the project site. The marine terminal will include the construction of a new dock that will require work (pile driving, dredging, and mitigation) below the OHWM of the Columbia River. The effects of dock construction, dredging, shipping, mitigation, water use, and pipeline construction on salmon, steelhead and eulachon are described below.

#### **Dock Construction**

##### *Pile Driving*

The project includes the installation of 320, 24-inch concrete and 16 (12- and 18-inch) steel piles over a five-month period during an in-water work window of September 1-January 31.

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<sup>13</sup> May 14, 2008, Memorandum from Mark Meyers (USGS) to the US Fish and Wildlife Service Director (“The Challenges of Linking Carbon Emissions, Atmospheric Greenhouse Gas Concentrations, Global Warming, and Consequential Impacts”), which cites several findings of the Intergovernmental Panel on Climate Change (2007) Fourth Assessment Synthesis Report. In particular, the IPCC noted difficulties in simulating and attributing observed temperature changes at smaller than continental scales, because it is a fundamental property of atmospheric CO<sub>2</sub> that it is considered to be “well-mixed”, i.e., its residence time in the troposphere is long enough that it becomes homogeneous both vertically and horizontally (i.e., distributed world-wide) and because at smaller than continental scales there are spatially heterogeneous forcings, such as those arising from changes in aerosol loadings and land use patterns, which may have large impacts on regional climate.

Construction may occur over two years. The concrete piles will be impact driven. The steel piles will be installed via vibratory hammer, and will likely also require proofing with an impact hammer. Each proofed pile may require 1,025 strikes and approximately 30 minutes to install. While proofing steel piles with an impact hammer, the applicant will use sound attenuation strategies including the use of a bubble curtains.

### Biological Effects of Pile Driving

Adverse biological effects to ESA-listed salmonids may result from the high sound pressures produced when the steel piles are driven with an impact hammer. These effects occur to fish with swim bladders, such as salmon and steelhead. Eulachon do not have swim bladders. The proposed pile driving of four, 18-inch and 12, 12-inch steel piles will last for less than one week and is scheduled to occur at a time when most salmonid species are not actively migrating through the action area. We do expect some juvenile salmon and steelhead to be present, but the overall density of fish present at the time of pile driving is expected to be low. Thus some effects, as described below, could occur, but low numbers of salmonids are likely to be exposed. Eulachon may be present but because they do not have swim bladders they are very unlikely to experience effects.

Fishes with swimbladders (salmon and steelhead) may suffer physical injury from underwater impulsive sounds, i.e., sounds with a sharp sound pressure peak occurring in a short interval of time (Caltrans 2001) as occurs during impact driving of steel piles. As the pressure wave passes through a fish, the swimbladder is rapidly squeezed due to the high pressure, and then rapidly expanded as the under pressure component of the wave passes through the fish. The pneumatic pounding may rupture capillaries in the internal organs as indicated by observed blood in the abdominal cavity, and maceration of the kidney tissues (Caltrans 2001). The injuries caused by such pressure waves are known as barotraumas, and include hemorrhage and rupture of internal organs and damage to the auditory system. Death can be instantaneous, can occur within minutes after exposure, or can occur several days later.

The type and intensity of the underwater sounds produced by pile driving depend on a variety of factors, including, but not limited to, the type and size of the pile, the firmness of the substrate and depth of water into which the pile is being driven, and the type and size of the pile-driving hammer (Nedwell and Edwards 2002). In general, driving steel piles with an impact hammer appears to generate pressure waves that are more harmful than those generated by impact-driving of concrete or wood piles, or by vibratory installation of any type of pile. Sound pressure levels (SPLs) associated with installation of concrete and wood piles are characterized by a longer rise time than those of steel piles. Rise time appears to be an important factor in whether or not a sound pressure wave is likely to cause physical injury (Carlson *et al.* 2001, Nedwell and Edwards 2002). To date, we are not aware of any situations where installation of concrete piles has been shown to cause injury or mortality in aquatic organisms. As such, we do not expect that the SPLs associated with impact installation of concrete piles to cause injury to fishes.

The sound pressure waves from vibratory pile driving are much shallower and do not result in physical injury. Vibratory hammers produce sound pressure levels approximately 17 dB below those produced by impact hammers (Nedwell and Edwards 2002), and injurious effects from

vibratory pile driving have not been reported from any empirical study of which the NMFS is aware. Based on this, the direct effects of sounds from vibratory pile driving are not expected to cause injury to fish.

For steel pile impact driving, a multi-agency work group (FHWG, 2008) determined that to protect listed species, sound pressure waves should be within a single strike threshold of 206 decibels (re: 1µPa), and for cumulative strikes either 187 dB sound exposure level (SEL) where fish are larger than 2 grams or 183 dB SEL where fish are smaller than 2 grams.

The Services use a Sound Pressure Exposure spreadsheet or calculator to estimate the area around each pile where fish would be considered at risk of injury or behavioral disruption during pile driving. Table 23 lists the expected sound levels that could be generated by the proposed pile driving associated with the project.

**Table 23.** Expected sound levels with attenuation reduction.

<b>Measured levels for pile driving with 10 dB attenuation reduction</b>			
	<b>Peak Level</b>	<b>Sound Exposure Level</b>	<b>Root Mean Squared</b>
20-inch steel pile	198	166	177
12-inch steel pile	198	165	181

Cumulative SEL is intended as a measure of the risk of injury from exposure to multiple pile strikes. A sound exposure formula based on the Equal Energy Hypothesis is used to calculate cumulative SEL exposure:

$$\text{Cumulative SEL} = \text{Single-strike SEL} + 10 \cdot \log(\text{number of pile strikes})$$

Using this calculation and the worst case scenario of the 20-inch pile sound levels (no sound analysis could be found for 18-inch steel piles), assuming eight piles will be driven per day with an estimated 1,025 strikes per pile, we would expect fish could be adversely affected within 385 feet of pile driving activities.

As indicated above, the proposed action states that a bubble curtain will be used to attenuate the effects of impact proofing steel piles. A conservative estimate of the use of a bubble curtain to attenuate sound levels would be expected to reduce effects by 10 dB SEL. However, a bubble curtain may not bring the sound pressure levels below biological thresholds, and some death or injuries of ESA-listed salmonids are likely to occur. The proposed steel pile driving will last for less than one week and is scheduled to occur at a time when most salmonid species are not actively migrating through the action area. We expect some salmon and steelhead to be present during this time period and these are reasonably certain to be injured or killed if they are within 385 feet of construction.

#### Behavior Effects of Pile Driving

Pile driving may have some effects on fish behavior. These effects have been studied for salmonids. In a field study, Grette (1985) investigated the impacts of steel sheet pile driving on

adult salmonid runs [Chinook, coho (*O. kisutch*), and sockeye (*O. nerka*)] through the Hiram H. Chittenden Locks in Seattle, Washington. The study found that daily patterns of migration through the locks were similar during periods of pile driving, and during periods when no pile driving occurred. The study concluded that pile driving did not influence the number of salmon ascending the fish ladder within the locks.

Feist *et al.* (1996) observed the behavior of juvenile pink (*O. gorbuscha*) and coho during wharf construction at Everett Homeport in the Snohomish estuary. Concrete piles were driven with impact hammers using two pile driving rigs that operated for 8-10 hour periods per day for three days during the week. The study found subtle effects and possible changes in fish behavior. On days when pile driving was not occurring, the fish exhibited a more polarized schooling behavior (moving in a definite pattern). Fish appeared to change their distributions about the site, orienting and moving towards an acoustically-isolated cove side of the site on pile driving days more than on non-pile driving days. It was also noted that the prevalence of fish schools did not change significantly with and without pile driving. Fish were feeding well the day they were sampled about the rigs and along the shore. Feist *et al.* (1996) concluded that the study could not demonstrate whether pile driving had a detrimental effect on the fitness of juvenile pink and chum salmon.

Ruggerone *et al.* (2008) placed juvenile coho salmon in cages between 6 and 45 feet from 14 steel piles while exposing them to 1,627 strikes during a 4.3-hour period. Only one fish showed an avoidance response and no fish exhibited a fright response. Startle responses of a small portion of total fish were observed in only 4 of 14 first strikes and they tended to occur when cages were close to the piles and sound pressure levels were relatively high. Visual stimuli, such as a contractor walking by a cage, caused a greater startle response. No external or internal injuries associated with pile driving sounds were observed. Behavioral responses of salmon to pile strikes were subtle. The report concluded that the coho salmon were not significantly affected by cumulative exposure to pile driving sounds produced in that study (Ruggerone *et al.* 2008).

Although numerous studies have attempted to discern behavior effects to different type of fish species from elevated sound levels that are below harm levels but above ambient levels, relatively few papers have linked this exposure to effects on fish (Popper *et al.* 2014). Under some conditions, with some species, elevated sound may cause an effect but it is not possible to extrapolate to other conditions and other species (Popper and Hastings 2009). Davidson *et al.* (2009) indicated that studies have shown that salmonids do not have a wide hearing bandwidth or hearing sensitivity to sound pressure levels and are therefore not as likely to be impacted by increased ambient sound.

Based on these studies, NMFS expects that some fish may react to elevated sound levels by avoiding the area during construction or by change in schooling behavior but we do not expect the effects to be detrimental.

### Suspended Sediments

Pile driving causes short-term and localized increases in turbidity and total suspended solids (TSS). The effects of suspended sediment on fish increase in severity with sediment

concentration and exposure time and can progressively include behavioral avoidance and/or disorientation, physiological stress (e.g., coughing), gill abrasion, and death—at extremely high concentrations. Newcombe and Jensen (1996) analyzed numerous reports on documented fish responses to suspended sediment in streams and estuaries, and identified a scale of ill effects based on sediment concentration and duration of exposure, or dose. Exposure to concentrations of suspended sediments expected during the proposed pile driving could elicit sublethal effects such as a short-term reduction in feeding rate or success, or minor physiological stress such as coughing or increased respiration. Studies show that salmonids have an ability to detect and distinguish turbidity and other water quality gradients (Quinn, 2005; Simenstad, 1988), and that larger juvenile salmonids are more tolerant to suspended sediment than smaller juveniles (Servizi and Martens, 1991; Newcombe and Jensen, 1996).

Very little data exists regarding the temporary increase in suspended sediment associated with pile driving. To estimate the magnitude of suspended sediment associated with the proposed pile driving, NMFS reviewed results from a vibratory pile removal project near the mouth of Jimmycomelately Creek in Sequim Bay (Weston\_Solutions, 2006) and Newcombe and Jensens (1996) ‘scale of ill effects’ to determine likely associated biological responses. The maximum increase in TSS reported in Weston Solutions (2006) was 83 mg/L. According to Newcombe and Jensen (1996) juvenile salmon would need to be exposed approximately two hours with an increase in TSS over background of up to 240 mg/L, to exceed a behavioral effect of short-term reduction in feeding rates and feeding success.

Any elevations in turbidity and TSS generated by the pile driving will be localized, short-term and similar to the variations that occur normally within the environmental baseline of the riverine environment—which is regularly subject to strong winds and currents that generate suspended sediments. Thus, the juvenile salmonids likely will have encountered similar turbidity before. Furthermore, turbidity caused by the proposed action will quickly dissipate as sandy material will quickly drop out of the water column and finer material will be diluted by riverine flow.

#### *Pier Shading - Prey Abundance.*

The proposed action will increase overwater shading by 44,943 square feet. Approximately 10,925 square feet of shading will occur in important nearshore areas that are used for juvenile salmon migration. Shade typically reduces juvenile salmonid prey organism abundance by reducing aquatic vegetation and phytoplankton abundance (Kahler *et al.*, 2000, Carrasquero 2001). Glasby (1999) found that epibiotic assemblages on pier pilings subject to shading were markedly different than in surrounding areas. While shade can reduce the presence of submerged aquatic vegetation, there is no submerged aquatic vegetation in this reach of the river, most likely due to the dynamic nature of the system and the high water velocities. The structure and composition of benthic organisms are constantly in a state of change in this reach of the Columbia River, due to the sand waves that naturally form and propagate along the river bottom. These sand waves move organisms down the river channel as they form and reform. In summary, due to the nature of the river bottom at the location of the proposed action, the action is unlikely to reduce aquatic vegetation or change phytoplankton abundance in a way that would result in more than a minor reduction in prey availability for juvenile salmonids.

New pilings may physically eliminate substrate available to benthic aquatic organisms and therefore, eliminate a possible food source for juvenile salmonids and eulachon larvae and juveniles in the project area. However, placement of pilings and associated structures has also been shown to provide foraging habitat, and may partially compensate for loss of benthic productivity. Carrasquero (2001) states that juvenile salmonids will feed upon periphyton, insects, and macroinvertebrates adhered to dock and pier pilings in the Columbia River. Any effects from shading to prey availability will likely be minor due to the lack of naturally existing submerged aquatic vegetation in this part of the river and the compensating growth of foraging habitat on the piles and associated structures that are part of the proposed action. Adults do not spawn in this area of the river and do not feed during spawning migration (NMFS 2011i) and would therefore not likely be affected by reduced prey availability resulting from increased overwater shading. In summary, it is unlikely the addition of pilings and the trestle will further degrade the existing prey habitat in a measurable amount.

*Predation—Salmon*  
Avian Predation

Over water structures erected as part of the proposed action could provide perching platforms for avian predators. Piscivorous birds that have been shown to feed on juvenile salmon include double-crested cormorants, Caspian terns, several species of gulls and American white pelicans. (Evans *et al.* 2012). Birds tend to congregate where prey is abundant. Upstream of Bonneville Dam, predation by birds (particularly terns and cormorants) can be substantial, but predation in the lower Columbia River is generally very low (Evans *et al.* 2012).

The surface of the proposed dock will be elevated 18 feet above OHW. Kahler *et al.* (2000) noted that double-crested cormorants and gulls in Lake Washington typically perch on the log booms or single piles rather than on elevated docks such as the one being constructed as part of this proposed action. This proposed action does not include log booms or single piles thus it is not likely to increase perching opportunities and thus hunting opportunities for cormorants and gulls. Pelicans are unlikely to use the proposed dock for perching as they generally are clumsy on the ground and hunt from the air or swimming on the surface. Similar to pelicans, terns are less likely to use the proposed dock for perching because when they forage, they fly high over the water, hover, and then plunge to catch fish below surface. In addition, the high amount of human activity on the industrial pier would dissuade bird activity. Therefore, we do not expect the new pier structure to result in an increase in avian predation.

Fish Predation

The project design minimizes nearshore shading by placing the majority of overwater structure in deeper water, however, the trestle leading to the main terminal is a solid platform located in the nearshore. Such nearshore overwater structures can increase predatory opportunity for fish that eat juvenile salmonids, since juvenile salmonids prefer the nearshore environment and they cannot view predators as well in shaded environments. In addition, the piling structure can slow the velocity of the water to become more conducive for predators to use. Adult salmon are not as susceptible to this type of predation as they tend to migrate in deeper waters away from the dock

structures. Approximately 173 square feet of pilings (approximately 52, 24-inch pilings) will be located in nearshore areas.

In the CR, salmon are a seasonally important part of the diet of piscivorous predators that include northern pike minnow and smallmouth bass (Ward et al. 1995). Of all piscivorous predators, pike minnow account for 78 percent of total salmonid losses to piscivorous predation (Rieman et al. 1991). Pike minnow consistently used low-velocity habitats in the tailraces of the Snake River dams (Isaak and Bjornn, 1996). In the Columbia River, Martinelli and Shively (1997) found pike minnow in 99 percent of the observations at all locations they studied where the water velocities were less than 1 meter per second. Faler et al. (1988) monitored the movements of 23 pike minnows below McNary Dam and found them to use habitats with velocities ranging from 0 to 70 centimeters per second. They noted that pike minnows avoided areas of high current velocity, as they did not move into a substantial portion of the tailrace when water velocities exceeded 100 centimeters per second. Pike minnows also prefer upriver, nearshore, slow current habitats for spawning.

A reward program, run by the Washington State Department of Fish and Wildlife, offers a bounty on pike minnow measuring nine inches or longer caught on the Columbia River. The cash-reward project funded by the Bonneville Power Administration began in 1990, and has been open in past seasons from May 1 through the end of September from the Columbia River mouth to Priest Rapids Dam, and from the Snake River mouth to Hells Canyon Dam. There are 17 check stations along both rivers with one existing three miles upstream of the proposed project near the Kalama Marina (RM 75). In 2016, 7,330 pike minnows were caught and returned at Kalama compared to 225,350 pike minnow caught on the entire river. While the numbers may give us an estimate of the large amount of pike minnow presence in this section of the river, it does not tell us the exact location of capture. The reward program conveys to fishermen that pike minnow may be caught in rocky areas near dams, islands, stream mouths, points, eddies, rows of pilings, and ledges or bars in the river. Most fish are caught in 7 to 25 feet of water.

Although overwater shading can contribute to predator hiding habitat, numerous studies have indicated that a large portion of seaward juvenile salmon migration takes place at night when shading effects would not be an issue (Meehan and Siniff 1962; McDonald 1960; Mains and Smith 1964; Lister et al. 1971; Volobuyev 1984; Kobayashi and Ishikawa 1964; Hunter 1959; Koski 1975 as cited in Groot and Margolis 1991). Chapman et al. (2012) stated that smolts may time their migration to nighttime hours to optimize their chance of completing migration to the ocean and lower their risk of predation.

As noted above, the proposed action will increase overwater shading and piling structures conducive for predator habitat at the site. The structure will not likely increase the amount of pike minnows in the area but will provide alternate habitats for pike minnows to prey from. Because the pilings are spaced approximately 30 feet apart they provide limited slow water habitat. The large catch of predators each year indicate that pike minnow would reside in the system even if the pier was not constructed. We do expect that the nearshore overwater coverage and pilings will slightly increase habitat that pike minnow prefers for preying on juvenile salmon and will likely lead to low amounts of salmon mortality because of the structure. It is expected

the large woody debris structures that are proposed for this project will help offset effects of the pier by providing refuge from predators for juvenile salmon.

### *Predation—Eulachon*

Eulachon are very high in lipids, and their historical large spawning runs made them an important part of the Pacific coastal food web. They have numerous avian predators, including sea birds such as harlequin ducks, pigeon guillemots, common murrelets, mergansers, cormorants, gulls, and eagles (NMFS 2011i). As stated above, avian predators are unlikely to use the dock structure because of its elevation off the water and the high level of industrial activity.

Fish that prey on eulachon include white sturgeon, spiny dogfish, sablefish, salmon sharks, arrowtooth flounder, Pacific hake, salmon, Dolly Varden, Pacific halibut, and Pacific cod (NMFS 2011i). The majority of these species do not occur in the riverine environment. Salmon do occur, but salmonid species are not dependent on over water structures to prey on eulachon. Eulachon and their eggs seem to provide a significant food source for white sturgeon in the Columbia and Fraser rivers (NMFS 2011i). White sturgeon lives on the bottom of slow-moving rivers, bays, and estuarine areas, and would not be expected to prefer dock structures. As eulachon do not utilize overwater structures for feeding or refuge, and their predators do not rely on such structures to hunt, we would not expect that the effects of the over water trestle would increase predation on eulachon.

## **Dredging**

### *Suspended Sediments*

Dredging operations maybe completed using either hydraulic or mechanical (clamshell) dredging methods. Approximately 16 acres of subtidal material is proposed to be dredged. Several reports summarized dredged material behavior and sediment resuspension due to hopper and clamshell dredging and associated open water disposal (Palermo et al. 2009; LaSalle et al. 1991; Havis 1988; McLellan et al. 1989; Herbich and Brahme 1991; Truitt 1988). Laboratory studies have consistently found that the 96- hour median lethal concentration (LC50) of suspended sediment for juvenile salmonids is above 6,000 mg/L (Stober et al. 1981) and 1,097 mg/L for 1 to 3-hour exposure (Newcombe and Jensen 1996). Based on an evaluation of seven clamshell dredge operations in fine silt or clay substrates, LaSalle (1988) determined that the upper limit in suspended sediment levels was 700 mg/l and 1,100 mg/l at the surface and bottom of the water column, respectively (within approximately 300 feet of the operation). Much lower concentrations (50 to 150mg/l at 150 feet) are expected at sites with coarser sediment such as the project location. Since the sediment in the Columbia River is primarily sand, it has a settling velocity in the range of 0.03 to 0.06 feet per second (redeposits in approximately 1 to 2 minutes).

The Portland Sediment Evaluation Team, composed of staff from the COE, the Environmental Protection Agency, NMFS, U.S. Fish and Wildlife, Washington Department of Ecology, and Oregon Department of Environmental Quality, reviewed the dredged material characterization report for the proposed action. The proposed action was evaluated using the 2009 Sediment Evaluation Framework for the Pacific Northwest guidance. All sediment contamination levels

were deemed to be below adverse effect levels for aquatic life and considered suitable for open water disposal (PSET 2015).

Minor suspended sediment from the dredge operations is expected to occur, but suspended sediments and associated turbidity is expected to be of short duration due to the coarse sediment being dredged and the quick settling rate and is not expected to reach levels leading to adverse effects. To the extent that adult salmonids or eulachon are present in the areas with elevated suspended sediment, they are expected to be of sufficient size to avoid these areas. Because the dredge material drops quickly out of solution and the dredge is operating in deep water, it is unlikely that elevated suspended sediments would affect juvenile rearing and migration areas.

### *Entrainment*

This proposed action includes dredging, during which fish could be entrained in the dredging device. The project includes dredging with both a clamshell dredge and hydraulic dredge and will occur over four months (August 1 to December 31) when juvenile salmonids species or eulachon are least likely to be in the area. Dredging will consist of removal of 126,000 cubic yards of sediment at water depths between minus 39 feet CRD to minus 50 CRD.

### Salmon

The probability of fish entrainment during dredging is largely dependent upon the likelihood of fish occurring within the dredge prism, dredge depth, fish densities, the entrainment zone (surface area of the clamshell impact plus the zone of induction for hydraulic dredges), location of dredging within the river, equipment operations, time of year, and species life stage. Demersal fish, such as sand lance, sculpins, and pricklebacks are most likely to have the highest rates of entrainment as they reside on or in the bottom substrates with life-history strategies of burrowing or hiding in the bottom substrate (Nightingale and Simenstad 2001). Larson and Moehl (1990) concluded that it is unlikely that anadromous fishes are entrained in significant numbers by dredges, at least outside of constricted river areas. The Columbia River is approximately 2,600 feet wide in the construction area, allowing large areas where fish can avoid dredge equipment.

The hydraulic dredge will operate at or below the river bed, and along with the clamshell dredge operations will be outside of the shallow nearshore depths. Juvenile salmonids prefer the shallow, nearshore depths rather than the minus 39 to 50-foot depth where dredging associated with the proposed action would occur; and are therefore unlikely to occur close enough to the dredging activity to be entrained. Adult salmonids are of sufficient size and speed to avoid potential entrainment and are therefore unlikely to be entrained. Consequently, the risk of entrainment of adult or juvenile salmon or steelhead by the dredge is extremely low and highly unlikely to lead to capture, death, or injury of these fish.

### Eulachon

Entrainment of adult eulachon in the clamshell or the hydraulic dredge is unlikely because: (1) they do not reside on the bottom of the channel where the dredging will occur; (2) eulachon density is lowest during the in-water work window (August 1 to December 31); (3) the contact

footprint of the clam shell and the hydraulic dredge is small, (4) dredging is done continuously in one small area causing eulachon to avoid the area; and (6) slow cycle times (time between buckets dredging the sediment) to control suspended sediment allow fish to swim out of the way.

Eulachon larvae would not be present in the water column until after the end of the in water work window and will not be exposed to dredging.

Entrainment of eulachon eggs during dredging is more likely. Adult eulachon enter the Columbia River from December through May and have appeared as early as November but peak adult abundance generally occurs in March. Eulachon spawn soon after the fish arrive and their eggs have an outer sticky membrane which sticks to particles of sand or other substrate (Gustafson et al., 2010b) so the eggs are transported downstream during bedload moving events. The eggs hatch in about 30-40 days and peak larval abundance can be expected 30 days later. Dredging has been timed to avoid when eulachon eggs are typically expected to be present. We do expect, if early spawners occur in the river, that low numbers of eggs released in November could be transported with bedload downstream into the project area in early December. Dredged material may be placed upland at the project site to provide material for construction or for other uses, or it may be placed at existing authorized in-water and upland placement sites which NMFS has analyzed in a prior consultation (NMFS No. NWR-2013-10116, dated July 15, 2013). If the dredge sediment is placed in-water, we would expect no effect to eulachon eggs. If the material is deposited upland, it is possible that eggs could be adversely affected. The proposed work window for this project ends in late December, prior to the peak of eulachon spawning (which occurs from March through June). This, timing reduces the likely abundance of eulachon eggs in the action area during the dredging, but does not eliminate the potential for eulachon entrainment from the proposed dredging.

## **Shipping**

### *Ship Wake Stranding*

#### **Salmon and Steelhead**

Ship wakes from OGV traffic transiting to the Columbia River to and from the NWIW facility will lead to indirect effects on salmon and eulachon species. Large, deep-draft vessels produce wakes that have been observed to strand juvenile salmon on beaches and have been identified as a threat to recovery of several salmon species on the Columbia River (NMFS 2011). The increase in OGVs resulting from the proposed action will likely increase the incidence of stranding and death of certain species of juvenile salmonids. Ship wake stranding is identified as a limiting factor in listings or recovery plans (NMFS, 2011) for LCR Chinook salmon, CR chum, and LCR coho salmon. The risk of wake stranding is more severe for smaller individuals, and as such, ocean-type Chinook originating from LCR tributaries and CR chum are particularly vulnerable. Larger, hatchery-reared components of the up-river ESUs or DPSs are less susceptible as they tend to outmigrate in deeper waters associated with the thalweg. Wake-stranding was rated medium low within a list of 17 threats in the Estuary Module for salmon recovery (NMFS 2011).

Five studies (Bauersfeld 1977, Hinton and Emmett 1994, Ackerman 2002, Pearson et al., 2006, and Pearson and Skalski 2010) have indicated and documented that under certain conditions, deep draft OGV can produce wakes that strand fish in the Columbia River. However, wake-stranding events are known to happen only when unique combination of physical conditions occur simultaneously with the presence of vulnerable salmonids, primarily ocean-type Chinook salmon originating from LCR tributaries. These physical conditions include size and speed of the vessel, distance from shore, river stage and tidal height, angle to the beach, beach slope and porosity characteristics, and whether the vessel is loaded (Pearson and Skalski, 2010).

Pearson et al., (2006) collected and analyzed data from three points in the Columbia River: Barlow Point (RM 62), County Line Park (RM 51, and Sauvie Island (RM 97) in 2004 and 2005 (Figure 9). Barlow Point (located approximately 10 miles downstream from the proposed project) had the highest occurrence of stranding, where 53 percent of observed vessels resulted in a stranding event. At Sauvie Island and County Line Park, the occurrence was lower, with 37 percent and 15 percent of vessels leading to stranding, respectively. Overall, approximately 36 percent of vessel traffic in the study led to strandings (Pearson et al., 2006) in winter, spring and summer ship passings. During 126 observed vessel passings in the Pearson et al., (2006) study, 426 Chinook, 8 chum, and 7 coho were identified stranded. The factors that influenced the occurrence of strandings included fish presence in the nearshore, the ship wake properties as they approached the shore, river elevation, and beach characteristics. Only three seasons of the year appear to have noticeable strandings. In addition, time of year and day at the Barlow Point site indicated that strandings only occurred during night passages during the summer season. Water quality, including dissolved oxygen, was sampled and was determined to be within expected limits.

Pearson et al., (2006) concluded that fish stranding occurred with larger vessels (bulk carriers, container ships, oil tankers, and car carriers) but was not observed with tug boats or smaller vessels. Different types of vessels, depending on size and bow configuration produced different patterns of wave draw-down and surge. From modeling different variables, ship speed was estimated to have the greatest effect on wave generation. For example, decreasing a 77-foot long beam ship's speed from 14 knots to 12 knots was predicted to have a 63 percent decrease in wake height (Pearson et al., 2006).

In addition to the above mentioned known stranding sites, a total of 208 river miles (104 miles on each side up to RM 104) of the LCR were spatially analyzed and Pearson et al., 2008 identified a total of 33 miles, or roughly 16 percent of shoreline was identified as having moderate physically-based susceptibility to stranding. A total of eight miles, or four percent of the 208 miles of shoreline identified, was described as having high susceptibility. Based on the location of the proposed project, and using Pearson et al., 2008 analysis we estimated that 10 miles below the project site or five percent of the shoreline could be susceptible to moderate risk stranding from vessels and one mile or one percent of the shoreline could be considered high risk to stranding.

As stated above, there are many variables that must occur at the same time for stranding to occur. There may be times, as reported in Hinton and Emmet (1994), where very few fish are affected. Then there may be years, as reported in Bauersfeld (1977) where thousands of fish are affected.

With all the variables that have been identified from the studies, there is still limited understanding of where and when the fish are vulnerable to stranding (ENVIRON 2012).

The action area includes two of the known stranding sites, County Line and Barlow, and as described above, approximately one mile of highly susceptible beach. We expect the proposed action to result in occasional stranding events when a few fish would be killed. Rarely, we expect a more significant event could occur in which a few hundred to a thousand or more juvenile fish may be killed. While as noted earlier a number of variables factor into the frequency and magnitude of wake stranding, we note that the numbers of fish affected in the Pearson study are quite low. The number of ship passages that will result from the proposed action is likewise relatively low (up to 72 round trips per year). Thus, we expect that small numbers of juvenile fish would likely be affected by wake stranding. These fish would be expected to be comprised mainly of LCR Chinook salmon, but would also include other species and multiple populations within these species. The level of mortality caused by wake stranding will not be high enough to have any observable impact on the long-term abundance trends of any of the affected species or their populations.

### Eulachon

No empirical, anecdotal, or other information was located that discusses wake stranding of eulachon. The adult migration period can range from December through April, but peaks in February and March (Emmett *et al.* 1991, WDFW and ODFW 2002). Spawning begins as early as December and January in the Columbia River system, peaks in February, and can continue through May. Eulachon adult are approximately 250 mm (fish 60 mm or smaller are the most likely to be stranded) and are less likely to migrate in the nearshore areas where stranding occurs. Therefore, adult eulachon are unlikely to be affected by ship wakes. Larval outmigration occurs 30 to 40 days after spawning. After hatching, larvae are carried downstream and are widely dispersed by estuarine and ocean currents. If larvae were stranded, it would be very unlikely that they would be recognized due to their small size (eggs 1mm, larva 4-8mm). As such, we believe it is reasonable to assume some larvae may be stranded and die as a result of wakes created by OGVs originating or heading to the methanol facility. Although the OGV traffic is likely to kill or injure juveniles in the area, the overall percentage of individuals that could be present during an individual wake stranding event is small.

### *Harassment from Increased OGV Traffic*

As discussed in section 2.3, the proposed upgrade of the dock will increase the amount of OGV traffic in the local area by four percent. Boating activity affects ESA-listed fish in a number of ways. The physical presence of boat hulls may disturb or displace nearby fishes (Mueller 1980). Boat activity can cause physiological harm to fish. Graham and Cooke (2008) studied the effects of three boat noise disturbances (canoe paddling, trolling motor, and combustion engine (9.9 hp)) on the cardiac physiology of largemouth bass (*Micropterus salmoides*). They found that exposure to each of the treatments resulted in an increase in cardiac output in all fish, associated with a dramatic increase in heart rate and a slight decrease in stroke volume, with the most extreme response being to that of the combustion engine treatment. Recovery times were the least with canoe paddling (15 minutes) and the longest with the power engine (40 minutes). They

postulate that this demonstrates that fish experienced sublethal physiological disturbances in response to the noise propagated from recreational boating activities. Directly, engine noise, prop movement, and the physical presence of a boat hull will likely disrupt or displace nearby fishes (Mueller 1980).

Only a portion of the Columbia River will be affected by increased ship traffic from the proposed action, particularly in close proximity to the dock where OGVs will moor and where they will transit the river. In addition, the occurrence of increased ship traffic will occur during only a portion of the time (approximately 6 days/months). The fish present are likely to suffer some of the adverse effects described above, but no fish are expected to die as a result of this exposure because the effects will be short term and the fish will be able to utilize other areas of the river for migration.

### *Bank Erosion*

Several studies have cited large waves caused by OGV traffic and other vessels as a source of bank erosion in rivers and other waterways (Long, 2007, McConchie and Toleman, 2003, Laderoute and Bauer, 2013, Cameron and Bauer, 2014). Propeller wash from ships in transit, as well as wakes breaking on shore, can cause erosion along unarmored sections of shoreline. Erosion can re-suspend eroded material within the water column, increasing turbidity, which can affect habitat suitability for ESA-listed fish, as well as for other aquatic organisms. This has the potential to result in degradation of habitat suitability. Changes or disruptions to riparian areas can threaten the survival of species that rely on this kind of habitat during their various life stages. They depend on these areas for breeding, spawning, nesting, feeding, growing and escaping from predators. Protecting such critical habitat is important.

Because erosion typically precedes bank armoring, we assume the operation of the methanol facility will indirectly affect nearshore habitat processes in a way that will promote bank armoring into the future for protection of property. Hardening of shorelines removes existing off channel habitat or precludes the formation of off channel habitat that is important juvenile salmon rearing habitat. As such, we expect some amount of erosion of riparian salmonid habitat, particularly for ocean-type juveniles from the Lower Columbia River that rear in shallow, nearshore margins of the Columbia River. We would expect the effects to be minor due to the limited amount of OGV traffic from this site (up to 72 methanol OGV round trips per year). Similarly, to the extent this minor amount of erosion leads to bank hardening, the amount of such hardening is expected to be very minor and to occur after years of erosion.

### *Ballast Water*

In order to provide adequate stability to vessels at sea, ballast water is used to weigh the ship down and lower its center of gravity. Vessel operators take on ballast water while the ship is at port or soon after leaving port. Discharge of ballast, occurs when the ship enters protected waters or while at port when the vessel is loading cargo (PSAT 2007). When ships take on ballast water, plants and animals that live in the region are also picked up. Discharging this ballast water releases these organisms into new areas where they can become harmful to economics and the environment. Not all newly established invasive species are harmful to listed species or their

critical habitat. Past research has concluded that the proportion of invasive species introduced from ballast water that are harmful ranges from approximately 15 percent to 19.9 percent (NMFS 2012).

Non-native species most often have indirect impacts to listed species through habitat alteration, which can result in changes in prey availability, changes in accessible habitat or cover, changes in predation risk due to effects on water clarity, and changes in water quality. Non-native species can also affect listed species or their critical habitat directly through competition, predation, or disease (NMFS 2012).

The States of Oregon and Washington require that ballast water be exchanged at sea or treated to eliminate living organisms prior to discharge (WDFW 2009, ODEQ 2011). In addition, NMFS developed a biological opinion addressing the United States Coast Guard's national ballast water management program and initial numerical standard. NMFS found that the discharge of ballast water using the initial numerical standard is not likely to jeopardize the continued existence of endangered or threatened species in the Columbia River (and elsewhere) (NMFS 2012). Vessels employing a Coast Guard approved ballast water management system must meet the following (USCG 2012):

- Organisms greater than or equal to 50 micrometers in minimum dimension, discharge must include fewer than 10 organisms per cubic meter of ballast water,
- Organisms less than 50 micrometers and greater than or equal to 10 micrometers, discharge must include fewer than 10 organisms per milliliter of ballast water,
- Toxicogenic *Vibrio cholerae* must be at a concentration of less than 1 colony forming unit (cfu) per 100 milliliter,
- *Escherichia coli* concentration must be fewer than 250 cfu per 100 milliliter, and
- Intestinal enterococci must have a concentration of fewer than 100 cfu per 100 milliliter.

The exchange of ballast water offshore replaces lower salinity ballast water with higher salinity water. The deeper ocean waters tend to contain relatively fewer organisms and any organisms entrained during the deep water exchange are not likely to survive in fresh or brackish water environments. Vessels that discharge effectively exchanged or partially exchanged ballast water still can pose a moderate risk (PSAT 2007).

Even though OGV transiting to and from the proposed facility are expected to comply with the Coast Guard standards, listed species and habitat will likely still be exposed to ballast water discharges with non-native organisms at any standard other than zero discharge of non-natives (NMFS 2012). Therefore, there remains a potential for accidental introduction of species into the Columbia River if ballast water from OGV associated with the proposed action is discharged that contains organisms capable of colonizing freshwater habitats. The impacts of introductions on fish species in the Columbia River will be dependent upon the species that is introduced, its success in reproduction in the river, and the impacts it ultimately has on the natural ecosystem in the river.

NMFS (2012) stated that Columbia River species and their critical habitat are likely to be harmed by no more than one ballast-mediated harmful invasive species per year, and at a total,

no more than one in the next 16 years from all of the vessel traffic that will be utilizing the region. This region encompasses Washington, Oregon, Idaho, and includes parts of Nevada, Montana, Wyoming, and British Columbia (region). The 2012 opinion assumed future introductions based on their historic rate of introductions in San Francisco Bay. The Opinion cautioned that because San Francisco Bay is the most invaded body of water in the US and possibly the world, that invasion rate can be used as a conservative estimate for all ports in the U.S. (NMFS 2012).

We determined, in our previous 2012 biological opinion that the modeled level of impact from all vessel traffic in the region was not likely to result in jeopardy to listed species or adverse modification of critical habitat. The 2011 Lower Columbia Estuary Recovery Plan (NMFS 2011) lists the risk of invasives becoming established as a very low threat probability of occurring. Because the possibility of invasive species introduction is expected to be small for the entire region and the Columbia River action area is only a portion of the region that was analyzed in the previous Opinion, we expect the possibility of invasive species introduction from OGV traffic utilizing the NWIW site to be quite low.

#### *Risk of Methanol Spill*

The overall proposed action includes the manufacture, loading, and shipping of methanol. Methanol is also known as wood alcohol or methyl alcohol. Methanol is a liquid that evaporates easily, is biodegradable, completely dissolves in water, and has a low aquatic toxicity (PAN 2016).

Groundings and collision events involving tankers are rare on the Columbia River. Only one collision and one grounding event involving tankers occurred between 2002 and 2013, and no events have been reported since 2013. On a worldwide basis, the frequency of accidents and the range of the volume of spills of petroleum products following shipping accidents have decreased for four consecutive decades. The methanol spill scenario modeled for this project was considered a worst case scenario given the very low probability of such a collision, and the fact that the volume of the modeled spill (one million gallons) far exceeds any spills reported to date from collisions involving double hull tankers transporting petroleum products in a river or channel environment (Geosyntec Consultants 2016).

The greatest concern with a methanol spill is not its toxicity to fish but rather the reduction of dissolved oxygen (DO) caused by the biodegradation process (Geosyntec Consultants 2016). The maximum concentration of methanol observed in the water quality simulation was approximately 1,200 milligrams per Liter (mg/L) at the source which quickly declines as it mixes with water. Toxic effects from methanol reportedly range from 1,700 mg/L for goldfish to between 15,400 mg/L and 28,100 mg/L for other species (U.S. EPA, 1994). Since the simulated methanol concentration is below the criteria for acute fish toxicity, should a spill occur, it is not anticipated to pose an acute risk for any ESA-listed fish species

The minimum DO concentrations that were modeled indicate more complex behavior, due to the time dependence of the methanol biodegradation. The duration of low DO concentrations is of importance since marine organisms can typically survive exposure to low DO concentrations for

a limited period of time. The following thresholds have been identified for migrating salmonid (Roegner *et al.* 2011):

1. Hypoxic or severe biological stress (0 to 2 mg/L);
2. Moderate biological stress (>2 to 4 mg/L);
3. Mild biological stress (>4 to 6 mg/L);
4. Normoxic (>6 to ~9 mg/L); and
5. Supersaturated (>9 to 10 mg/L).

The simulated minimum DO concentrations remained greater than 2 mg/L at all locations following this spill scenario. The lowest minimum DO modeled was 3 mg/L for a few hours until the next tidal cycle occurred and was spatially isolated to the only one area. The DO remained higher, the farther downstream modeling occurred, where greater mixing of water happened. Should a spill occur, fish may suffer from moderate biological stress for a few hours as they move through the area.

NWIW has spill contingency plans with the Environmental Protection Agency, U.S Coast Guard, and the Washington State Department of Ecology that cover potential spills in the Columbia River and the marine environment. Given the low probability of a severe collision in the Columbia River and the limited amount of OGV traffic (up to 72 methanol OGV round trips per year), the overall risks to ESA-listed fish would be expected to be low.

#### *Risk of Oil Spill*

Depending on the location and time of year, a tanker collision that results in the spill of oil that is carried for the purpose of operating the vessel into the Columbia River could affect migrating juvenile and adult LCR Chinook salmon, UWR Chinook salmon, UCR spring run Chinook salmon, SR spring/summer run Chinook salmon, SR fall Chinook salmon, LCR coho salmon, SR sockeye salmon LCR steelhead, UWR steelhead, MCR steelhead, UCR steelhead, MCR steelhead, UCR steelhead, SR steelhead, Southern green sturgeon and all life stages of CR chum salmon and eulachon. The oil would be part of the operation of the vessel and not being transported as cargo.

Logan *et al.* (2015) provides a good summary of the acute toxic effects of oil to fish. The components of oil that are acutely toxic include low molecular weight alkanes, benzene, toluene, ethylbenzene, xylenes (BTEX), and naphthalene because these compounds are sufficiently water soluble to partition from the non-aqueous phase liquid (NAPL) to the water and reach lethal concentrations. These compounds pass through juvenile and adult fish gill cell membranes, concentrate in the lipid fraction of organs and cause narcosis for days or longer. Since low molecular weight organic compounds are volatile and biodegradable, their aqueous concentration decreases rapidly and acute effects depend on a steady source of oil, such as a pipeline leak, to sustain high aqueous phase concentrations.

Tjeerdema *et al.* (2007) exposed Chinook salmon smolts for 96 hours to various concentrations of Prudhoe Bay crude oil in seawater such that the concentration of crude oil decreased from the initial concentration to zero over 8 hours to simulate dilution and dispersion. The average 96

hour LC50 s was 7.46 milligram per liter. Muscle and liver samples from surviving fish revealed metabolic changes at concentrations significantly lower than the LC50 and concluded that exposure to crude oil could possibly delaying smolt development.

Kazlauskiene et al. (2008) performed a four day and a 14 day crude oil toxicity tests on juvenile and adult rainbow trout by exposing them to 0.87 and 1.73 grams crude oil per liter (1.73 g/L consisted of 28.2 mg/L of dissolved constituents and a dispersed NAPL). They found these doses to not be lethal to juveniles or adults although that both concentrations increased heart rate and gill ventilation frequency. The most obvious difference in these tests is that Tjeerdema tested in closed tanks and simulated mixing by diluting with clean seawater and Kazlauskiene tested in open tanks so that volatile compounds could be removed by evaporation. It may be that the volatile compounds evaporated from the Kazlauskiene test faster than they were diluted in the Tjeerdema test. Kazlauskiene concluded that fish kills are usually caused by large amounts of oil that become trapped in shallow waters and that it is unlikely that large numbers of fish inhabiting large bodies of flowing water would be killed by the toxic effects of petroleum.

As describe above in the methanol spill analysis, NWIW has spill contingency plans with the Environmental Protection Agency, U.S Coast Guard, and the Washington State Department of Ecology that cover potential spills in the Columbia River and the marine environment. The on-board oil quantity is used only for operation of the OGV and is not a component of the transported materials. Given the low probability of a severe collision in the Columbia River, the relatively small amount of oil on-board, and the limited amount of vessel traffic (up to 72 methanol OGV round trips per year), the overall risks to ESA-listed fish would be expected to be low.

### **Mitigation**

To mitigate the effects of the proposed action, the applicant proposes to remove approximately 157, 12- to 14-inch diameter treated timber piles associated with a deteriorated timber pile structure in the freshwater tidal backwater channel adjacent to the project site, install ten ELJs within the nearshore habitat along the Columbia River shoreline adjacent to the site, to conduct riparian enhancement and invasive species management within an area approximately 2.42 acres in size along the Columbia River shoreline, and to preserve approximately 90 to 95 acres of habitat north of the project site.

The proposed pile removal will restore approximately 123 square feet of benthic habitat, improve fish access, and improve hydraulics and sediment transport within approximately 13 acres of backwater habitat that provides refugia for outmigrating and wintering juvenile salmonids. The installation of ELJs will increase aquatic habitat complexity with interstitial spaces that will allow juvenile and adult salmonids to evade predation. They will also provide refuge and foraging opportunities for both juvenile and adult salmon, particularly for small outmigrant fish moving downstream during the spring and early summer peak of outmigration activity. The proposed riparian restoration would result in both terrestrial and aquatic habitat improvements by providing a biologically productive riparian habitat that would serve as a source of insect and invertebrate fauna, leaf litter, detritus, and woody debris to the aquatic system. The riparian enhancements would also provide natural streambank stability, minimizing bank erosion and

sedimentation. The proposed plantings will replace native vegetation that is impacted as a result of the project, and will help establish a forest canopy where none currently exists. The area proposed for the restrictive covenant contains high quality habitat, including critical habitat for several populations of ESA-listed salmonids. Small amounts of suspended sediments will occur when piles are pulled, but the water quality effects will be temporary, localized, and will not be more than what natural exists in a dynamic system. Work will be done when juvenile fish are least likely to be present or will be done in the dry to minimize any effects.

Overall, restoration will address limiting factors described in the Recovery Plan (NMFS 2013) that are recognized to decrease individual fitness, survival, and productivity of salmonid populations. These benefits in habitat suitability will translate in proportionally increased abundance, productivity, and survival of LCR populations. For example, restoration via increasing riparian vegetation will result in more autochthonous input to the stream and will provide cover and shade. The preservation of off-channel habitats, the addition of large woody debris structures, and removal of piles will restore the habitat-forming process. This habitat will, in time, result in increased spawning success and likely increased forage abundance for listed fish. This increased food abundance will in times of food limitation translate into increase growth, individual fitness, and survival. Thus, we are reasonably certain, that the restoration will proportionally increase abundance and productivity of listed fish. We expect, that as intended, it will offset some of the losses that likely will be incurred from indirect and direct effects related to the structure being permitted.

### **Water Supply**

The proposed project will require water for industrial process uses as well as for domestic uses (*e.g.*, drinking, sanitation, showers, etc.) when constructed. Domestic water will be provided by the City of Kalama's water supply system. Process water will be provided by a collector well (Ranney well) to be constructed by the Port near the Columbia River shoreline. Ranney wells pull water out of deep alluvium in the river bottom, avoiding any possibility of impinging or entraining fish. The well will be constructed under Groundwater Permit No. G2-30283 issued by the Washington State Department of Ecology (Ecology). The groundwater permit allows the use of up to 10,640 acre feet and 6,600 gallons per minute (gpm) of water for various uses, including industrial activities. It is estimated that the proposed project will use approximately 5 million gallons per day (mgd) of process water, or approximately 5,700 acre feet or 440gpm.

The volume of water withdrawn from groundwater will be small relative to the flows in the Columbia River; flows in the tidal portions of the river typically range between 110,000 and 400,000 cubic feet per second (cfs) (<http://waterdata.usgs.gov/wa/nwis/>). (The average discharge of the Columbia River at its mouth is approximately 265,000 cfs [Kammerer 1990]). The approximately 440 gpm that the project will use represents approximately 1.0cfs, which is less than 0.0001 percent of even the lowest anticipated flows in the river.

### **Pipeline Construction**

The proposed project includes the COE issuance of a permit to NW Pipeline LLC for the Kalama Lateral Pipeline that will connect the Kalama methanol facility with the existing NW Pipeline

mainline (COE # NWP-2015-111 0). Northwest Pipeline LLC requested authorization to construct and operate about 3.1 miles of natural gas transmission pipeline to provide approximately 320 million cubic feet per day of natural gas to the NWIW proposed methanol production facility.

The 3.1-mile linear project will cross seven water bodies during construction. Five of the seven waterbodies are intermittent and are expected to be dry during construction. According to Washington State Department of Fish and Wildlife, the remaining two waterbodies could support anadromous salmonids. However, due to the flow patterns, and limited connection with the Columbia River, these two waterbodies likely provide at best only limited rearing, refugia, or potential foraging habitat for occasional fish that may stray into the area or may enter during extremely high-water periods in the Columbia River when backwater flows may occur. These streams will be crossed using a horizontal directional drill that will avoid any direct effects to the waterbody and subsequently will avoid any direct or indirect effects to anadromous salmonids or their critical habitat.

NW Pipeline safety is regulated by the U.S. Department of Transportation under the Pipeline and Hazardous Materials Safety Administration (PHMSA). According to the Environmental Assessment, prepared by NW Pipeline (2015), the transportation of natural gas by pipeline involves some incremental risk due to the potential for accidental release of natural gas. The greatest hazard is a fire or explosion following a major pipeline rupture. Methane, the primary component of natural gas, is colorless, odorless, and tasteless. It is not toxic, but is classified as a simple asphyxiate, possessing a slight inhalation hazard. Methane has an auto-ignition temperature of 1,000 degrees Fahrenheit and is flammable at concentrations between 5.0 percent and 15.0 percent in air. An unconfined mixture of methane and air is not explosive; however, it may ignite and burn if there is an ignition source. Because any accidental release would be air-borne, we would not expect aquatic resources to be affected.

To maintain accessibility to the right-of-way and accommodate pipeline integrity surveys, vegetation along the pipeline right-of-way would be cleared periodically, using mechanical mowing, cutting, and trimming where necessary, and in accordance with NW pipeline erosion control and revegetation plan. Vegetation removal at above-ground facilities owned by Northwest would be conducted in the same manner, except that selective use of herbicides may be employed. Herbicides may also be selectively used to control noxious weed infestations. Application of herbicides and other maintenance actions will be conducted during the dry season and will observe applicable BMPs to avoid waterbodies and any biota that may be present. As such, we do not expect any direct or indirect effects on species or critical habitats resultant from maintenance activities related to the pipeline.

We expect that the construction of the pipeline will not affect any listed species or critical habitat.

### **Summary of Effects.**

**Salmon and Steelhead.** The in-water work required for the proposed action is scheduled to occur during days of the year when juvenile salmonids could be present for either rearing or

migration; however, it will not occur during peak abundance. Adults of the following species will be present in the action area during the in-water work: LCR fall Chinook salmon-peak occurrence; LCR coho salmon-peak occurrence; UWR steelhead-relatively abundant; and CR chum-relatively abundant. All ESA-listed fish species will be present in the action area during year-round operation of the dock, including the increased OGV traffic.

Several of the effects of the proposed action will not likely result in any measurable effect to listed salmon or steelhead. These include entrainment during dredging; harassment, ballast water discharge, methanol or oil spill from increased OGV traffic; mitigation; water use, and construction/operation of the pipeline. The effects that are likely to result in measurable effects to listed fish are elevated noise during pile driving, shade, increased predation from the new structures, and wake stranding and erosion from ship traffic.

Some of the fish present will incur short-term stress due to elevated noise and reduced water quality during pile driving and dredging. Any non-lethal stress experienced by individual fish from these activities is likely to be brief (minutes to days). A few salmon or steelhead may be injured or killed by pile driving or they may be harmed by the culmination of joint causes, such as a previous wound inflicted by the environmental baseline and genetic weakness.

Although the applicant has designed the terminal to minimize effects on ESA-listed species by moving the greatest part of the structure into deeper water away from nearshore juvenile migration, the solid platform trestle over nearshore habitats will increase shading and potentially increase the chance of predation on juvenile salmonids by predatory fish. Pilings associated with the trestle will cause habitat conducive to predators by slowing water velocities, however the distances between pilings will render this effect relatively minor. Large numbers of predators naturally exist in this section of the river and we would expect predation to occur whether the structure was constructed or not. Shading from the new structures will also likely have minor effects because the area does not have much submerged aquatic vegetation naturally and the piles themselves will likely grow organisms that replace to some extent the benthic habitat displaced by the piles. Still, we expect that the effects of the nearshore over water trestle and associated pilings could injure or kill a few individuals. Smaller, nearshore dependent salmon in this area such as LCR Chinook, LCR coho, UWR Chinook, and CR chum salmon are the most likely to be affected by predation resulting from the overwater coverage and the approximately eight pilings located in nearshore habitat.

Increases in OGV traffic in the LCR by future terminal construction will result in increases in ship wake stranding of juvenile salmonids, and exacerbation of nearshore habitat erosion and degradation as discussed in section 2.4.1. The habitat effects of ship traffic are likely to be minor for reasons described in that section. The increase in OGV traffic resulting from the proposed action will likely increase the incidence of stranding and death of juvenile salmonids from ship wake stranding. Ship wake stranding is identified as a limiting factor for LCR Chinook salmon, CR chum, LCR and coho salmon. Wake stranding is more severe for smaller individuals, and as such, ocean-type Chinook originating from LCR tributaries and CR chum are particularly vulnerable: larger, hatchery-reared components of the up-river ESUs are less susceptible as they tend to outmigrate in deeper waters associated with the river thalweg.

All sources of mortality and injury caused by the proposed action are likely to be minor even when considered collectively. Effects on LCR Chinook salmon, CR chum, LCR coho salmon, and LCR steelhead might be a little higher than on others due to small size of fish affected, but still relatively small compared to the size of the populations. Thus, while individual salmon and steelhead are expected to be adversely affected, the number of any one ESU or DPS affected is not likely to rise to the level at which population-level effects would be expected.

**Eulachon.** Entrainment from dredging could negatively affect eulachon eggs. Eggs from adults that spawn in the upstream Columbia River in November could be transported with bedload into the Columbia River in early December where they could be dredged at the end of the work window. The small occurrence of early spawners is dependent on environmental variables, which cannot be predicted with any certainty. The project has been timed to avoid the major portion of the eulachon spawning (peak abundance occurs in March). In summary we expect the number of eulachon affected to be small.

As with salmon, the increases in OGV traffic from future development in the LCR will result in increases in wake stranding to eulachon larvae and may have a negative effect to the species and their recovery. Larval eulachon are expected to be in the LCR and nearshore areas between January and April in a given year and only a proportion of new shipping traffic would be transiting LCR during that time of year. During that time, we would expect that larval eulachon in the vicinity of the known stranding spots and along the 1 mile of highly susceptible beaches could be stranded. We assume that larvae eulachon are widely distributed in the LCR and those at the stranding spots and highly susceptible beaches represent an extremely small portion of the larvae population. Further, as we currently understand the data, ship wakes that result in stranding do not occur with every passing. While larvae densities are unknown – we expect an extremely small proportion of the larvae population to be stranded – such that we would be able to detect an impact at the overall population level.

Because the area of affect is small compared to the entire river system and that work will be done when eulachon are less likely to be present, all sources of mortality and injury caused by the proposed action are likely to be minor even when considered collectively and are not likely to rise to the level at which population-level effects would be expected

**Marine Mammals and Leatherback Sea Turtles.** Thirteen species of ESA-listed marine mammals and leatherback sea turtles occur in the Pacific Ocean portion of the action area.

**Increased Risk of Ship Strikes on Marine Mammals and Sea Turtles.** As discussed in the Environmental Baseline section, collision with OGV remains a source of anthropogenic mortality or serious injury for both sea turtles and whales.

The proposed project will lead to increased long-term operation of the dock that would not exist but for the proposed action. We assume that the risk of an OGV collision is proportional to the number of whales and OGVs in an area; however, defining the proportionality requires more information than is currently available at this scale. The increase in marine OGV traffic (72 round trips per year) from the proposed action will result in some increased risk of a ship strike

with blue whales, fin whales, humpback whales, sperm whales, and leatherback sea turtles because of the overlap between OGVs and whales and leatherbacks. The destination of ships leaving the proposed facility is also likely to change over time based on many factors including market demand. It is therefore impossible to compare the precise overlap in shipping and whale density to estimate the increased risk of a collision. In spite of being one of the primary known sources of direct anthropogenic mortality to whales, and to a lesser degree, sea turtles, ship strikes remain relatively rare, stochastic events, and a 4 percent increase in ship traffic entering and exiting the Columbia River would not necessarily translate into a 4 percent increase in ship strikes. In the context of all of the shipping traffic in the range of the whales and leatherbacks in the action area, the increase in total ship traffic is an even smaller percentage. Nonetheless, the risk of a collision between an OGV and a whale or leatherback sea turtle will increase due to new traffic in the future.

**Effects of Ship Strikes on Marine Mammals.** Large whales are vulnerable to injury and mortality from ship strikes (Vanderlaan and Taggart 2007). Due to the overlap of heavy shipping traffic and high whale density, Oregon and Washington waters are a high risk area for ship strike events, particularly in the continental shelf and shelf slope (Laist *et al.* 2001).

The effects of a ship strike will impact all ESA-listed marine mammals considered in this opinion in a similar nature (i.e., it will injure or kill them). Although the occurrence is variable for different species in the action area, the effects will occur year-round and will have an equal chance of affecting individuals of different species. Therefore, we are not conducting an individual analysis of ship strike effects on each species of marine mammal.

In U.S. waters, ship strikes account for tens of large whale deaths per year (Con and Sibley 2013, Henry *et al.* 2012, Van der Hoop *et al.* 2012), and in the hundreds of deaths each year globally (Con and Sibley 2013, Laist *et al.* 2001, Jensen and Sibley 2003, Van Waerebeek *et al.* 2007). The documented number of ship strikes is an underestimate of the actual number of collisions because ship strikes have a low probability of detection (Laist *et al.* 2001, Con and Sibley 2013).

Ship strike injuries to whales include propeller wounds characterized by external gashes or severed tail stocks, blunt trauma injuries indicated by fractured skulls, jaws, and vertebrae (Laist *et al.* 2001), and hemorrhaging that sometimes lacks external expression (Con and Sibley 2013). Collisions with smaller OGV may result in propeller wounds or no apparent injury, depending on the severity of the incident. A majority of whale ship strikes seem to occur over or near the continental shelf, probably reflecting the concentration of OGV traffic and whales in these areas (Laist *et al.* 2001). As discussed in the Status of the Species section, all whales are potentially vulnerable to collisions with ships in areas where there is overlap.

Limited data are available on whale behavior in the vicinity of an approaching OGV and the hydrodynamics of whale/OGV interactions. The conservation measures outlined in the NOAA Fisheries West Coast Region Recommendations to Avoid Collisions are the best available means of reducing ship strikes of whales: (1) Consult the Local Notice to Mariners in your area or Coast Pilot for more information; (2) Keep a sharp look-out for whales, including posting extra crew on the bow to watch, if possible; (3) Reduce speeds while in the advisory zones, or in areas of high seasonal or local whale abundance; and (4) If practicable, re-route OGV to avoid areas of high

whale abundance (available at: [http://www.westcoast.fisheries.noaa.gov/protected\\_species/marine\\_mammals/ship\\_strikes\\_recommendations.html](http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/ship_strikes_recommendations.html)).

OGV size and speed are associated with the number and severity of ship strikes with whales. Of collisions that killed whales, at least 87 percent involved ships more than 250 feet long (Laist *et al.* 2001). There is a significant positive relationship between ship speed and the probability of a lethal injury (Conn and Sibley 2013). Vanderlaan and Taggart (2007) reported that the greatest probability of a lethal injury to a large whale occurs between OGV speeds of 8.6-15 knots. The OGVs that will be used for the proposed methanol project will be 600-900 feet long and will travel up to 20 knots when in the Pacific Ocean. Given the length and the speeds at which the OGVs are likely to travel, they pose some risk of collision between these OGVs and marine mammals. In addition, the OGVs proposed for the methanol project may not use NOAA Fisheries West Coast Region Recommendations to Avoid Collisions, and there are no regulations currently in place to restrict OGV activity in the vicinity of whales in the action area. As such, there is a high likelihood that the whales may not be able to avoid approaching OGVs, particularly when traveling at higher speeds. Based on the above, NMFS assumes that any whales struck by OGVs will likely die as a result of OGV collision.

The proposed project will lead to increased long-term operation that will increase the amount of OGV traffic, and will result in some increased risk of ship strike, and a high likelihood of death, if struck, of listed species. Due to the limited information available regarding the incidence of ship strikes and the factors contributing to ship strike events, it is impossible to determine how a particular number of OGV transits or a percentage increase in OGV traffic will translate into a number of likely ship strike events. Although we do not have sufficient information to conduct a quantitative analysis linking the increased OGV traffic associated with the project to a potential number of ship strikes or mortalities in the action area, we can qualitatively assess the relative risk from the project in the context of existing information on population size and the current number of ship strikes for the large whales commonly found in the action area. In the context of all of the shipping traffic in the range of the whales in the action area, the increase in total ship traffic from the proposed action is a small percent of total shipping traffic.

After considering the available information on risk of OGV whale strikes, we conclude that the risk posed by the proposed action is minimal and the total number of strikes on marine mammal species considered in this opinion is expected to be very small because:

1. The increase in OGV traffic in the action area is small.
2. Although ship strike events often go unreported, they are a relatively rare event.
3. The total area affected by increased OGV traffic is a small portion of the affected stocks of marine mammals' overall available habitat.

**Effects of Ship Strikes on Leatherback Sea Turtles.** Interactions between OGVs and sea turtles occur and can take many forms, from the most severe (death or bisection of an animal or penetration to the viscera), to severed limbs or cracks to the carapace which can also lead to mortality directly or indirectly. Sea turtle stranding data for the U.S. Gulf of Mexico and Atlantic coasts, Puerto Rico, and the U.S. Virgin Islands show that between 1986 and 1993, about 9

percent of living and dead stranded sea turtles had propeller or other boat strike injuries (Lutcavage *et al.* 1997). Between 2000 and 2005, there were three reported boat collisions with leatherbacks off the coast of California, and fate of these turtles is unknown (SWR stranding data base). Two of the reports documented damage to the carapace, head, or flippers. In 2008, there was another boat collision reported off Cayucos Point, California and the turtle was observed dead (SWR stranding data base). Ship strikes likely go largely unreported, and may pose a threat to leatherbacks in foraging areas like the Gulf of the Farallones (Benson *et al.* 2007b). This number underestimates the actual number of boat strikes that occur since not every boat-struck turtle will strand, every stranded turtle will not be found, and many stranded turtles are too decomposed to determine whether the turtle was struck by a boat. It should be noted, however, that it is not known whether all boat strikes were the cause of death or whether they occurred post-mortem (NMFS SEFSC 2001).

Information is lacking on the type or speed of OGV involved in sea turtle ship strikes; however, there does appear to be a correlation between the number of vessel-struck turtles and the level of recreational boat traffic (NRC 1990). Sea turtles have been reported with injuries consistent with propeller wounds, which are likely from interactions with small, fast moving vessels, such as recreational boats.

Although little is known about a sea turtle's reaction to OGV traffic, sea turtles are thought to be able to avoid injury from slower-moving OGVs (under 2 knots) since the turtle has more time to maneuver and avoid the OGV (Hazel *et al.* 2007). The OGVs will be travelling at high speeds (12-20 knots). As such, there is a high likelihood that sea turtles will not be able to avoid an approaching OGV and will incur injury or death from a collision.

The proposed project will lead to increased long-term operation that will increase the amount of OGV traffic, and will result in some increased risk of vessel strike, and a high likelihood of death, if struck. We estimated the number of leatherback sea turtles that could potentially be killed or injured from OGV strikes. The likelihood of a OGV encountering a leatherback sea turtle is based on the area of a OGV's path through the critical habitat off the coast of Oregon and Washington (25,004 square miles), and the number of turtles in that area. There are not reliable abundance estimates for the foraging population of leatherback sea turtles for Oregon and Washington waters; however, Benson *et al.* (2007b) estimated foraging population abundance for California. Estimates were linked to the Northern Oscillation Index and ranged from 12 in 1995 to 379 in 1990. Greatest densities were found off central California and in waters off the Columbia River, where oceanographic retention areas or upwelling shadows created favorable habitat for leatherback sea turtle prey (*Scyphomedusae*) (Benson *et al.* 2007b, 2011, and NMFS 2012a).

Given that the foraging area off the Columbia River is similar in characteristics to central California, we assume there are similar numbers of leatherback sea turtles in the action area. We used the highest number of leatherback sea turtles determined for California (379) to give the benefit of the doubt to the species.

Based on our calculations in Appendix 2, we expect that any one OGV has a 0.5 percent chance of encountering a leatherback sea turtle while crossing the action area, and the effects of each

encounter may vary from minor (e.g., sound only) to severe (e.g., death due to direct impact). Some of the assumptions behind this include that the OGVs have an equal chance of encountering leatherback sea turtles that the leatherback sea turtles are evenly distributed throughout the critical habitat, and that leatherback sea turtles are present approximately half of the year. We expect the number leatherback sea turtles to be struck during the next several decades as a result of the proposed action to be discountable.

**Effects of Acoustic Disturbance on Marine Mammals.** When anthropogenic disturbances elicit responses from marine mammals, it is not always clear whether they are responding to visual stimuli, the physical presence of humans or manmade structures, or acoustic stimuli. Because sound travels well underwater, it is reasonable to assume that, in many conditions, marine organisms would be able to detect sounds from anthropogenic activities before receiving visual stimuli. As such, exploring the specific effects of sound on marine mammal and sea turtle behavior provides a reasonable and conservative estimate of the magnitude of disturbance caused by vessel traffic.

Marine organisms rely on sound to communicate with conspecifics and derive information about their environment. There is growing concern about the effect of increasing ocean noise levels due to anthropogenic sources on marine organisms, particularly marine mammals. Effects of noise exposure on marine organisms can be characterized by the following range of physical and behavioral responses (Richardson *et al.* 1995):

1. Behavioral reactions—Range from brief startle responses, to changes or interruptions in feeding, diving, or respiratory patterns, to cessation of vocalizations, to temporary or permanent displacement from habitat.
2. Masking—Reduction in ability to detect communication or other relevant sound signals due to elevated levels of background noise.
3. Temporary threshold shift—Temporary, fully recoverable reduction in hearing sensitivity caused by exposure to sound.
4. Permanent threshold shift—Permanent, irreversible reduction in hearing sensitivity due to damage or injury to ear structures caused by prolonged exposure to sound or temporary exposure to very intense sound.
5. Non-auditory physiological effects—Effects of sound exposure on tissues in non-auditory systems either through direct exposure or as a consequence of changes in behavior, (e.g., resonance of respiratory cavities or growth of gas bubbles in body fluids).

Source level data specific to the OGVs proposed to be used for this project are not available; however, data exist for other tankers of similar size and power. Large commercial OGV and supertankers have powerful engines and large, slow-turning propellers. These OGV produce high sound levels, mainly at low frequencies. At these frequencies the noise is dominated by propeller cavitation noise combined with dominant tones arising from the propeller blade rate (Neptune 2005). A large bulk cargo ship called the Overseas Harriette has been used previously as a model for an LNG carrier in transit and transmitted a dominant frequency of 50 Hz (Neptune 2005).

Blue, humpback, and fin whales are all known to be sensitive to sounds within the frequency ranges of OGV noise. Blue whales vocalize at frequencies between 12.5-200 Hz (Au *et al.*

2000). Sperm whales are odontocetes, and are considered mid-frequency specialists rather than low frequency specialists, although sperm whales are also known to produce loud broad-band clicks from about 100 Hz to 20 kHz (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995). The only data on the hearing range of sperm whales are evoked potentials from a stranded neonate (Carder and Ridgway 1990). These data suggest that neonatal sperm whales respond to sounds from 2.5-60 kHz. OGV noise will not likely be within the most sensitive hearing frequency of sperm whales.

None of the noise associated with vessel activity is expected to reach levels that would potentially cause direct physical injury (*i.e.*, ear drum damage) to marine mammals. All tanker-related noise is continuous, and has the potential to result in some type of behavioral disturbance or harassment, including displacement, site abandonment (Gard 1974; Reeves 1977; Bryant *et al.* 1984), and masking (Richardson *et al.* 1995). These disturbances could cause minor, short-term displacement and avoidance, alteration of diving or breathing patterns, and less responsiveness when feeding. OGV noise from the proposed action could also cause acoustically induced stress (Miksis *et al.* 2001 in NRC 2003) which can cause changes in heart rate, blood pressure, and gastrointestinal activity. Stress can also involve activation of the pituitary-adrenal axis, which stimulates the release of more adrenal corticoid hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg 1987, Rivest and Rivier 1995) and altered metabolism (Elasser *et al.* 2000), immune competence (Blecha 2000) and behavior.

The evidence presented above indicates that animals do respond and modify behavioral patterns in the presence of noise, although adequate data do not exist yet to quantitatively assess or predict the significance of minor alterations in behavior and shifts in energy budgets or accumulation of stress responses to the health and viability of marine mammal populations.

The OGVs will produce sound frequencies in the hearing range of blue, fin, and humpback whales; however, the sound pressures levels will be transient and will attenuate to background ambient sound levels a short distance from the tanker. Individuals may react to noise generated, or the presence of, OGVs by changing the direction of their movements, or increasing their swimming speed. Although these reactions could increase an individuals' energy budget, the effects are likely to be temporary and not be detrimental to the species.

**Effects of Acoustic Disturbance on Leatherback Sea Turtles.** As noted in the Status Section 2.3 in relation to anthropogenic noise, sea turtles are thought to be far less sensitive to sound than marine mammals. Leatherback sea turtles may be exposed to potentially disturbing levels of sound during OGV transit.

A single individual's exposure to OGV noise is likely to be transient, as all of the turtles in the action area are migratory, and a single individual is not likely to be within the zone of impact year-round. Based on our calculation in Appendix 2, we would expect that between 14 and 19 leatherback sea turtles per year could be exposed and adversely affected by to the new OGV traffic and experience temporary behavioral changes and acoustically-induced stress from the moderate noise output associated with OGV transit. Temporary, short-term behavioral effects, such as decreased ability to monitor its acoustic environment, cause habituation, or sensitization

(decreases or increases in behavioral response) (Dow *et al.* 2012), during OGV transit are likely, although these effects are not likely to appreciably reduce an individual's likelihood of survival or reproduction.

## **2.4.2 Effects on Critical Habitat**

Designated critical habitat within the action area for the ESA-listed fish species considered in this opinion consists primarily of freshwater rearing sites, freshwater and estuarine migration corridors, and their essential physical and biological features as listed below. Completion of the action is likely to have the following effects on the PBFs or habitat qualities essential to the conservation of each species.

### **Pacific Salmon.**

1. ***Freshwater Spawning.*** There is no known spawning habitat within the project area in the Columbia River.
2. ***Freshwater Rearing.***
  - a. Floodplain connectivity. No effect.
  - b. Water quality. Although dredging and construction activities will increase suspended sediments during project activities the effects will be short-term and return to pre-project levels as soon as construction activities cease. The proposed action will have no impact on the water temperature needs of salmon in the Columbia River.
  - c. Water quantity. No effect.
  - d. Forage. Temporary decreased forage quantity and quality due to increased suspended sediment. Increased prey insect availability with improved riparian plantings from mitigation.
  - e. Natural cover. Long term degradation of nearshore habitat from over water shading. Improvement with the placement of ELJs and improved riparian plantings.
3. ***Freshwater Migration Corridors.***
  - a. Free passage. Upstream and downstream migration will be disrupted due to the presence of the dock and the increased ship traffic.
  - b. Water quality. Similar to effects on water quality at freshwater rearing sites.
  - c. Water quantity. No effect.
  - d. Natural cover. Long term degradation of riparian areas resulting from nearshore shading. Improvement with the placement of ELJs and improved riparian plantings.
4. ***Estuarine Areas.***
  - a. Free passage. Similar to effects on free passage in freshwater migration corridors.
  - b. Natural cover. Long term degradation of riparian areas resulting from nearshore shading. Improvement with the placement of ELJs and riparian plantings.
  - c. Salinity. No effect.
  - d. Forage. Temporary decreased forage quantity and quality due to increased suspended sediment. Increased insect drop with improved riparian plantings

- e. Water quality. Similar to effects on water quality at freshwater rearing sites.
  - f. Water quantity. No effect.
5. *Nearshore Marine Areas*. None designated.
  6. *Offshore Marine Areas*. None designated.

In summary, the effects of the proposed action are likely to have an adverse impact on PBF conditions that all Pacific salmonids need for water quality, forage, and free passage at sites used for freshwater rearing and for water quality and free passage in freshwater migration corridors. The adverse impacts of the proposed action on PBFs are not expected to cause a reduction in the conservation value of any of the critical habitat considered here, at either the watershed or designation scale, and are not expected to appreciably alter the trajectory toward recovery. The proposed dock will effect 44,943 square feet of aquatic resources, with 10,925 square feet located over nearshore areas important to juvenile salmon rearing and migration. This area is very minor compared to the size of the Columbia River and the rearing and migration habitat within the action area.

### **Eulachon.**

#### **1. *Freshwater Spawning***

- a. Water flow. No effect.
- b. Water quality. Dredging and construction activities will increase suspended sediments during project activities. Turbidity concentrations will increase during project activities (August 1- January 31). The proposed project will not affect the temperature of the Columbia River.
- c. Water temperature. The proposed action will have no impact on the water temperature needs of eulachon in the Columbia River.
- d. Substrate. Dredging may remove habitat that eulachon utilize for larvae development.

#### **2. *Freshwater Migration***

- a. Migratory corridor. No effect.
- b. Water flow. No effect.
- c. Water quality. Similar to water quality impacts at freshwater spawning sites.
- d. Water temperature. The proposed action will have no impact on the water temperature needs of eulachon in the Columbia River.
- e. Food. No effect.

In summary, the effects of the proposed action are likely to have an adverse impact on PBF conditions that eulachon need for water quality and substrate in freshwater spawning areas, and for water quality in freshwater areas. Due to the small scale of the project, the adverse impacts of the proposed action on PBFs are not expected to cause a reduction in the conservation value of any of the critical habitat considered here, at either the watershed or designation scale, and are not expected to appreciably alter the trajectory toward recovery.

## 2.5 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 C.F.R. § 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

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

### **Salmon, Steelhead, and Eulachon**

For this action, state or private activities in the vicinity of the project location are expected to cause cumulative effects in the action area. Additionally, future state and private activities in upstream areas are expected to cause habitat and water quality changes that are expressed as cumulative effects in the action area. Our analysis considers: (1) how future activities in the Columbia 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 1.13 million people live in the lower Columbia River, concentrated largely in urban parts of the lower Columbia River (U.S. Census Bureau 2017). 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 2.3). 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.

Resource-based industries (*e.g.*, agriculture, hydropower facilities, timber harvest, fishing, and metals and gravel mining) have caused many long-lasting environmental changes that have harmed ESA-listed species and their critical habitats, such as basin-wide loss or degradation of stream channel morphology, spawning substrates, instream roughness and cover, estuarine rearing habitats, wetlands, floodplains, riparian areas, water quality (*e.g.*, temperature, sediment, dissolved oxygen, contaminants), fish passage, and habitat refugia. Those changes have reduced the ability of populations of ESA-listed species to sustain themselves in the natural environment by altering or interfering with their behavior in ways that reduce their survival throughout their life cycle. The environmental changes have also reduced the quality and function of critical habitat PBFs that are necessary for successful spawning, production of offspring, and migratory access necessary for adult fish to swim upstream to reach spawning areas and for juvenile fish to proceed downstream and reach the ocean. Without those features, the species cannot successfully spawn and produce offspring.

While widespread degradation of aquatic habitat associated with intense natural resource extraction is no longer common, ongoing and future land management actions are likely to continue and to have a reduced level of the effects described above, and therefore to have a depressive effect on aquatic habitat quality in the Columbia River basin and within the action area. As a result, recovery of aquatic habitat is likely to be slow in most areas and cumulative effects from basin-wide activities are likely to have a slightly negative impact on population abundance trends and the quality of critical habitat PBFs.

Within the action area there are numerous over-water structures that will remain into the future. These include private and commercial marinas. In addition, large sections of the bankline on both sides of the LCR have been armored with rock riprap. These alterations have impacted biological and physical characteristics of the habitat, increased shading and increasing use by predatory fish and reducing natural cover that would provide refuge for listed fish. We expect the general habitat characteristics and quality in the action area to remain stable which will continue to have a negative impact on population abundance and productivity.

Additionally, we assume that future private and public actions will continue within the action area based on trends in development. As the human population in the action area continues to grow (OFM 2017), demand for agricultural, commercial, or residential development and supporting infrastructure is also likely to grow. We believe the majority of environmental effects related to future growth will be linked to land clearing, associated land-use changes (i.e., from forest to lawn or pasture) and increased impervious surface and related subbasin changes that contribute contaminants to area waters. Land use changes and development of the built environment that are detrimental to salmonid and eulachon habitats are likely to continue under existing zoning regulations. Though these existing regulations could decrease potential adverse effects on habitat function, as currently constructed and implemented, they still allow incremental degradation to occur. Over time, the incremental degradation, when added to the already degraded environmental baseline, can result in reduced habitat quality for at-risk salmon, steelhead, and eulachon.

Increases in OGV traffic in the LCR and Pacific Ocean will result in increases in ship wake stranding of juvenile salmonids and eulachon, increases in ship strikes on marine mammal and sea turtles, and exacerbation of nearshore habitat erosion and degradation as discussed in section 2.4.1. While it is impossible to predict the severity of these effects into the future, they are reasonably certain to occur. As such, baseline nearshore habitat conditions and status of listed species affected by this project in the Lower Columbia River will continue to be degraded into the future.

Because of long-term trends in monitoring, NMFS also expects that things such as ocean cycles, climate change, and storms will continue to influence ESA-listed fish in the action area. Climate change effects are likely to include reduced base flows, altered peak flows, and increased stream temperature. Other effects, such as increased vulnerability to catastrophic wildfires, may occur as climate change alters the ecology of forests.

Non-federal restoration is occurring that is likely to benefit salmon, steelhead, and eulachon species. The Lower Columbia River Partnership is one such entity who has over 100 regional

partners in the lower Columbia River and has completed 199 projects with a total of 22,685 acres. Projects include land acquisitions and conservation easements, adding large logs to streams to create fish habitat, planting trees to shade and cool streams, and removing barriers to fish passage (LCEP 2017).

When considered together, these cumulative effects are likely to have an adverse effect on salmon and steelhead and eulachon population abundance and productivity. To the extent that non-federal recovery actions are implemented and on-going actions continued, adverse cumulative effects may be mitigated by recovery actions but will probably not be completely avoided.

### **Marine Mammals and Leatherback Sea Turtles**

Marine mammals and leatherback sea turtles occur in the portion of the action area where OGV shipping traffic that overlaps with the continental shelf and slope, located up to 40 miles offshore of Oregon and Washington. Activities that may occur in this area consist of state government actions related to ocean use policy and management of public resources, such as fishing or energy development projects. However, changes in ocean use policies as a result of government action are highly uncertain and may be subject to sudden changes as political and financial situations develop. Examples of actions that may occur include development of aquaculture projects; changes to state fisheries which may alter fishing patterns or influence the bycatch of ESA-listed marine mammals and sea turtles; installation of hydrokinetic projects near areas where marine mammals and sea turtles are known to migrate through or congregate; designation or modification of marine protected areas that include habitat or resources that are known to affect marine mammals and sea turtles; and coastal development which may alter patterns of shipping or boating traffic. None of these potential state, local, or private actions, however, can be anticipated with any reasonable certainty in the action area at this time. Even if some of the projects were developed with any certainty, the level of direct or indirect effects associated with most of these types of actions appear speculative at this point. Current and continuing non-federal actions that may occur in the action area and may be affecting ESA-listed marine mammals and sea turtles are addressed in the environmental baseline section. As the leather back sea turtle is a marine species, the recovery plan for this species will have little effect on State or private actions in the Columbia River.

NMFS also expects recurring events in the action area (*e.g.*, ocean cycles, climate change, storms, natural mortality) will continue to influence ESA-listed marine mammals and leatherback sea turtles and may increase in frequency and/or severity as has been observed in recent years possibly as a result of climate change. Climate change effects for marine mammals are likely to include changes in food and habitat availability, changes in breeding and feeding locations, and decreased productivity. Climate change effects for leatherback sea turtles are likely to include decreased nesting success, and skewed sex ratios.

## **2.6 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 will add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5) 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. These assessments are made in full consideration of the status of the species and critical habitat (Section 2.2).

### **2.6.1 Species**

#### **Salmon, Steelhead, and Eulachon**

Adult and juvenile salmon, steelhead, and eulachon migrate through the action area. Many of the species also spend time rearing in the action area, and eulachon spawn in the action area. Therefore, individuals from all the populations of the species considered in this opinion could potentially be affected by the proposed action.

The status of the species addressed by this consultation varies considerably from very high risk to moderate risk. Similarly, the hundreds of individual populations affected by the proposed action vary considerably in their biological status. For instance, SR sockeye salmon and UCR spring-run Chinook salmon are at the highest risk of extinction. The total abundance for these species is low and they are distributed across one to a few populations at most. LCR Chinook salmon are at moderate risk. This species is still distributed across much of its historic range and is comprised of 32 populations. However, most of these populations are at very high risk and only a few populations are viable. MCR steelhead is at moderate risk also, with 3 viable populations and several 'maintained' populations which have met their recovery targets. Eulachon are at moderate risk with varying returns over the past several years.

The environmental baseline is such that individual ESA-listed species in the lower Columbia River are exposed to reduced water quality, lack of suitable riparian and aquatic habitat, and restricted movement due to developed urban areas and land use practices. These stressors, as well as those from climate change, already exist and are in addition to any adverse effects produced by the proposed action. Major factors limiting recovery of the ESA-listed species considered in this opinion include degraded estuarine and nearshore habitat; degraded floodplain connectivity and function; channel structure and complexity; riparian areas and large wood recruitment; stream substrate; streamflow; fish passage; water quality; harvest and hatchery impacts; predation/competition; and disease. The result of economic and population demands, which are expected to continue and increase, will probably affect habitat features such as water quality, which are important to the survival and recovery of the listed species.

Climate change effects in the lower Columbia River will likely include direct effects of temperature such as mortality from heat stress, changes in growth and development rates, and

disease resistance. Behavioral responses include shifts in seasonal timing of important life history events, such as the adult migration, spawn timing, fry emergence timing, and the juvenile migration. Indirect effects on salmon mortality, growth rates and movement behavior are also expected to follow from changes in the freshwater habitat structure and the invertebrate and vertebrate community, which governs food supply and predation risk. Both direct and indirect effects of climate change will vary among Pacific salmon ESUs and among populations in the same ESU. Adaptive change in any salmonid population will depend on the local consequences of climate change as well as ESU-specific characteristics and existing local habitat characteristics (NWFSC 2015).

Several of the effects of the proposed action will not likely result in any measurable effect to listed salmon, steelhead, or eulachon. These include; harassment, ballast water discharge, methanol or oil spill from increased OGV traffic; mitigation; water use, and construction/operation of the pipeline. Salmon and steelhead will also not be measurably affected by entrainment during dredging.

In the Effects analysis we identified two construction-related effects that are likely to have measurable effects on salmonids or eulachon: sound effects from impact driving steel piles and entrainment of eulachon eggs during dredging. We cannot accurately quantify the short-term effects to salmonid species from elevated sound levels during steel impact pile driving or to eulachon populations due to the entrainment of eulachon eggs during dredging because the precise distribution and abundance of adult, juvenile fish, and eulachon eggs within the action area are not a simple function of the quantity, quality, or availability of predictable habitat resources within that area. Nonetheless, the adverse effects related to construction activities are likely to kill or injure fish in the area. The effects of the action will affect too few fish from any one population to influence population viability characteristics of the affected species. This is because: (1) impacts associated with construction are expected to only last several months in each of two years and (2) construction has been timed to minimize effects to juvenile salmon and eulachon.

We have also identified increased predation resulting from overwater structures and ship wake stranding as effects to listed salmonids and eulachon that are likely to result from the long-term existence and operation of the facility. As with the construction related effects, we cannot accurately quantify the long-term effects from overwater coverage that can create predator habitat because it would be hard to discern if predation related to the new over-water coverage would occur even if the structure was not constructed. The structure will not increase the amount of pike minnows in the area but will provide alternate habitats to prey from. It is expected the large woody debris structures that are proposed for this project will help offset effects of the pier by providing refuge from predators for juvenile salmon, however a small number of juvenile salmon will likely be killed or injured from increased predation. Based on existing data, the small amount of area susceptible to wake stranding in the action area, and the relatively small increase in ship traffic from the proposed action, wake stranding is expected to kill a small number of juvenile fish from the LCR Chinook salmon, CR chum, LCR coho salmon populations.

In summary we expect a small number of juvenile salmonids (mostly from ESUs for which juveniles migrating in the Columbia mainstem are particularly small and nearshore dependent, including LCR Chinook, LCR coho, UWR Chinook, LCR steelhead, and CR chum to suffer measurable adverse effects as the result of the construction, existence and operation of the proposed structures. Even when we consider the current status of the threatened and endangered fish populations and degraded environmental baseline within the action area, the proposed action itself is not expected to affect abundance, distribution, diversity, or productivity of any of the component populations of the ESA-listed species, nor further degrade baseline conditions or limiting factors. The effects of the action will be too small in scale and too minor to have a measurable impact on the affected populations. Because the proposed action will not reduce the productivity, spatial structure, or diversity the affected populations, the action, when combined with a degraded environmental baseline and additional pressure from cumulative effects, will not appreciably affect the status of any of the listed species considered in this opinion.

### **Marine Mammals**

All species of marine mammals considered in this opinion are endangered. Minimum population estimates of the Eastern North Pacific stock of blue whales is 1,551 individuals and show trends that numbers are increasing, although the mark-recapture estimates show there is no evidence of growth in global populations since the early 1990s. Minimum population estimates of the CA/OR/WA stock of fin whales are 2,598 individuals and show trends that numbers are increasing. Removal of the threat of commercial whaling has allowed increased recruitment in global populations and expected to grow. Minimum population estimates of the CA/OR/WA stock of humpback whales are 1,876 individuals and show a 7.5percent increase per year in numbers. The majority of the stocks in the global populations are also showing trends in increasing numbers of individuals. The minimum population estimate of the CA/OR/WA stock sperm whales is 1,332 individuals. There is no trend information for any of the global populations.

In this opinion, we identified in the Effects section that blue whales, fin whales, humpback whales, and sperm whales may be affected by the marine OGV traffic occurring off the Washington and Oregon coasts. Marine OGV traffic affects these whales through noise and ship strikes. The proposed project will lead to increased long-term operation that will increase the amount of OGV traffic in the action area by one percent along the U.S West Coast. Therefore, the proposed action will increase the risk of OGV-related effects on whales in the action area.

The proposed project will lead to increased long-term operation that will increase the amount of OGV traffic by four percent on the Columbia River and one percent on the West Coast., and will result in some increased risk of harassment by anthropogenic noise sources. There are no sound levels associated with OGV traffic that are likely to cause injury to listed whales; however, whales may be exposed to levels of sound that may cause temporary, short-term disturbance, or behavioral effects during OGV transit. A single individual's exposure to OGV noise is likely to be transient, as all of the whales in the action area are highly migratory, and a single individual is not likely to be within the zone of impact year-round. Although these reactions could increase an individuals' energy budget, the effects are likely to be temporary. The proposed action will likely result in a small increase in these temporary disturbances, as it increases the amount of OGV

traffic in the action area slightly. Whales are transitory and sound levels will be reduced as boats transit away from the whales. As such, NMFS anticipates that the increased risk of noise on whales is not likely to reduce the likelihood of survival and recovery of any these populations.

As mentioned in the Environmental Baseline section, threats to whales include ship strikes. Table 25 shows the number of ship strikes to whales off the U.S. West Coast for the years 2007–11. Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma.

**Table 25.** Stock population size, potential biological removal (PBR), and known ship strike mortalities on the West Coast for ESA-listed whales considered in this opinion.

	Stock Population Size	PBR	Average Annual Ship Strike Mortality Based on Known Ship Strike Mortality (1998-2013)
Blue Whale	Eastern North Pacific 1,551	2.3	1.2
Fin Whale	CA/OR/WA 2,598	16	1.3
Humpback Whale	CA/OR/WA 1,918	11	0.7
Sperm Whale	CA/OR/WA 1,332	2.7	0.3

The proposed project will lead to increased long-term operation that will increase the amount of OGV traffic by one percent along the West Coast, and will result in some increased risk of ship strikes, and a high likelihood of death, if struck, of listed species. Combined with the fact that the Columbia River ports are smaller than other West Coast ports, such as, LA/Long Beach, it is unlikely that this increase in traffic due to the NWIW methanol project will substantially increase the average annual ship strike mortality.

In this opinion, we must consider the impacts from the proposed action on the globally-listed populations of whales. As mentioned in the Status of the Species section, under the MMPA, we rely upon the concept of PBR to assist or guide decision making about acceptable or appropriate levels of fisheries impacts that marine mammal stocks can withstand. While PBR serves as a useful metric for gauging the relative level of impact on marine mammal stocks as defined in the MMPA, PBR by itself does not equate to a species or population level assessment under the ESA where analyses are conducted at the level of the species listed as threatened or endangered.

Global populations of whales covered in this opinion do not have a clear population trend, or are increasing. As with most large whales, removal of the threat of whaling has relieved the primary source of mortality that resulted in reduced population sizes and the listing of these species as endangered.

The proposed project will lead to increased long-term operation that will increase the amount of OGV traffic by 1 percent along the West Coast, and will result in some increased risk of ship

strikes, and a high likelihood of death, if struck, of listed species. Based on ship strike data from the WCR Stranding Database, the current levels of ship strike and other human-caused mortality for the whales along the coast do not exceed PBR for the MMPA stocks most likely to be affected by the proposed action (Table 25, above); however, it is likely that the number of Eastern North Pacific blue whales that are injured or killed from ship strikes exceeds PBR due to the low level of ship strike detection. Although PBR is likely exceeded for one of the blue whale stocks, there is no evidence to suggest that that stock is either increasing or decreasing. Based on the relatively small level of impact expected from the proposed action and analysis supporting a negligible impact determination for the stocks of whales found off the U.S. West Coast, there is no reason to expect these anticipated impacts would lead to effects on the global populations that would be significant or detectable. As such, NMFS anticipates that the increased risk of ship strikes on whales is not likely to appreciably reduce the likelihood of survival and recovery of blue, fin, affected humpback whale DPSs, and sperm whale species.

### **Leatherback Sea Turtles**

Leatherback sea turtles are widely distributed across the oceans of the world and face a variety of threats depending on the region in which they occur. In the marine environment, threats include, but are not limited to, direct harvest, debris entanglement and ingestion, fisheries bycatch, and boat collisions. Nesting aggregations in the eastern Pacific occur primarily in Mexico and Costa Rica, and in the western Pacific are found in Indonesia, the Solomon Islands, and Papua New Guinea. Leatherbacks within the action area are most likely to originate from nesting aggregations in the western Pacific. The abundance of leatherback sea turtles is currently unknown but the most recent global estimate for nesting females is 34,500 turtles. The trend for the western Pacific subpopulation has been declining over the past four decades and continues to decline (NMFS 2009b).

The NMFS and USFWS (1998a) recovery plan for leatherback turtles in the U.S. Pacific contains goals and criteria that must be met to achieve recovery for this species. These include research efforts to determine the stock structure of populations and to monitor their status, at least for populations that range into U.S. waters, in part because the abundance goals for leatherback populations in the western Pacific rest primarily on the productivity of nesting beaches.

As mentioned in the Environmental Baseline section, sea turtles in the action area have been exposed to noise levels during OGV transit that can cause disturbance, such as decreased ability to monitor its acoustic environment, cause habituation, or sensitization (decreases or increases in behavioral response) (Dow *et al.* 2012). Sea turtles are also at risk of ship strikes from OGV traffic. Effects in the environmental baseline are likely to continue into the foreseeable future, as discussed in the analysis of cumulative effects. The proposed project will increase the amount of OGV traffic, and therefore some increased risk of behavioral disturbance and ship strikes. Based on our calculations (Appendix 2) any one OGV has a 0.5 percent chance of encountering a leatherback sea turtle while crossing the action area, and the effects of each encounter may vary from minor (*e.g.*, sound only) to severe (*e.g.*, death due to direct impact).

As discussed in the Cumulative Effects section, NMFS also expects recurring events in the action area (e.g., ocean cycles, climate change, storms, natural mortality) will continue to influence leatherback sea turtles and may increase in frequency and/or severity as has been observed in recent years possibly as a result of climate change. Climate change effects for leatherback sea turtles are likely to include decreased nesting success, and skewed sex ratios.

The limited exposure of individual leatherback turtles to the adverse effects of the proposed action presents an extremely small additional risk to survival and recovery of the western Pacific leatherback sea turtle population. The proposed action will not affect leatherback nesting populations or substantially impair the access of individual turtles to foraging grounds in the Columbia River plume. Given the best available information, we conclude that the occasional behavioral disturbance and/or the removal of leatherback turtles because of increased OGV traffic is not likely to appreciably reduce the likelihood of survival or recovery of this species.

### **2.6.2 Critical Habitat**

The value of critical habitat for LCR Chinook salmon, UWR Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, Columbia River chum salmon, LCR coho salmon, SR sockeye salmon, LCR steelhead, UWR steelhead, MCR steelhead, UCR steelhead, SRB steelhead, and southern distinct population of eulachon in the Columbia River currently is limited by poor water quality, altered hydrology, lack of floodplain connectivity and shallow-water habitat, and lack of complex habitat to provide forage and cover. The action area is in an area where the habitat has been degraded due to past land use practices including stormwater runoff and industrial and urban development. Despite this, the critical habitat in the action area has a high conservation value for the ESA-listed species covered in this opinion due to its critical role as a migration corridor.

Within the action area there are numerous over-water structures that will remain into the future. In addition, large sections of the bankline on both sides of the LCR have been armored with rock riprap. These alterations have impacted biological and physical characteristics of the habitat, increased shading and increasing use by predatory fish and reducing natural cover that would provide refuge for listed fish.

As the human population in the action area continues to grow (OFM 2017), the majority of environmental effects related to future growth will be linked to land clearing, associated land-use changes (i.e., from forest to lawn or pasture) and increased impervious surface and related subbasin changes that contribute contaminants to area waters. Over time, the incremental degradation, when added to the already degraded environmental baseline, can result in reduced habitat quality for at-risk salmon, steelhead, and eulachon.

Adverse effects to the quality and function of critical habitat PBFs and biological and physical features influenced by this project will take place in a small part of the Columbia River. The Columbia River alone is 545 miles long from its mouth to Chief Joseph Dam, which is currently the upstream extent of fish passage, not including its largest tributary (the Snake River). The proposed action will affect less than 0.03 percent of the available mainstem length of the Columbia/Snake River system from RM 72 to the mouth. The likely effects of the action on

salmon critical habitat include shading of nearshore habitat and providing cover for predatory fish and elevated sound levels for a small time period (10 hours) during construction. The adverse effects from over water coverage are reasonably certain to persist for the duration the pier exists. While measurable in the action area, on a critical habitat designation scale their effect will be small. The proposed placement of ELJs, riparian plantings, and pile removal will increase juvenile cover and food supply, which will offset some project-related effects. These small adverse effects to the quality and function of PBFs and physical and biological features will be minimal at the action area level.

Any land or water management action that changes habitat conditions beyond the tolerance of the species results in lower life-stage survival and abundance of the species. This the effects of continued non-federal development on high-risk species will further increase the risk to ESA listed species. . In some cases, the range of tolerance for some species is quite narrow and relatively small changes in habitat can have large effects on species survival (Upper Columbia Salmon Recovery Board (UCSRB) 2007). However, the proposed action’s negative effects will provide improved habitat conditions following project completion. Additionally, Columbia River salmon and steelhead, although currently well below historic levels, are distributed widely enough and are presently at high enough abundance levels that any short-term adverse effects resulting from project activities will not have an observable effect on the spatial structure, productivity, abundance and diversity of these species. Therefore, when considered in light of existing risk, baseline effects, and cumulative effects, the project does not increase risk to either of the affected populations to a level that would reduce appreciably the likelihood for survival and recovery of the subject ESU or DPS.

## **2.7 Conclusion**

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS’ biological opinion that the proposed action is not likely to jeopardize the continued existence of LCR Chinook salmon, UWR Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, Columbia River chum salmon, LCR coho salmon, SR sockeye salmon, LCR steelhead, UWR steelhead , MCR steelhead, UCR steelhead, SRB steelhead, eulachon, blue whales, fin whales, humpback whales, sperm whales, or leatherback sea turtles, or destroy or adversely modify designated critical habitat for these species.

## **2.8 Incidental Take Statement**

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption.

“Take” is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. “Harm” is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). “Incidental take” is defined by regulation as

takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

This incidental take statement (ITS) provides a take exemption for the action agency and applicant for any take caused by the effects of the proposed action. Those effects include injury or death from predation caused by overwater coverage, injury or death from elevated sound levels, injury or death from eulachon egg entrainment during dredging, and injury or death from ship wake stranding.

### **2.8.1 Amount or Extent of Take**

The proposed dock upgrades will take place in locations where ESA-listed fish will be present. Incidental take caused by the adverse effects of the proposed action will include the following for ESA-listed fish: (1) Nearshore overwater coverage will increase the opportunity for in-water predation, (2) elevated sound levels during construction may injure or kill a few fish, and (3) eulachon eggs may be entrained during dredging. This take cannot be accurately quantified as a number of ESA-listed fish because the distribution and abundance of fish that occur within the action area is affected by dam and reservoir operations, habitat quality, interactions with other species, harvest programs, and other influences that cannot be precisely determined by observation or modeling. There is no practicable means to monitor for the number of fish taken through increased predation (fish cannot be counted once consumed), elevated sound levels (fish will move in and out of affected area and harm is not necessarily visible), or egg entrainment (miniscule eulachon eggs cannot be practicably distinguished from dredge material). Therefore, we will not identify the amount of take, but will identify habitat indicators that will serve as surrogates for incidental take. Each of these surrogates (described below) is proportionally related to the numbers of fish expected to be taken, and thus will serve as a meaningful re-initiation trigger.

In addition, the proposed methanol facility (interrelated and interdependent to the COE proposed action) will increase vessel traffic on the Columbia River by 72 OGV round trips per year. In turn the additional OGV trips are expected to increase wake stranding events (see Section 2.4.1 of this opinion) and are expected to result in injury and death to juvenile salmonids and eulachon. At this time, there is limited understanding on the variables that contribute to wake stranding events and the limited data associated with wake stranding is considered insufficient to provide an exact take estimate. NMFS' analysis and no jeopardy determination is based on potential wake stranding assuming the maximum number of ship trips associated with the methanol facility. NMFS is using the number of methanol OGV trips (which translates to potential wake stranding incidents) as a surrogate for quantifying take consistent with 50 CFR § 402.14(h)(i)(1). Using methanol OGV trips as a surrogate establishes a clear standard for determining when the level of anticipated take has been exceeded. For example, if the methanol OGV round trips supported by the new facility exceeds 72 per year then we expect that anticipated effects and resulting take would also be exceeded. Thus, we believe that OGV trips is

an easily assessed and reliable take surrogate that meets the legal standards as they relate to a re-initiation trigger.

NMFS has elected not to provide a take exemption for the third party incidental take of leatherback sea turtles in this case. Given the factual situation, it would be difficult to provide meaningful reasonable and prudent measures/terms and conditions - or to develop a meaningful reinitiation trigger - because, for example, it is not possible to identify the third parties at this juncture, and it is not clear who and under what authority would monitor the impacts of the third party incidental take.

The best available indicators for the extent of take are:

1. For harm associated with predation on salmon and steelhead, we used the area the area of nearshore that would be shaded as a habitat surrogate. The extent of take is the coverage by a structure of 10,925 square feet of nearshore habitat. If the portion of the proposed structure in the nearshore (20 feet below the Ordinary High Water Mark to the shore) is larger than 10,925 square feet, the extent of take will be exceeded.
2. For harm associated with hydroacoustic impacts to salmon and steelhead from the driving of steel pile with an impact hammer: we used the amount of impact pile driving of steel piles that is expected to occur. Specifically, if more than 8,200 pile strikes/day with an impact hammer occur the anticipated take will be exceeded. This number is based on the proposed action including installation of 8 steel piles, and that impact driving of each single steel pile would not likely require more than 1025 strikes.
3. For harm associated with entrainment of eulachon eggs we use the area that will be dredged, which is expected to be proportional to the number of eggs entrained. The extent of take would be the 16 acres of deep water habitat that is proposed for dredging.
4. For harm associated with wake stranding events, we used the number of vessels that will access the NWIW facility per year. In this case take will be exceeded if more than 72 vessels arrive at the NWIW operational facility to load methanol per year.

These features best integrate the likely take pathways associated with this action, are proportional to the anticipated amount of take, and are the most practical and feasible indicators to measure.

### **2.8.2 Effect of the Take**

In Section 2.7, NMFS determined that the level 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.

### **2.8.3 Reasonable and Prudent Measures**

“Reasonable and prudent measures” are nondiscretionary measures to minimize the amount or extent of incidental take (50 C.F.R. § 402.02). The Corps or the Port shall minimize incidental take by:

1. Applying permit conditions regarding terminal construction to avoid or minimize harm to ESA-listed species considered in this opinion.
2. The applicant will (individually or in partnership with others joining to fund implementation of the Wake Stranding Rate Monitoring Plan (“Monitoring Plan”)) prepare and submit for NMFS approval a monitoring plan as described in Appendix I within 9 months of the issuance of the COE permit, and will subsequently implement that plan.
3. The applicant will provide an annual report prepared pursuant to the monitoring plan. The report will be submitted to NMFS by December 31 each year during the duration of the monitoring, and a final report at the conclusion of the monitoring plan.

### **2.8.4 Terms and Conditions**

The terms and conditions described below must be complied with by the entity to whom they are directed in order to implement the RPMs (50 CFR 402.14). There is a continuing duty to monitor and report the impacts of incidental take as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with such terms and condition, their exemption under section 7(o)(2) of the ESA would lapse.

1. To implement reasonable and prudent measure No. 1, the COE shall ensure that:
  - a) Timing of In-water Work. Piling installation will be completed during the period of September 1-January 31. Dredging will be completed August 1 - December 31.
  - b) Pile Driving. When installing the steel piles the applicant, when using an impact hammer to proof steel piles, use one of the following sound attenuation methods:
    - (1) If water velocity is 1.6 feet per second (1.1 miles per hour) or less for the entire installation period, surround the pile being driven by a confined or unconfined bubble curtain that will distribute small air bubbles around 100 percent of the pile perimeter for the full depth of the water column.
    - (2) If water velocity is greater than 1.6 feet per second (1.1 miles per hour) at any point during installation, surround the pile being driven by a confined bubble curtain (*e.g.*, a bubble ring surrounded by a fabric or non-metallic sleeve) that will distribute air bubbles around 100 percent of the pile perimeter for the full depth of the water column.

2. To implement reasonable and prudent measure No. 2, the applicant shall ensure that:
  - The monitoring plan should be designed to provide details as described in Appendix I to this opinion.
  - The applicant must submit a draft of the plan within 9 months of the Corps' issuance of the permit described as the proposed action for this opinion. The applicant must begin implementation of the plan in the first March following the first shipment from the new facility.
  - If any stranded fish are observed alive during implementation of the plan, they should be returned to the water as soon as possible.
  
3. To implement reasonable and prudent measure No. 3, the applicant shall ensure that the annual monitoring report includes:
  - An estimate of stranding rates of juvenile Lower Columbia River Chinook, chum and coho salmon occurring in the monitoring year.
  - A table summarizing the data collected for RPM 2

The applicant must submit monitoring reports to:

National Marine Fisheries Service  
Oregon Washington Coastal Office  
Attn: WCR-2015-3594  
510 Desmond Drive SE, Suite 103  
Lacey, Washington 98503

## **2.9 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 C.F.R. § 402.02). The following conservation recommendations are discretionary measures that NMFS believes are consistent with this obligation and therefore should be carried out by the Corps and that the applicant, and where appropriate, users of the proposed project, should be encouraged to conduct these activities:

- Work with NMFS, USCG, ports, and industrial facilities on the Columbia River to advance further studies to understand the potential of wake stranding beyond the known locations and to include the highly susceptible beaches as identified by Pearson 2008, and advance discussion on how to reduce ship wake stranding events.
- Work with the USCG and ports to identify marine shipping routes.
- Time dredging to occur prior to November 1.

- Recommend that shipping companies adhere to the NOAA Fisheries West Coast Region Recommendations to Avoid Collisions to minimize the risk of marine mammal and sea turtle ship strikes. Measures include the following:
  - Consult the Local Notices to Mariners in your area or Coast Pilot for more information.
  - If possible, post extra crew on the bow (or appropriate observation point) to watch for whales such that ships can move out of a potential path of collision.
  - Reduce speeds while in the advisory zones, or in areas of high seasonal or local whale abundance.
  - If practicable, re-route OGV to avoid areas of high whale abundance.
  - Report any injured, entangled or ship-struck whales to the 24/7 hotline at (877) SOS-WHALE (767-9425).

Please notify NMFS if the Federal action agency carries out any of these recommendations so that NMFS will be kept informed of actions that are intended to improve the conservation of listed species or their designated critical habitats.

## **2.10 Reinitiation of Consultation**

This concludes formal consultation for the Kalama Manufacturing and Marine Export Facility.

As provided in 50 C.F.R. § 402.16, 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 take 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 to 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.

## **2.11 “Not Likely to Adversely Affect” Determinations**

### **Green Sturgeon**

The only known spawning population of the southern DPS of green sturgeon occurs in the Sacramento River. Adults migrate into the river to spawn between April and July. Juveniles spend 1 to 4 years in freshwater before migrating to the ocean. Evidence of green sturgeon spawning in the coastal estuaries of Washington is lacking and not expected to occur (Adams *et al.* 2002). Consequently, the proposed action will have no impact on Southern green sturgeon spawning or juvenile rearing.

During the late summer and early fall, subadult and non-spawning adult green sturgeon can frequently be found aggregating in estuaries along the Pacific coast (Emmett *et al.* 1991; Moser and Lindley 2007) with particularly large concentrations occurring in the Columbia River estuary, Willapa Bay, and Grays Harbor (Moyle *et al.* 1992). Adult green sturgeon are common

in the seawater and mixing zones of Grays Harbor during high salinity periods, with the highest abundance from July through early October (Monaco *et al.* 1990).

Although non-spawning individuals of this species could be present in the Lower Columbia River during project construction activities, pile installation and dredging will occur in a small area compared to the entire Lower Columbia River estuary area.

Green Sturgeon may be affected by turbidity and suspended sediments, entrainment, and/or elevated sound levels. Sturgeon are typically found in turbid conditions and forage in the benthos by stirring up the sediment to access benthic prey such as burrowing shrimp and are thus relatively tolerant of higher suspended sediment concentrations. Adult or subadults that may be present in the dredge area would be mobile enough to avoid any suspended sediments created.

Adults and subadults are strong swimmers with the speed and power to escape and avoid entrainment in the clamshell dredge and to avoid noise and disturbance from pile driving activities. The hydraulic dredge will operate below the bed of the river; where entrainment would not be likely to occur.

### **Guadalupe Fur Seals**

Guadalupe fur seals occur primarily near Guadalupe Island, Mexico, their primary breeding area. As a non-migratory species, they are only occasionally found north of the U.S.-Mexican border and therefore, their encounter rate with marine OGV in the action area can be considered discountable. In addition, according to the NMFS Northwest Marine Mammal Stranding Network records, maintained by the NMFS Northwest Region, no human-caused Guadalupe fur seal mortality or serious injuries were reported from non-fisheries sources between 1998-2004. The lack of interactions with ships through reporting or the stranding network lead us to conclude that the exposure risk of collision from OGVs is discountable. Therefore, the proposed action is not likely to adversely affect Guadalupe fur seals.

### **Southern Resident Killer Whales**

According to Northwest Marine Mammal Stranding Network records, maintained by the NMFS West Coast Region, no human-caused killer whale mortality or serious injuries were reported from non-fisheries sources between 2007–2011 (Carretta *et al.* 2013). There was documentation of a whale-boat collision in Haro Strait in 2005 which resulted in a minor injury to a whale. In 2006, whale L98 was killed during an OGV interaction. It is important to note that L98 had become habituated to regularly interacting with OGVs during its isolation in Nootka Sound. Both of these collisions were from small tankers, in contrast to the large OGVs likely to be transiting to and from the proposed facility. Although Southern Residents do overlap with the area in which the proposed action is expected to lead to increased shipping traffic, the lack of interactions between Southern Residents and large ships through reporting or the stranding network leads us to conclude that risk of collision from OGVs is discountable. The sound from the large OGVs is largely low frequency sound that does not overlap with the most sensitive hearing range of the Southern Resident killer whales. OGV sound may still be audible to the whales, but any disturbance from the sound of passing OGV is expected to be short-term and

transitory and insignificant. Therefore, the proposed action is not likely to adversely affect Southern Resident killer whales.

The proposed action may affect Southern Residents indirectly by reducing availability of their primary prey, Chinook salmon. As described in the ship wake stranding section (Section 2.4.1), NMFS has concluded that the amount of adult fish estimated to be affected by OGVs is expected to be very low. The proposed activities are not expected to produce an observable effect on the abundance, distribution, diversity, or productivity of this species at either the population or species level and would not affect the quantity of prey available to the whales in the long term.

Given the total quantity of prey available to Southern Resident killer whales throughout their range, this reduction in prey is extremely small, and is not anticipated to be different than zero by multiple decimal places (based on NMFS's previous analyses of the effects of salmon harvest on Southern Residents; *e.g.*, NMFS 2008b, NMFS 2011f). Because the reduction is so small, there is also a low probability that any of the juvenile Chinook salmon killed by the proposed activities would have as adults (in 3-5 years' time) been intercepted by the killer whales across their vast range in the absence of the proposed activities. Therefore, the anticipated reduction of salmonids associated with the proposed action would result in an insignificant reduction in adult equivalent prey resources for Southern Resident killer whales. Therefore, the proposed action is not likely to adversely affect Southern Resident killer whales.

### **North Pacific Right Whales**

North Pacific right whales are rarely found off the U.S. West Coast and have primarily been documented foraging in the Bering Sea and the Gulf of Alaska, where critical habitat was designated in 2006. In addition, the increase in the amount of OGV traffic in the action area is small (approximately 4 percent). Due to the rare occurrence of North Pacific right whales in the action area, and the small increase in OGV traffic in the action area, it is extremely unlikely there would be an interaction between North Pacific right whales and OGVs. This leads us to conclude that the risk of ship strikes is discountable. Therefore, the proposed action is not likely to adversely affect North Pacific right whales.

### **Sei Whales**

Sei whales have a global distribution and occur in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere (NMFS 2011d). The species is cosmopolitan, but with a generally anti-tropical distribution centered in the temperate zones. Sei whales are distributed far out to sea in temperate regions of the world and do not appear to be associated with coastal features (Caretta *et al.* 2013). The action area extends up to 40 miles off the Pacific Coast of Oregon and Washington to the edge of the Continental shelf and slope, thus sei whales are unlikely to occur in the action area. In addition, the increase in the amount of OGV traffic in the action area is small (approximately 4 percent). Due to the rare occurrence of Sei whales in the action area, and the small increase in OGV traffic in the action area, it is extremely unlikely there would be an interaction between Sei whales and OGVs. This leads us to conclude that the risk of ship strikes is discountable. Therefore, the proposed action is not likely to adversely affect Sei whales.

## **Western North Pacific Gray Whales**

Western North Pacific (WNP) gray whales are found from Russian foraging areas along the Aleutian Island, through the Gulf of Alaska, and south to the Washington State and Oregon coasts (Mate *et al.* 2011), and to the southern tip of Baja California and back to Sakhalin Island (IWC 2012). The Western North Pacific gray whales are rare, with population estimates of only 130 individuals. Off the Oregon and Washington coasts, the occurrence of Eastern North Pacific gray whales is much more common, with population estimates of approximately 20,000 animals (Calambokidis *et al.* 1998). The Eastern North Pacific stock was delisted from the ESA in 1993, therefore we are not analyzing the Eastern North Pacific stock in this opinion.

Recently, information from tagging, photo-identification, and genetic studies show that WNP gray whales have been observed migrating in the winter to the eastern North Pacific off the outer coast of North America from Vancouver, B.C to Mexico (Lang 2010, Mate *et al.* 2011, Weller *et al.* 2012, Urban *et al.* 2013). Although there is potential for WNP gray whales to occur along the Washington coast, available data indicate that occurrence is likely to be rare in the project vicinity.

In addition to the rare occurrence of the Western North Pacific stock, the increase in the amount of OGV traffic in the action area is small (approximately 4 percent). Due to the rare occurrence of Western North Pacific gray whales in the action area, and the small increase in OGV traffic in the action area, it is extremely unlikely there would be an interaction between Western North Pacific gray whales and OGVs. This leads us to conclude that the risk of ship strikes is discountable. Therefore, the proposed action is not likely to adversely affect Western North Pacific gray whales.

## **Green Sea Turtles**

Green sea turtles use open ocean convergence zones and coastal areas for benthic feeding of macroalgae and sea grasses. There are no known resting areas along the U.S. West Coast. In the eastern North Pacific, green sea turtles commonly occur south of Oregon, but have been sighted as far north as Alaska (NMFS and USFWS 1998b). Stranding reports indicate that the green sea turtle appears to be a resident in waters off San Diego Bay, California (NMFS and USFWS 1998b) and in the San Gabriel River and surrounding waters in Orange and Los Angeles counties, California. Although there is potential for green sea turtles to occur along the Washington and Oregon coasts, available data indicate that occurrence is likely to be rare in the action area. In addition, the increase in the amount of OGV traffic in the action area is small (approximately 4 percent). Due to the rare occurrence of green sea turtles in the action area, and the small increase in OGV traffic in the action area, it is extremely unlikely there would be an interaction between green sea turtles and OGVs. This leads us to conclude that the risk of ship strikes is discountable. Therefore, the proposed action is not likely to adversely affect green sea turtles.

### **Loggerhead Sea Turtles**

Loggerhead sea turtles inhabit continental shelves, bays, estuaries, and lagoons in the Atlantic, Pacific, and Indian Oceans (NMFS and USFWS 1998c). On the U.S. West Coast, most sightings of loggerhead turtles are of juveniles. Most sightings are off California; however, there are also a few sighting records from Washington and Alaska (Bane 1992). There are no known resting areas along the U.S. West Coast. Although there is potential for loggerhead sea turtles to occur along the Washington and Oregon coasts, available data (NMFS and USFWS 1998c) indicate that occurrence is likely to be rare in the action area. In addition, the increase in the amount of OGV traffic in the action area is small (approximately 4 percent). Due to the rare occurrence of loggerhead sea turtles in the action area, and the small increase in OGV traffic in the action area, it is extremely unlikely there would be an interaction between loggerhead sea turtles and OGVs. This leads us to conclude that the risk of ship strikes is discountable. Therefore, the proposed action is not likely to adversely affect loggerhead sea turtles.

### **Olive Ridley Sea Turtles**

Olive ridley sea turtles have a mostly pelagic distribution, but they have been observed to inhabit coastal areas. They are the most common and widespread sea turtle in the eastern Pacific. On the U.S. West Coast, they primarily occur off California although stranding records indicate olive ridleys have been killed by gillnets and boat collisions in Oregon and Washington waters (NMFS and USFWS 1998d). In the eastern Pacific, nesting largely occurs off southern Mexico and northern Costa Rica (NMFS and USFWS 1998d). Although there is potential for olive ridley sea turtles to occur along the Washington and Oregon coasts, available data indicate that occurrence is likely to be rare in the action area. In addition, the increase in the amount of OGV traffic in the action area is small (approximately 4 percent). Due to the rare occurrence of olive ridley sea turtles in the action area, and the small increase in OGV traffic in the action area, it is extremely unlikely there would be an interaction between olive ridley sea turtles and OGVs. This leads us to conclude that the risk of ship strikes is discountable. Therefore, the proposed action is not likely to adversely affect olive ridley sea turtles.

## **3. MAGNUSON-STEVENSON FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION**

The consultation requirement of 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 effects occur when EFH quality or quantity is reduced by a direct or indirect physical, chemical, or biological alteration of the waters or substrate, or by the loss of (or injury to) benthic organisms, prey species and their habitat, or other ecosystem components. 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 C.F.R. § 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 Corps and descriptions of EFH for Pacific coast groundfish (PFMC 2005), and Pacific coast salmon (PFMC 2014) contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.

### **3.1 Essential Fish Habitat Affected by the Project**

The proposed action and action area for this consultation are described in the Introduction section to this document. The action area includes areas designated as EFH for various life-history stages of groundfish, and Chinook and coho salmon.

### **3.2 Adverse Effects on Essential Fish Habitat**

NMFS reviewed the proposed action of pipeline installation for potential effects on EFH. In this case, NMFS concluded the action would not adversely affect EFH. Thus, consultation under the MSA is not required for this action.

We conclude that the proposed action will have the following adverse effects on EFH designated for 49 species of Pacific Coast groundfish, and coho and Chinook salmon:

- Long-term increase in predation from over water coverage and shading.
- Short-term increase in underwater noise from installation of steel pipe piles using an impact hammer.
- Short-term increase in suspended sediment from pile installation.

### **3.3 Essential Fish Habitat Conservation Recommendations**

NMFS expects that fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in Section 3.2 above, approximately 6,220,799 acres of designated EFH for Pacific Coast salmon and Pacific groundfish.

1. Follow term and condition 1 as presented in Section 2.8.4 in the ESA portion of this document to minimize adverse effects to the ecology of aquatic systems from project-related activities.
2. Use a vibratory hammer whenever possible to drive the steel piles.

### **3.4 Statutory Response Requirement**

As required by section 305(b)(4)(B) of the MSA, the Corps 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's 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, mitigating, or 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 C.F.R. § 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 Corps 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 C.F.R. § 600.920(l)).

## **4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW**

The 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 COE and applicant. Individual copies of this opinion were provided to the COE and the Port. 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 C.F.R. § 402.01, *et seq.*, and the MSA implementing regulations regarding EFH, 50 C.F.R. § 600 *et seq.*

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

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

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

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## **Appendix 1. Monitoring Plan for Wake Stranding**

The applicant will fund, either individually or with others, a study to re-examine the rates of fish stranding at three sites along the Columbia River. The objective of the study is to add to the knowledge of stranding rates at Barlow Point, County Line Park, and Sauvie Island. The applicant will work collaboratively with NMFS to develop additional details of the observation sampling program. The applicant will submit a draft of the sampling study protocol within four (4) months of issuance of the Corps permit.

Monitoring will occur at the known stranding locations at Barlow Point, County Line Park and Sauvie Island. Fish stranding observation methods will replicate the efforts of Pearson et al., 2006, although current technology will be employed to increase information and focus efforts. Beach seining to determine fish abundance adjacent to the known stranding locations will be included on each observation day.

The study will include an observation at a high risk stranding beach other than Sauvie Island. This will be an informal observation conducted once during the course of each sampling year. The purpose of this study element is to expand the knowledge of the prevalence of stranding at beaches predicted to have high stranding risk.

The study effort will include thirty (30) total days of observations (10 days at each of three beaches) per year over a 7-month period (March through September). The study will be conducted in years 1, 3, and 5, with year zero being the first March after product shipment from the new facility is initiated. Initiation of the study can be delayed by two (2) additional years if the delay would allow applicants from other projects to participate in funding the study. Initiation of the study is also subject to obtaining any necessary scientific permits or other necessary regulatory approvals.

Three observers will be on-site for each observation sampling day (6 to 8 hours) to walk the beach immediately after each ship passage to locate stranded fish. Stranding locations will be marked by GPS. It is anticipated that by coordinating with the pilots and viewing ship traffic on the AIS ship tracking system ([marinetraffic.com](http://marinetraffic.com)) several vessel passages could be recorded on each day of sampling. This level of effort is expected to exceed the number of vessel passage observations made annually during the Pearson et al., 2006 study. A report describing methods and results will be prepared by the end of the calendar year for each year that observations occur.

If others join to fund the study, additional effort will be added to: 1) develop a proposed study to more accurately assess the highly susceptible beaches as defined by Pearson et al to provide broader coverage beyond the known stranding location hotspot so that a more accurate average stranding rate can be calculated throughout the Lower Columbia River, and 2) implement such study.

## Appendix 2. Turtle Strike Calculation

### Turtle Strike Calculation

The likelihood of a vessel encountering a Leatherback Turtle (LBT) is based on the area of a vessels path through the critical habitat off the coast of Oregon and Washington (CHOW), and the number of turtles in that area. Given there between 5,400 and 7,200 LBTs that could be in all the CH, we used the fraction of CHOW to show there are 0.59 times all turtles, or 3186 to 4248. These can be spread over the 25,000 square miles of CHOW with a distribution of 0.13 to 0.17 per square mile. The total square miles of a vessels shipping path is 2.6 square miles, so turtles per shipping path area could be .33 to .44 LBT/sq mile. The amount of time a vessel will be in the shipping path area is based each crossing the full path in approximately 6.5 hours, which is .074% of a year. This multiplied by the turtles per shipping path, and the time they are present (half the year), provides a reasonable estimate of a vessel meeting a leatherback turtle along their path.

Any one vessel could encounter between 0.39 and .52 turtles while crossing the critical habitat area. Some of the assumptions behind this include that the vessels have an equal chance to encountering turtles, and that the turtles are evenly distributed. If we find that there are shipping lanes preferentially used by vessels, and a known subset of the critical habitat with a higher likelihood of LBTs present, this estimate could be modified, but lacking better tracking data for LBTs or vessels, it's difficult to say if more or fewer LBTs would be encountered by a vessel. We reviewed Dransfield *et al* approach to humpback whale (*Megaptera novaeangela*) interaction with vessels, where the shipping lanes were mapped and the highly used habitat was available to overlay, but without mapped data we cannot provide as complete an analysis.

#### *Low Population*

Area of CHOW = 25,000 square miles

Turtles low population = 5,400

Turtles per square mile =  $5,400/25,000 = 0.216$ / all critical habitat

Percent of area of CHOW in critical habitat = 0.59

Turtles in CHOW =  $5400 \times 0.059 = 3,186$

Percent of turtles in CHOW per square mile =  $3,186 \times 0.59 = 0.13$

Vessel path = square mile / shipping path = 2.604

Turtles in shipping path area =  $0.13 \times 2.604 = 0.332$

Time vessel is present in CHOW per year = 6.5 hours to cross CHOW/ (365 days per year/ 24 hours per day) = 0.074%

Vessel per half a year = 36

Any one vessel encountering a turtle =  $0.074 \times 0.332 \times 0.5 \times 3,186 = 0.392283$

Total encounters per year =  $0.392283 \times 36$  vessels = 14

#### *High Population*

Area of CHOW = 25,000 square miles

Turtles low population = 7,200

Turtles per square mile =  $7,200/25,000 = 0.288$ / all critical habitat

Percent of area of CHOW in critical habitat = 0.59

Turtles in CHOW =  $7,200 \times 0.059 = 4,248$

Percent of turtles in CHOW per square mile =  $4,248 \times 0.59 = 0.17$

Vessel path = square mile / shipping path = 2.604

Turtles in shipping path area =  $0.17 \times 2.604 = 0.443$

Time vessel is present in CHOW per year = 6.5 hours to cross CHOW/ (365 days per year/ 24 hours per day) = 0.074%

Vessel per half a year = 36

Any one vessel encountering a turtle =  $0.074 \times 0.332 \times 0.5 \times 4,248 = 0.523044$

Total encounters per year =  $0.523044 \times 36$  vessels = 19

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