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

Refer to NMFS No:
WCRO-2019-01316

September 8, 2020

Michelle Walker
Regulatory Branch Chief
Department of the Army
P.O. Box 3755
Seattle, Washington 98124-3755

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Proposed Grays Harbor Potash Export Facility, Grays Harbor County, Washington (HUC 17100105, Corps No.: NWS-2017-715)

Dear Ms. Walker:

Thank you for your letter of June 21, 2019, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Proposed Grays Harbor Potash Export Facility. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).

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

We concluded that the proposed action is adverse to, but not likely to jeopardize; Lower Columbia River Chinook salmon, Upper Willamette River Chinook salmon, Columbia River chum salmon, Pacific eulachon, North American green sturgeon, Mexico and Central American distinct population segments of humpback whales, fin whales, blue whales, sperm whales, sei whales, and leatherback sea turtles. We concluded that the proposed action is adverse to but not likely to adversely modify green sturgeon critical habitat. We concluded that the proposed action is not likely to adversely modify proposed humpback whale critical habitat or leatherback sea turtle critical habitat.

We concluded that the proposed action is not likely to adversely affect Puget Sound Chinook salmon or Puget Sound steelhead or their critical habitat. We also concluded that the proposed action is not likely to adversely affect Western North Pacific gray whales, North Pacific right whales, Southern Resident killer whales, green turtles, Loggerhead turtles, Olive ridley turtles or Guadalupe fur seals.

We concluded that the action would adversely affect the EFH of Pacific Coast salmon, Pacific Coast Groundfish and Coastal Pelagic Species. Therefore, we have included the results of that review in Section 3 of this document.

As required by section 7 of the ESA, we are providing an incidental take statement with the opinion. The incidental take statement describes reasonable and prudent measures we consider necessary or appropriate to minimize incidental take associated with this action. The take statement sets forth nondiscretionary terms and conditions, including reporting requirements that the USFS and any person who performs the action must comply with to carry out the reasonable and prudent measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA take prohibition.

Please contact Tom Hausmann, in Portland, Oregon, at 503-231-2315, or Tom.Hausmann@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

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

cc: Evan Carnes
Val Bond

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

Proposed Grays Harbor Potash Export Facility
Grays Harbor County, Washington (Corps No.: NWS-2017-715)

NMFS Consultation Number: WCRO-2019-01316

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	ESA Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
LCR Chinook salmon	T	Yes	No	NA	NA
UWR Chinook salmon	T	Yes	No	NA	NA
CR chum salmon	T	Yes	No	NA	NA
Pacific eulachon	T	Yes	No	NA	NA
North American green sturgeon	T	Yes	No	Yes	No
Humpback whale Mexico DPS	T	Yes	No	Proposed-Yes	No
Humpback whale Central America DPS	E	Yes	No	Proposed-Yes	No
Fin whale	E	Yes	No	NA	NA
Blue whale	E	Yes	No	NA	NA
Sperm whale	E	Yes	No	NA	NA
Sei whale	E	Yes	No	NA	NA
Leatherback sea turtle	E	Yes	No	No	No
Puget Sound Chinook salmon	T	No	No	No	No
Puget Sound steelhead	T	No	No	No	No
Western North Pacific Gray whale	E	No	NA	NA	NA
North Pacific right whale	E	No	No	NA	No
Southern Resident killer whale	E	No	No	Proposed-No	No
Green turtle	E	No	NA	NA	NA
Loggerhead turtle	E	No	NA	NA	NA
Oive Ridley turtle	E	No	NA	NA	NA
Guadalupe fur seal	E	No	NA	NA	NA

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

Consultation Conducted By: National Marine Fisheries Service
West Coast Region

Issued By: ______________
Kim W. Kratz, Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

Date: September 8, 2020

TABLE OF CONTENTS

1. Introduction 1
   1.1 Background 1
   1.2 Consultation History 1
   1.3 Proposed Federal Action 2
2. Endangered Species Act: Biological Opinion And Incidental Take Statement 8
   2.1 Analytical Approach 9
   2.2 Rangewide Status of the Species and Critical Habitat 10
      2.2.1 Status of the Species 12
      2.2.2 Status of Critical Habitat 27
   2.3 Action Area 30
   2.4 Environmental Baseline 32
   2.5 Effects of the Action 35
      2.5.1 Effects of the Proposed Action in Grays Harbor 35
      2.5.2 Potash Terminal OGV Operations in the Ocean 50
   2.6 Cumulative Effects 57
   2.7 Integration and Synthesis 58
   2.8 Conclusion 64
   2.9 Incidental Take Statement 64
      2.9.1 Amount or Extent of Take 65
      2.9.2 Effect of the Take 67
      2.9.3 Reasonable and Prudent Measures 67
      2.9.4 Terms and Conditions 67
   2.10 Conservation Recommendations 69
   2.11 Reinitiation of Consultation 70
   2.12 "Not Likely to Adversely Affect" Determinations 70
3. Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response 74
   3.1 Essential Fish Habitat Affected by the Project 74
   3.2 Adverse Effects on Essential Fish Habitat 74
   3.3 Statutory Response Requirement 76
   3.4 Supplemental Consultation 76
4. Data Quality Act Documentation and Pre-Dissemination Review 76
5. References 78
6. Appendices 89
   Appendix 1 89
   Appendix 2 91

1. INTRODUCTION

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

1.1 Background

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

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

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at Portland, Oregon.

1.2 Consultation History

The proposed action takes place in Grays Harbor, Washington. Grays Harbor is critical habitat for green sturgeon. In some return years, Pacific eulachon swim through Grays Harbor to reach spawning habitat in the Chehalis River. Some Lower Columbia River (LCR) and Upper Willamette River (UWR) fall Chinook salmon and Columbia River (CR) chum salmon smolts follow the Columbia River plume into Grays Harbor. Grays Harbor is Essential Fish Habitat for Pacific Coast Salmon, Pacific Coast Groundfish and Coastal Pelagic Species. Trains carrying potash from Canada to the terminal cross and adjoin Puget Sound Chinook salmon and Puget Sound steelhead critical habitat. Ocean Going Vessels (OGVs) loaded at the proposed terminal will travel across the Pacific Ocean Exclusive Economic Zone (EEZ) where they are likely to encounter humpback whales, fin whales, blue whales, sperm whales, right whales, sei whales, Southern Resident killer whales, Western North Pacific Gray whales and leatherback sea turtles.

The applicant for proposed permits is the BHP Billiton Canada, Inc.

The applicant seeks permits from the U.S. Army Corps of Engineers (Corps) under section 10 of the Rivers and Harbors Act, and Section 404 of the Clean Water Act. The purpose of the proposed action is commerce in potash.

NMFS received a consultation package from the Corps on June 21, 2019, with the Corps requesting formal consultation on the effects of the potash terminal project on Pacific eulachon, and green sturgeon.

On August 28, 2019, NMFS informed the Corps that the proposed action and the consequences of the proposed action are also likely to adversely affect; Puget Sound salmon and steelhead and their critical habitat that is crossed by or adjacent to BNSF railroad tracks carrying potash to the proposed terminal, ocean type salmon from the Columbia River Basin that migrate into Grays Harbor (LCR Chinook salmon, UWR Chinook salmon, CR chum salmon) and ESA listed marine mammals and turtles that encounter potash terminal ocean going vessels (OGV) in the Washington Coast Exclusive Economic Zone (EEZ). NMFS requested no additional information about or modifications to the proposed action.

On August 28, 2019, the Corps acknowledged NMFS expanded species list and provided NMFS with revisions to the mitigation plan.

On September 19, 2019, NMFS issued a proposed rule to revise the critical habitat designation for the Southern Resident killer whale Distinct Population Segment (DPS) pursuant to section 4 of the ESA to include six new offshore areas along the U.S. West Coast (84 FR 49214).

NMFS initiated consultation on September 28, 2019.

On October 9, 2019, NMFS issued a proposed rule to designate critical habitat for the endangered Western North Pacific DPS, the endangered Central America DPS, and the threatened Mexico DPS of humpback whales pursuant to section 4 of the ESA (84 FR 54354).

1.3 Proposed Federal Action

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

Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).]

We considered whether the proposed action would cause any other new activities that affect ESA listed species and their critical habitat. We determined that the proposed action would cause the following activities: 1) Up to 520 additional Burlington Northern Santa Fe (BNSF) unit trains per year will cross Puget Sound Chinook salmon and steelhead rivers and streams and travel along Puget Sound to transport potash from Canadian mines to the proposed Grays Harbor terminal; and 2) Up to 220-ocean going vessels (OGV) will travel across the west coast Exclusive Economic Zone, encountering ESA listed marine mammals and turtles, to transport potash from the Grays Harbor terminal to Asia. These unit trains and OGVs would not affect ESA species and critical habitat but for the new Grays Harbor potash terminal.

The Corps proposes to issue permits under the Rivers and Harbors Act of 1899 and the Clean Water Act to BHP Billiton Canada, Inc. (BHP) to redevelop the Port of Grays Harbor Terminal 3 facility and adjacent land into a bulk potash export facility. Each year, BHP will transport up to 8 million metric tons of potash (potassium chloride, KCl) from the Jansen Mine in Saskatchewan, Canada to the facility by up to 520 unit trains (177 cars). Each year, at the terminal, BHP will load potash in up to 220 ocean going vessels for export to Asia. Construction of the new terminal includes the following actions that affect fish in Grays Harbor; increased impervious surface, stormwater, and potential for fuel or hazardous liquid spills, pile driving, overwater construction, dredging and mitigation.

Impervious surface, stormwater, and potential spills

BHP will increase impervious surface at the project site by constructing a 380,000 square foot potash storage building, a 38,000 square foot administration building with parking, a 38,000 square foot maintenance building with parking, and a covered 6080 square foot rail car unloading facility. BHP will also increase impervious surface by constructing 8,500 feet of new track on crushed rock subballast and ballast and a 20,000 square foot covered conveyor system. Four large retention ponds adjacent to the new buildings and parking lots and five smaller retention ponds distributed through the site will treat stormwater runoff from these impervious surfaces. Ditches will convey stormwater to the treatment ponds. Treated stormwater will be discharged to the Grays Harbor through an existing outfall. BHP will collect stormwater that becomes contaminated with spilled potash and disposed of it at an approved wastewater disposal facility.

Northeast of the maintenance building, BHP will construct a covered fueling station that meets Federal and Washington State Department of Ecology (Ecology) standards and the stormwater control provisions in the facility's stormwater pollution prevention plan. The fueling station will have double-walled above ground fuel tanks within a concrete secondary containment area. The fueling island pad adjacent to the tanks will be impervious and graded with a center drain that will convey to a dead-end sump with capacity for potential spills.

Impervious Surface and Spills Best Management Practices (BMPs):

- Stormwater treatment facilities will infiltrate stormwater runoff from new and existing impervious surfaces to the extent possible; or stormwater will be collected, treated, and discharged to the bay via existing outfalls. Stormwater treatment would comply with Ecology's 2012 Stormwater Management Manual for Western Washington, as amended in December 2014.

- All conveyors will be covered to protect the potash from exposure to rain.

- The potash will be transferred to the vessels at the berth via covered conveyors in order to avoid potash spillover from the conveyors. Spill pans and side skirts will contain spills or fugitive dust from the return belt.

- The site will have a facility-specific spill prevention control and countermeasures (SPCC) plan and spill kits throughout the site to prevent, minimize, and respond to spills that may result from day-to-day operations at the site.

- The facility includes a fueling station that will be constructed on a concrete pad within secondary containment appropriate to the size of the station.

- The facility will control risks during operations by following the Industrial Stormwater Pollution Prevention Plan (SWPPP) and Spill Prevention and Control Countermeasures plan to prevent liquid products from leaving the containment areas. Spill kits will be placed in strategic and easily accessible locations for use if small spills occur; containment, control, and cleanup procedures will be immediately implemented, including notifying Ecology and other resource agencies as required by law.

Pile Driving

BHP will construct an access trestle, a quadrant shiploader with two berthing dolphins and four mooring dolphins. A conveyor supported by the access trestle will move potash from the railcar unloading facility or the potash storage building to a quadrant shiploader. BHP will construct the part of the trestle over water with forty-eight 48-inch diameter steel pipe piles, each of fourteen quadrant shiploader supports with four 48-inch diameter steel pipe piles and each of six OGV berthing/mooring dolphins with sixteen 48-inch diameter steel pipe piles. The entire terminal will require 199 48-inch diameter steel pipe piles.

BHP will install permanent piles with a vibratory pile driver to refusal and then an impact pile driver to the final depth. BHP expects that reaching the final elevation and proofing will require 2500 strikes per pile but may require up to 5,000 strikes. BHP will drive one pile per day for 200 days during two October 1 to February 14 in water work windows. BHP will use a bubble curtain to attenuate impact pile driving sound pressure levels and will not permit the pile driver barge to ground out.

Construction may also require up to 48 temporary 24-inch diameter steel pipe piles installed with vibratory pile driving.

Pile Driving BMPs:

- A vibratory hammer will be used to drive steel piles to the extent possible to minimize noise levels.

- A bubble curtain or other similarly effect noise attenuation device will be employed during all impact pile proofing or installation. The bubble curtain will be consistent with standard NOAA Fisheries/USFWS bubble curtain specifications (Appendix 1).

- Pile installation will be conducted during the approved WDFW in-water work window for Tidal Reference Area 10 (16 July to 14 February, midnight). Impact pile driving will be done between 1 October and 14 February. This period was established to minimize impacts to aquatic species. All in-water work will be completed within the work window when ESA-listed species are least likely to be present.

- Check equipment for leaks and other problems that could result in the discharge of Petroleum-based products or other material into waters of Grays Harbor. Corrective actions will be taken in the event of any discharge of oil, fuel, or chemicals into the water including: 1) Containment and cleanup efforts will begin immediately upon discovery of the spill and will be completed in an expeditious manner, in accordance with all local, state and federal regulations. Cleanup will include proper disposal of any spilled material and used cleanup material; 2). Oil absorbant materials will be present on site for use in the event of a spill or if any oil product is observed in the water; 3) The cause of the spill will be ascertained and appropriate actions taken to prevent further incidents or environmental damage; and 4) Spills will be reported to Ecology's Southwest Regional Spill Response Office.

- Work barges will not be allowed to ground out.

- Excess or waste materials will not be disposed of or abandoned waterward of ordinary high water or allowed to enter waters of the state. Waste materials will be disposed of in an appropriate manner consistent with applicable local, state, and federal regulations.

- Demolition and construction materials will not be stored where wave action or upland runoff can cause materials to enter surface waters.

Overwater Construction

BHP will construct steel or concrete pile caps, steel beams, and steel deck with grating on the piles to support the mooring structure. Steel up-stands will support the pivot loads for the quadrant loaders. The quadrant beams will consist of steel beams with extended flanges for walkways on both sides of the crane rail.

Overwater concrete placement BMPs:

- Wet concrete will not come into contact with surface waters.

- Forms for any concrete structure will be constructed to prevent leaching of wet concrete.

- Concrete process water will not be allowed to enter the bay. Any process water/contact water will be routed to a contained area for treatment and will be disposed of at an upland location.

Dredging

The area of the marine terminal berth is 19,000 square meters. BHP will dredge the marine terminal berth to -43 feet mean lower low water plus 2 feet of allowable over dredge. The existing depths range from -32 feet MLLW to -44 feet MLLW. The USACE Dredged Material Management Program (DMMP) approved the dredge material for in water disposal. Dredge material will be disposed of at the DNR Point Chehalis or the South Jetty disposal sites (Figure 1). Dredgers will remove approximately 110,000 cubic yards of sediment with clamshell or hydraulic dredge during facility construction and BHP will do (as needed) annual maintenance dredging of the marine terminal berth for 10 years. Maintenance dredge material will require characterization for in water disposal 6 years after receiving the suitability determination.

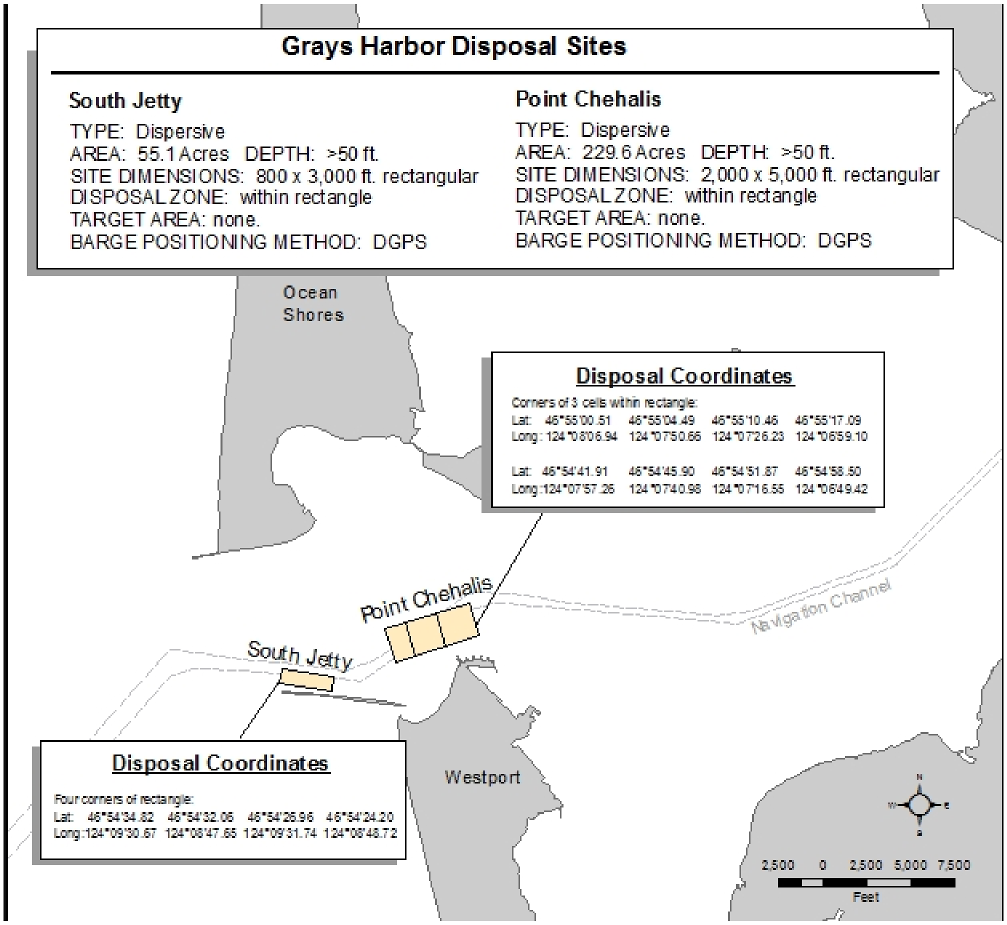

Figure 1. Potash terminal dredge disposal sites

Dredging BMPs to minimize suspended sediment:

- No stockpiling of dredged material below mean higher high water.
- Maintain suction head of hydraulic dredge at the mudline to the extent practicable.
- Use a buffer plate or other means to reduce flow discharge of the hydraulic dredge at the placement area.
- Smooth closure of the bucket when at the bottom.
- Slowing the velocity (cycle time) of the ascending loaded clamshell bucket through the water column.
- Pausing the dredge bucket near the bottom while descending and near the waterline while ascending.

- Placing filter material over the barge scuppers to clear return water.

- If sediment is placed on a barge for delivery to the placement area, no spill of sediment from the barge will be allowed. 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.

- Dredging is expected to be conducted using hydraulic (pipeline) or mechanical (clamshell bucket) and disposed at the nearest DNR-managed Point Chehalis or South Jetty disposal sites if characterization finds the material suitable for in-water placement.

- Visual water quality monitoring and, if necessary, follow-up measurements will be conducted during dredging in accordance with a project-specific water quality monitoring plan and associated permit conditions.

- Sediment that is dredged by hydraulic dredge and placed in water by hydraulic pipeline will be discharged at the mudline to the extent practicable to minimize turbidity in the water column.

- Sediment placement will occur using methods that minimize sediment loss and turbidity to the maximum extent possible.

- The placement activities will be visually monitored to ensure placed sediment is contained inside of the specified boundaries.

Mitigation

Forty-five acres of filled tideland at the mouth of the Hoquiam River will be restored by removing fill and excavating tidal channels to create a mosaic of tidal channels, 5.17 acres of low salt marsh, 24.1 acres of high salt marsh, 3.26 acres of palustrine emergent wetland, 8.78 acres of wetland and enhanced scrub-shrub and forested buffer habitat.

A derelict concrete overwater structure and 1,368 creosote treated timber piles will be removed from nearshore waters of Grays Harbor near the Port of Grays Harbor Terminal 4 near the mouth of the Chehalis River. Pile removal will restore 1,464 square feet of benthic habitat in an area of 4.35 acre. Overwater structure removal will restore 2,147 square feet of nearshore habitat.

Pile removal BMPs:

- While creosote-treated piles are being removed, a containment boom will surround the work area to contain and collect any floating debris and sheen. Any debris will be retrieved and disposed of properly.

- The piles will be dislodged with a vibratory hammer when possible and will not be intentionally broken by twisting or bending.

- The piles will be removed in a single, slow, and continuous motion in order to minimize sediment disturbance and turbidity in the water column.

- If a pile breaks above or below the mudline, it will be cut or pushed in the sediment consistent with agency approved BMPs.

- Removed piles, stubs, and associated sediments (if any) will be contained on a barge. If piles are placed directly on the barge and not in a container, the storage area will consist of a row of hay or straw bales, filter fabric, or similar material placed around the perimeter of the barge.

- All creosote-treated material, pile stubs, and associated sediments (if any) will be disposed of by the contractor in a landfill approved to accept those types of materials.

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

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

We determined that the proposed action to construct and operate the potash export terminal and the ocean going vessel shipping that is a consequence of the proposed action are likely to adversely affect Lower Columbia River Chinook salmon, Upper Willamette River Chinook salmon, Columbia River chum salmon, Pacific eulachon, North American green sturgeon, Mexico and Central American distinct population segments of humpback whales, fin whales, blue whales, sperm whales, sei whales and leatherback sea turtles. The proposed action is also likely to adversely affect critical habitat of green sturgeon.

We determined that consequences of the proposed action are not likely to adversely affect Puget Sound Chinook salmon and Puget Sound steelhead or their critical habitat, gray whales, right whales, Southern Resident killer whales, green turtles, loggerhead turtles, olive ridley turtles or Guadaupe fur seals. Our analysis is documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.12).

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

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

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

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this opinion we use the terms "effects" and "consequences" interchangeably.

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

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

2.2 Rangewide Status of the Species and Critical Habitat

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

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

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

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

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

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

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

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 degrees 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 (Reeder et al., 2013; Tillmann and Siemann, 2011).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. A 38 percent to 109 percent increase in acidity is projected by the end of this century in all but the most stringent CO_2 mitigation scenarios, and is essentially irreversible over a time scale of centuries (IPCC, 2014). Regional factors appear to be amplifying acidification in Northwest ocean waters, which is occurring earlier and more acutely than in other regions and is already impacting important local marine species (Barton et al., 2012; Feely et al., 2012). Acidification also affects sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than 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 (Reeder et al., 2013; Tillmann and Siemann, 2011). 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 (Reeder et al., 2013; Tillmann and Siemann, 2011).

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

2.2.1 Status of the Species

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

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

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

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

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

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

The summaries that follow describe the status of the 16 ESA-listed species, and their designated critical habitats, that occur within the geographic area of this proposed action and are considered in this opinion. More detailed information on the status and trends of these listed resources, and their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register (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; 'E' means listed as endangered; 'P' means proposed for listing or designation.

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon *(Oncorhynchus tshawytscha)*			
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
Puget Sound	T 6/28/05: 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Chum salmon *(O. keta)*			
Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Steelhead (*O. mykiss*)			
Puget Sound	T 5/11/07; 72 FR 26722	3/25/16; 81 FR 9251	9/25/08; 73 FR 55451
Eulachon *(Thaleichthys pacificus)*			
Southern DPS	T 3/18/10; 75 FR 13012	10/20/11; 76 FR 65324	Not applicable
Green sturgeon (*Acipenser medirostris*)			
Southern DPS	T 4/07/06; 71 FR 17757	10/09/09; 74 FR 52300	6/2/10; 75 FR 30714
Humpback whale (*megaptera novaengliae*)			
	E 12/02/1970; 35 FR 183019	2/24/16; 81 FR 9252	ESA section 9 applies
Fin whale (***Balaenoptera physalus***)			
	E 12/01/1970; 35 FR 18319	Not applicable	ESA section 9 applies
Blue whale (*Balaenoptera musculus*)			
	E 12/02/1970; 35 FR 183019	Not applicable	ESA section 9 applies
Sperm whale *(Physeter microcephalus*)			
	E 12/021970;	Not applicable	ESA section 9 applies
Right whale (*Eubalaena japonica*)			
	E 3/06/08; 73FR 12024	4/08/08; 73FR19000	ESA section 9 applies

Species	Listing Status	Critical Habitat	Protective Regulations
Sei whale add species name			
	E 7/30/1970; 35FR 12222	Not applicable	ESA section 9 applies
Southern Resident Killer whale add species name			
	E 11/18/200;	11/29/2006; 71FR34571	ESA section 9 applies
Western North Pacific Gray whale add species name			
	E 3/06/08; 73FR 12024	4/08/08; 73FR19000	ESA section 9 applies
Leatherback turtle (*Dermochelys coriacea*)			
	E 6/02/1970; 39 FR 19320	3/23/79; 44 FR 17710 1/26/2012 77 FR 4170	ESA section 9 applies

Status of North American Green Sturgeon

The southern DPS of green sturgeon was listed as threatened on April 7, 2006 (71 FR 17757). We completed a 5-year review for this DPS in 2015 and recommended the DPS retain its threatened classification. The recovery plan for this DPS was finalized in August, 2018 (NMFS, 2018). A key recovery strategy is to reestablish additional spawning areas in currently occupied rivers in California.

Spatial Structure and Diversity. A northern DPS spawns in the Klamath and Rogue rivers and a southern DPS that spawns south of the Eel River in Humboldt County, California. Currently, all Southern green sturgeon spawn in the Sacramento River. Southern green sturgeon telemetry data and genetic analyses suggest that Southern DPS green sturgeon range from Graves Harbor, Alaska to Monterey Bay, California (Lindley et al., 2011; Lindley et al., 2008; Moser and Lindley, 2007). Within this range they most frequently occur in coastal waters of Washington, Oregon, Vancouver Island and San Francisco and Monterey bays (Huff et al., 2012). Northern and Southern DPS green sturgeon prefer marine waters of less than a depth of 110 m (Erickson and Hightower, 2007).

Abundance and Productivity. Recent studies are providing preliminary information on the population abundance of Southern DPS green sturgeon. The current estimate of spawning adult abundance is between 824 and 1,872 individuals (NMFS, 2015).

Limiting Factors. The principle extinction risk for Southern DPS of green sturgeon is the reduction of their spawning area to a small portion of the Sacramento River. The spawning population congregates in a limited area of the river compared to potentially available habitat. The reason for this is unknown. A catastrophic event or targeted poaching at just a few holding areas would affect a significant portion of the adult population. No comparable data on holding area occupancy within the Sacramento River were available at the time of the 2020 status review making it difficult to assess whether the current observations reflect an improvement or decline in the species status (NMFS, 2015). The other limiting factors are degradation of freshwater and estuarine water quality and water diversions on the Sacramento River, Sacramento River Delta and the Feather River (USDC, 2010). The effects of poaching, contaminants and nonnative species are unknown but potentially serious (NOAA Fisheries, 2011).

Status of LCR Chinook Salmon

LCR Chinook salmon were listed as threatened on June 28, 2005 (70 FR 37160). A recovery plan was published in 2013 (NMFS, 2013).

Spatial Structure and Diversity. The ESU consists of 32 historical populations in the Columbia River and its tributaries from the mouth to a point between Washington and Oregon just east of the Hood River and the White Salmon River. The ESU includes the Willamette River to Willamette Falls with the exception of spring-run Chinook salmon in the Clackamas River. The ESU spans three distinct ecological regions, Coastal, Cascade, and Gorge. Populations exhibit three different life history types base on return timing and other features. There are 21 fall-run (or "tules") populations, 2 late-fall-run (or "brights") populations, and 9 spring-run populations. Distinct run times within each ecological regions are organized into 6 major population groups (MPGs). Fall-run Chinook salmon hatchery programs have released 50 million fish annually. Spring-run and upriver bright (URB) programs release 15 million fish annually. As a result of this high level of hatchery production and low levels of natural production, many of the populations contain over 50 percent hatchery fish among their naturally spawning assemblages.

Abundance and Productivity. Specific population VSP targets are identified for each life history (NMFS, 2013a). Only the Lewis River and Sandy River late-fall run populations are considered viable (or nearly viable) (NWFSC, 2015a). Late fall Chinook salmon recovery also requires maintenance of the North Fork Lewis population, which is comparatively healthy, and increasing the probability of persistence of the Sandy population from "high" to "very high" through harvest and hatchery changes. All Spring Chinook populations are affected by habitat loss and degradation. Of the seven spring-run DIPs in the Cascade MPG only the Sandy River spring-run population appears to be currently self-sustaining. The Fall-run Cascade MPG exhibits stable population trends at low abundance levels, and most populations have hatchery contribution exceeding the recovery plan target of 10 percent (NMFS, 2013b). The two populations in the Late-Fall-run Cascade MPG are 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. The Sandy River late-fall run has not been directly monitored in a number of years but the most recent estimate was 373 spawners in 2010 (Takata, 2011).

Limiting factors. Four of the nine Spring Chinook populations require significant reductions in every limiting factor. Protection and improvement of tributary and estuarine habitat are specifically noted. Fall Chinook salmon, recovery requires restoration of the Coast and Cascade strata to high probability of persistence. Most fall Chinook salmon populations require large VSP improvements by ensuring habitat protection and restoration. The two historical populations in the Spring-run Gorge MPG are extirpated or nearly so. Many of the populations in the Fall-run Gorge MPG have limited spawning habitat available. The populations in the Coastal fall-run

MPG are dominated by hatchery-origin spawners. Natural-origin returns for most populations are in the hundreds of fish. Limiting factors for this species include NMFS (2013a):

- 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, 2011b). 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 (NWFSC, 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., 2015; Jepson et al., 2013).

Spatial Structure and Diversity. This species includes all naturally spawned populations of spring-run Chinook salmon originating from the Clackamas River; from the Willamette River and its tributaries above Willamette Falls; and from six artificial propagation programs (NMFS, 2016; USDC, 2014). All seven historical demographically independent populations (DIPs) 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 2).

Table 2. 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, 2011a). All populations are in the Western Cascade Range ecological subregion. Risk ratings included very low (VL), low (L), moderate (M), high (H), and very high (VH). The current general directions of population viability scores based on data reviewed in the 2015 status update are also shown (NWFSC 2015).

Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Extinction Risk	Current VSP Score Trend
Clackamas River	M	M	L	M	Declining
Molalla River	VH	H	H	VH	Increasing
North Santiam River	VH	H	H	VH	Increasing
South Santiam River	VH	M	M	VH	Increasing
Calapooia River	VH	H	VH	VH	Stable
McKenzie River	VL	M	M	L	Declining
Middle Fork Willamette River	VH	H	H	VH	Increasing

Abundance and Productivity. Abundance levels for five of the seven DIPs in this ESU remain well below their recovery goals. Of these, the Calapooia River may be functionally extinct and the Molalla River remains critically low (although perhaps only marginally better than the 0 VSP score estimated in the Recovery Plan; (ODFW and NFMS 2011). Abundances in the North and South Santiam rivers have risen since the 2010 review, but still range only in the high hundreds of fish. The proportion of natural origin spawners improved in the North and South Santiam basins, but was still well below identified recovery goals. Improvement in the status of the Middle Fork Willamette River relates solely to the return of natural adults to Fall Creek, however the capacity of the Fall Creek basin alone is insufficient to achieve the recovery goals for this DIP. The Clackamas and McKenzie Rivers have previously been viewed as natural population strongholds, but have both experienced declines in abundance despite having access to much of their historical spawning habitat. Fish passage improvements made at dams and numerous habitat restoration projects completed in upper Willamette River tributaries are expected to eventually provide benefit to the UWR Chinook salmon ESU, however, the scale of improvements needed is greater than the scale of habitat actions implemented to date (NMFS 2016c). Overall, populations appear to be at either moderate or high risk, there has been likely little net change in the VSP score for the ESU since the last review, so the ESU remains at moderate risk (NWFSC 2015).

Limiting Factors. Limiting factors for this species include (ODFW and NMFS 2011):

- Degraded freshwater habitat, including floodplain connectivity and function, channel structure and complexity, incubation gravels, riparian areas, and gravel and large wood recruitment
- Degraded water quality including elevated water temperature and toxins
- Increased disease incidence
- Altered stream flows
- Reduced access to spawning and rearing habitats due to migration barriers, impaired fish passage, and increased pre-spawn mortality associated with conditions below dams
- Altered food web due to reduced inputs of microdetritus

- Predation by native and non-native species, including hatchery fish
- Competition related to introduced races of salmon and steelhead
- Altered population traits due to fisheries, bycatch, and natural origin fish interbreeding with hatchery origin fish

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). CR chum salmon spawning aggregations identified in the mainstem Columbia River were included in the population associated with the nearest river basin. 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).

Abundance and Productivity. The very low persistence probabilities or possible extirpations of most chum salmon populations are due to low abundance, productivity, spatial structure, and diversity. 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 3. 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).

Ecological Subregion	Run Timing	Spawning Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Persistence Probability
Coast Range	Fall	Young's Bay (OR	*	*	*	VL
		Grays/Chinook River (WA)	VH	M	H	M
		Big Creek (OR)	*	*	*	VL
		Elochoman/Skamakowa Rivers (WA)	VL	H	L	VL
		Claskanie 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

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 Pacific eulachon

Eulachon were listed as a threatened species on March 18, 2010 (75 FR 13012). NMFS adopted a final recovery plan for eulachon on September 6, 2017 (NMFS, 2017). On April 1, 2016, we announced the results of our 5-year review of eulachon status. After completing the review, we recommended the southern DPS of eulachon remain classified as a threatened species.

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 predation (species-wide) (NMFS, 2017).

Spatial Structure and Diversity. The southern DPS 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 bycatch in the pink shrimp fishery seems to indicate that the distribution of these organisms overlap in the ocean. The southern DPS includes four major subpopulations: Columbia, Klamath, Frazier, and British Columbia. However, these subpopulations do not include all spawning aggregations within the DPS. For instance, spawning runs of eulachon have been noted in Redwood Creek and the Mad River in California, the Umpqua River and Tenmile Creek in Oregon, and the Naselle and Quinault rivers in Washington (NMFS, 2017).

Abundance and Productivity. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River with no evidence of returning to their former population levels since then (Drake et al., 2008). Persistent low returns and landings of eulachon in the Columbia River from 1993-2000 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 2001-2003, the returns and associated commercial landings have again declined to the very 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 Although eulachon abundance in monitored rivers has generally improved, especially in the 2013-2015 return years, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years. Therefore, it is too early to tell whether recent improvements in the southern DPS of eulachon will persist or whether a return to the severely depressed abundance years of the mid-late 1990s and late 2000s will recur (NMFS, 2017).

Limiting Factors:

- Changes in ocean conditions due to climate change, particularly in the southern portion of the species' range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success.
- Climate-induced change to freshwater habitats
- Bycatch of eulachon in commercial fisheries
- Adverse effects related to dams and water diversions
- water quality,
- Shoreline construction
- Over harvest
- Predation

Marine Mammal Recovery Plans

Recovery plans are in place for all of the marine mammal species considered in this Opinion and they can be found at: https://www.fisheries.noaa.gov/resource/document.

Status of Humpack whale

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). The majority of humpback whales off the coast of Washington are from the Hawaii DPS (Calambokidis et al., 2017) and were delisted under the ESA. Mexico DPS humpback whales are listed as threatened and Central America DPS humpback whales are listed as endangered. Critical habitat is proposed.

Spatial structure and diversity. Humpback whales are in all major oceans and most seas. They typically spend the summer on high-latitude nearshore feeding grounds and the winter in the tropics and subtropics around islands, over shallow banks, and along continental coasts, where calving occurs (Barlow et al., 2011; Bettridge et al., 2015; Calambokidis et al., 2017; Calambokidis et al., 2009b). Visual surveys and acoustic monitoring studies detect some humpbacks along the Washington coast year round (Cogan, 2015; Emmons et al., 2019; Oleson et al., 2009). The Central America DPS is composed of humpback whales that breed along the Pacific coast of Costa Rica, Panama, Guatemala, El Salvador, Honduras and Nicaragua and feed almost exclusively offshore of California and Oregon with only a few individuals identified at the northern Washington – southern British Columbia feeding grounds (81 FR 62259). The Mexico DPS consists of humpback whales that breed along the Pacific coast of mainland Mexico, and the Revillagigedos Islands and transit through the Baja California Peninsula coast.

The DPS feeds across a broad geographic range from California to the Aleutian Islands, with concentrations in California-Oregon, northern Washington – southern British Columbia, northern and western Gulf of Alaska and Bering Sea feeding grounds (81 FR 62259). Three biologically important humpback whale feeding areas are off of the Washington Oregon coast (Calambokidis et al., 2015); (1) Point St. George off Crescent City, Oregon from July to November (2) Stonewall and Heceta Bank off Newport, Oregon from May to November, and (3) Northern Washington from May–November. Surveys of the Northern Washington feeding area found that humpback whale sightings were concentrated around the edge of what appears to be the semi-permanent eddy associated with the outflow from the Strait of Juan de Fuca (Dalla Rosa et al., 2012). Satellite tag location data from humpback whales indicate a preference for water less than 200 meter deep (Barlow et al., 2011; Becker et al., 2016; Campbell et al., 2015).

Abundance and productivity. Current abundance of the Central America DPS is 411 (81 FR 62259). The current abundance of the Mexico humpback whale DPS is 3,264 (81 FR 62259). A population growth rate is currently unavailable for these DPSs. Current estimates of abundance for the CA/OR/WA stock is 1918 individuals with 1729 feeding off California and Oregon and 189 feeding off Washington (NMFS, 2019).

Threats. The most common source of injury to humpback whales along the U.S. Pacific coast is entanglement in pot and trap fisheries (Carretta et al., 2018). There were 54 separate entanglement cases reported for humpback whales along the U.S West Coast in 2016 (National Oceanic and Atmospheric Administration, 2017). For the five-year period between 2011 and 2015 there were 34 cases of entanglement involving pot/trap fisheries and an additional 26 cases of reported interactions with other fisheries (Carretta et al., 2017). Available data from NMFS indicate that along the U.S. Pacific coast between 2011 and 2015, there were nine ship strikes involving humpback whales (Carretta et al., 2018). Humpback whales are also potentially affected by loss of habitat, loss of prey (for a variety of reasons including climate variability), underwater noise, jet skis and similar fast waterborne tourist-related traffic disturbance and vessel strike, and pollutants (Muto et al., 2017).

Status of Fin Whale

Fin whales were listed as endangered worldwide under 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 in the action area are from the CA/OR/WA stock.

Spatial Structure and Diversity. In the action area NMFS recognizes two fin whale stocks, the Northeast Pacific stock and the California, Oregon, and Washington stock. Fin whales prefer temperate and polar waters making long-range movements along the entire U.S. West Coast (Falcone et al., 2011) following prey off the continental shelf (Azzellino et al., 2008). There was one sighting of a group of three fin whales during 42 small boat surveys from Grays Harbor out to the 1,000 meter isobath off Quinault conducted over a five-year period in the summer between 2004 and 2009, (Oleson and Hildebrand, 2012). During aerial surveys within the 2,000 m isobath off southern Washington, Oregon, and Northern there were six sightings of 13 fin whales during winter and summer 2012 (Adams et al., 2014). Acoustic monitoring has indicated a yearly seasonal pattern of fin whale calls in the action area with the absence of calls from approximately May through July (Oleson and Hildebrand, 2012).

Abundance and Productivity. 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).

Limiting factors. Fin whales are susceptible to both ship strikes and entanglement in fishing gear (Carretta et al., 2017; National Oceanic and Atmospheric Administration, 2017). Between 1991 and 201 there were 20 reported ship strikes of fin whales along the U.S. West Coast. From 2010 to 2014 along the U.S West Coast there were nine reported ship strikes to fin whales (Carretta et al., 2017). Since 2002, 10 out of the 12 stranded fin whales in Washington have showed evidence attributed to a large ship strike (Cascadia Research, 2017). Four fin whales were seriously injured by entanglement in fishing gear off the U.S. West Coast between 2007 and 2014 (Carretta et al., 2017; Carretta et al., 2013).

Status of blue whales

The blue whale 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 FR 8491; June 2, 1970). The entire species remains endangered under the ESA. There is no designated critical habitat for blue whales.

Spatial structure and diversity. The Eastern North Pacific Stock of blue whales includes animals found in the eastern north Pacific from the northern Gulf of Alaska to the eastern tropical Pacific (Carretta et al., 2017). Most blue whale sightings are in nearshore and continental shelf waters. However, blue whales frequently migrate through deep oceanic waters to spend their summers feeding in productive waters near the higher latitudes of the Gulf of Alaska and the Aleutian Islands and their winters in the warmer waters at lower latitudes from Southern California to Costa Rica (Calambokidis and Barlow, 2013; Calambokidis et al., 2009b). None of the nine feeding areas for blue whales off the U.S. West Coast areas are within the Action Area (Calambokidis et al., 2015). There was one sighting of a blue whale (Oleson and Hildebrand, 2012) during 42 small boat surveys from Grays Harbor out to the 1,000 meter isobath off Quinault between 2004 and 2009. Aerial surveys conducted in waters off southern Washington, Oregon, and Northern California in the spring, summer, and fall of 2011 and 2012, encountered a total of 16 blue whales during the fall (Adams et al., 2014). Acoustic monitoring in waters off the coast of Washington show a yearly seasonal pattern of blue whale presence from summer through winter (Oleson and Hildebrand, 2012).

Abundance and productivity. The Eastern Pacific blue whale population may have reached a stable level at 97 percent of carrying capacity in 2013 following the cessation of commercial whaling in 1971 (Monnahan et al., 2015).

Limiting factors. In waters off California between 1991 and 2010 there were 14 ship strikes involving blue whales (Calambokidis, 2012a; Calambokidis et al., 2009a; Monnahan et al., 2015) and 10 blue whales died from vessel strikes between 2007 and 2011 in waters of the U.S. West Coast (Carretta et al., 2017; Carretta et al., 2013). There was one blue whale ship strike death reported in 2016 (Carretta et al., 2017).

Status of sperm whales

Sperm whales are listed as endangered under the ESA, but there is no designated critical habitat for this species. Sperm whales in Alaska are from the North Pacific stock. Sperm Whales in the action area are from the California, Oregon, Washington stock (Carretta et al., 2017; Carretta et al., 2018).

Spatial structure and diversity. Sperm whales are typically found in temperate and tropical waters of the Pacific but they are also found in areas of higher latitudes in the northern Pacific including Alaska (Whitehead, 2009; Whitehead et al., 2008). Sperm whales have a preference for deep water areas of high productivity, generally near drop offs and areas with strong currents and steep topography (Gannier and Praca, 2007). The semi-permanent the Strait of Juan de Fuca eddy is one such area (MacFadyen et al., 2008). Sperm whales are somewhat migratory. No sperm whales were detected during systematic surveys of waters between the British Columbia border with Alaska and Washington (Williams et al., 2007). Sperm whales were observed twice in deep water off the coast from Grays Harbor in aerial surveys of waters off Washington, Oregon, and Northern California in the spring, summer, and fall of 2011 and 2012 (Adams et al., 2014). There were a total of five sperm whale sightings during the NMFS 2014 summer shipboard survey off the coast of Washington .

Abundance and productivity. Estimates of sperm whale total global abundance range from 300,000 and 450,000 individuals (Whitehead, 2009). The California/Oregon/Washington stock abundance is 2,106 individuals (Nmin=1,332), and the Hawaii stock abundance is 3,354 individuals (Nmin=2,539) (Carretta et al., 2019).

Limiting factors. In waters off the U.S. Pacific West Coast between 2011 and 2015, there was one reported ship strike involving a sperm whale in 2012 (Carretta et al., 2017). From 2010 to 2014, a total of five sperm whales were entangled in fishing gear off the U.S. Pacific West Coast (Carretta et al., 2016).

Status of Sei Whales

The sei whale 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 FR 8491; June 2, 1970). The entire species remains endangered under the ESA. There is no designated critical habitat for blue whales.

Spatial structure and diversity. Sei whales migrate to spend the summer months feeding in the subpolar higher latitudes and return to lower latitudes as far south as Southern California to calve in the winter (Horwood, 2009). They are found feeding along the California Current, preferring deep water habitat along the continental shelf (Perry et al., 1999). Four sei whales were sighted off Oregon and Washington waters during six ship surveys to 300 nautical miles conducted between 1991 and 2008 (Barlow, 2010). No sei whale were sighted during coastal ship survey to the 200 meter isobaths off the northern Washington coast between 1995 and 2002 (Calambokidis et al., 2004a).

Abundance and productivity. In 2012, the North Pacific Ocean sei whale population was estimated to be 29,632 (95 percent confidence intervals 18,576 to 47,267) (International Whaling Commission, 2016; Thomas et al., 2016).

Limiting factors. Sei whales, because of their offshore distribution and relative scarcity in U.S. Atlantic and Pacific waters, probably have a lower incidence of fishing gear entanglement than fin whales. One sei whale was killed in a collision with a vessel off the coast of Washington in 2003 (National Marine Fisheries Service, 2017).

Status of Leatherback sea turtle

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

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 we do not know if they nest there. Biologists designated populations by their nesting locations. In the eastern Pacific, major nesting sites are located in Mexico, Costa Rica, and Nicaragua. In the western Pacific, nesting 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 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 (Benson et al., 2007a; Benson et al., 2011; Eckert, 1998; Eckert and Lien, 1999; Morreale et al., 1994). 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, 1998).

Recent work by NMFS have tracked leatherbacks across the Pacific and confirmed that leatherbacks utilize zones of upwelling relaxation. Central California and the waters off the Columbia River are two primary feeding areas (Benson et al., 2011; Benson et al., 2007b; NMFS, 2012). 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 the upper water column retains larval fish, crabs, and jellyfish during relaxation of upwelling. Biologists have documented the main areas of foraging on the U.S. West Coast. Leatherbacks forage over the coastal shelf off central California in waters of 14-16° C and off central and northern California at sea surface temperature fronts in deep offshore areas (Benson et al., 2011). They also forage over the continental shelf and slope off Oregon and Washington, particularly off the Columbia River plume (Benson et al., 2011).

Abundance and Productivity. Population abundance and trends vary in the different regions. 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). The 2020 status review estimates a global abundance of 32,175 nesting females (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2020).

In the Indian Ocean and Southeast Asia the 2020 status review estimates 258 nesting females (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2020).

In the Northwest Atlantic Ocean, NMFS and the USFWS conducted an extensive review of the status of leatherbacks in 2020. The total index of nesting female abundance is 20,659 females with a decreasing nest trend at the nesting beaches with the greatest known nesting female abundance. (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2020).

In the Pacific Ocean, leatherback populations declined at all major Pacific basin nesting beaches (NMFS and USFWS, 1998; Spotila et al., 1996; Spotila et al., 2000) leading some researchers to conclude that the Eastern Pacific beach nesting populations were on the verge of extirpation (Spotila et al., 1996; Spotila et al., 2000). Steep declines continued in the two major eastern Pacific nesting sites in Mexico and Costa Rica (Mast et al 2017). The most recent estimates of the number of nesting females per year in Mexico and for Costa Rica is approximately 755 (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2020).. Leatherback turtles from the populations that nest on Mexico and Costa beaches forage in waters off the coast of California but rarely travel as far north as the action area (personal communication from Penny Ruvelas to Scott Anderson).

The abundance of the western Pacific leatherback population that nests in Indonesia is 1277 females (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2020). 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).

Most western leatherback turtle populations forage in the Southern Hemisphere. 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 were tracked to foraging areas in the Southern Hemisphere, including the Coral Sea and the western south Pacific (Benson et al., 2011). Thirty years ago there were 15 nesting beaches in the Solomon Islands (Vaughan 1981) but today nesting beaches are only on Isabel Island (2 beaches), Sasakoloa and Litogarhira, 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 et al., 2007). There is limited sporadic leatherback nesting activity in Vietnam and Thailand (Eckert et al., 2012; Hamann et al., 2006). 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).

Leatherback sea turtles that nest on Northwest Papua beaches forage in the Northern Hemisphere and are found in the action area. 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 ±1.6, approximately 489 females nested on Pacific beaches in 2011. Researchers estimate that an average of 178 leatherbacks (CV=0.15) were present between the coast and roughly the 50 fathom isobath off California, Oregon and Washington. Abundance over the study period was variable between years, ranging from an estimated 20 leatherbacks (1995) to 366 leatherbacks (1990) (Benson et al., 2007b).

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 Critical Habitat

Southern DPS Green Sturgeon

A team similar to the CHARTs, referred to as a Critical Habitat Review Team (CHRT), identified and analyzed the conservation value of particular areas occupied by southern green sturgeon, and unoccupied areas they felt are necessary to ensure the conservation of the species (USDC 2009b). The CHRT did not identify those particular areas using HUC nomenclature, but did provide geographic place names for those areas, including the names of freshwater rivers, the bypasses, the Sacramento-San Joaquin Delta, coastal bays and estuaries, and coastal marine areas (within 110 m depth) extending from the California/Mexico border north to Monterey Bay, California, and from the Alaska/Canada border northwest to the Bering Strait; and certain coastal bays and estuaries in California, Oregon, and Washington.

For freshwater rivers north of and including the Eel River, the areas upstream of the head of the tide were not considered part of the geographical area occupied by the southern DPS. However, the critical habitat designation recognizes not only the importance of natal habitats, but of habitats throughout their range. Critical habitat has been designated in coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; the lower Columbia River estuary; and certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) and freshwater (USDC 2009b). Table 4 delineates physical and biological features for southern green sturgeon.

Table 4. Physical or biological features of critical habitat designated for southern green sturgeon and corresponding species life history events.

Physical or Biological Features Site Type	Physical or Biological Features Site Attribute	Species Life History Event
Estuarine areas	Food resources Migratory corridor Sediment quality Water flow Water depth Water quality	Juvenile growth, development, seaward migration Subadult growth, development, seasonal holding, and movement between estuarine and marine areas Adult growth, development, seasonal holding, movements between estuarine and marine areas, upstream spawning movement, and seaward post-spawning movement
Coastal marine areas	Food resources Migratory corridor Water quality	Subadult growth and development, movement between estuarine and marine areas, and migration between marine areas Adult sexual maturation, growth and development, movements between estuarine and marine areas, migration between marine areas, and spawning migration

Humpback whales

When humpback whales were originally listed, there was no statutory requirement to designate critical habitat for this species. The ESA now requires that, to the maximum extent prudent and determinable, critical habitat be designated at the time of listing. Thus, the listing of DPSs of humpback whales under the ESA in 2016 triggered the requirement to designate critical habitat for the Central American (CAM) and Mexican (MX) DPSs occurring in areas under U.S. jurisdiction. In 2018, a critical habitat review team (CHRT) was convened to assess and evaluate information in support of a critical habitat designation. The CHRT identified a prey biological feature that is essential to the conservation of the whales. The prey essential feature was specifically defined as follows: Prey species, primarily euphausiids and small pelagic schooling fishes of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth. For the endangered CAM DPS of humpback whales, we propose to designate 48,459 square nautical miles of marine habitat off the coasts of Washington, Oregon, and California as occupied critical habitat that contain the essential prey feature and serve as the only major feeding areas for the CAM DPS; thus, these areas are critical to supporting population growth and recovery of this endangered DPS. For the threated MX DPS of humpback whales, we propose to designate 175,812 square nautical miles of marine habitat off the coasts of Alaska, Washington, Oregon, and California as occupied critical habitat that are seasonal feeding areas that contain the essential prey feature, and are critical in supporting population growth and recovery of this wide-ranging threatened DPS.

Prey quantity, quality and availability. Whales from these two DPSs travel to U.S. coastal waters specifically to access energy-rich feeding areas, and the high degree of loyalty to specific locations indicates the importance of these feeding areas. Although humpback whales are generalist predators and prey availability can very seasonally and spatially, substantial data indicate that the humpback whales' diet is consistently dominated by euphausiid species (of genus Euphausia, Thysanoessa, Nyctiphanes, and Nematoscelis) and small pelagic fishes, such as northern anchovy (Engraulis mordax), Pacific herring (Clupea pallasii), Pacific sardine (Sardinops sagax), and capelin (Mallotus villosus; Nemoto 1957, Nemoto 1959, Klumov 1963, Rice Krieger and Wing 1984, Baker 1985, Kieckhefer 1992, Clapham et al. 1997, Neilson et al. 2015; See "Diet and Feeding Behavior" and Appendix A in NMFS 2019a). Because humpback whales only rarely feed on breeding grounds and during migrations, humpback whales must have access to adequate prey resources within their feeding areas to build up their fat stores and meet the nutritional and energy demands associated with individual survival, growth, reproduction, lactation, seasonal migrations, and other normal life functions.

Essentially, while on feeding grounds, the whales must finance the energetic costs associated with migration to breeding areas, reproductive activities, as well as the energetic costs associated with their return migration to high-latitude feeding areas. Fat storage has been linked to reproductive efficiency in other species of large, migratory, baleen whales (Lockyer 2007), and some evidence suggests that variation in prey availability during summer is directly connected to variation in annual reproductive rates for humpback whales in the following year (Clapham 1993). Calf condition has also been significantly correlated with female body condition (low calf body condition with lower female condition) for humpback whales in Australia (Christiansen et al. 2016), and, of all life stages, lactating females have the highest energy demands (McMillan 2014). Given the energetic demands of lunging and other prey capture techniques, foraging is only expected to be profitable above some lower threshold for an energetic return, and evidence suggests that humpback whales will only feed when they encounter suitable concentrations of prey. Within their North Pacific feeding areas, humpback whales have often been observed in association with, or specifically targeting, dense aggregations of prey (e.g., Bryant et al. 1981, Krieger and Wing 1986, Goldbogen et al. 2008, Sigler et al. 2012, Witteveen et al. 2015), but the precise range of prey densities required to support feeding are not generally known and therefore cannot be described quantitatively on the basis of the best scientific data available. Thus, it is essential that the whales not only have reliable access to prey within their feeding areas, but that prey are of a sufficient density to support feeding and the build-up of energy reserves.

Leatherback sea turtles

Critical habitat was designated off the U.S. West Coast for leatherback sea turtles (77 FR 4170, January 26, 2012). In the final rule, NMFS identified one primary constituent element essential for the conservation of leatherbacks in marine waters off the U.S. West Coast: the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (e.g., Chrysaora, Aurelia, Phacellophora, and Cyanea), of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks; however, the critical habitat designation does not specifically define or develop standards or measurable criteria for any of these particular aspects of prey occurrence. The critical habitat designation emphasizes that the preferred prey of leatherbacks off the Oregon coast is jellyfish, with other gelatinous prey, such as salps (a pelagic tunicate), considered of lesser importance. The CHRT also considered another PCE, water quality to support normal growth, development viability, and health. This PCE would encompass bioaccumulation of contaminants and pollutants and subsequent accumulation in leatherback as well as direct ingestion and contact with contaminants and pollutants. The CHRT eliminated this option because knowledge on how water quality affects scyphomedusae was lacking, and, where data were available, the CHRT believed prey condition, distribution, diversity, and abundance would encompass water quality considerations regarding bioaccumulation. The CHRT also felt that direct ingestion and contact with contaminants and pollutants would be encompassed in a direct effects analysis for the listed species (NMFS 2009b).

2.3 Action Area

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

There are two distinct action areas. The first is an action area for the construction effects of the proposed action and the second is an action area for the consequences of the proposed action. The construction effects action area is bounded by the area where fish will be exposed to elevated underwater noise during both vibratory installation and removal of steel piles. Noise extends throughout the water column of Grays Harbor in straight-line distances from the pile-driving to the point of intersection with the nearest land mass or structure. This area is shown in Figure 2. All of the other construction effects take place within this action area.

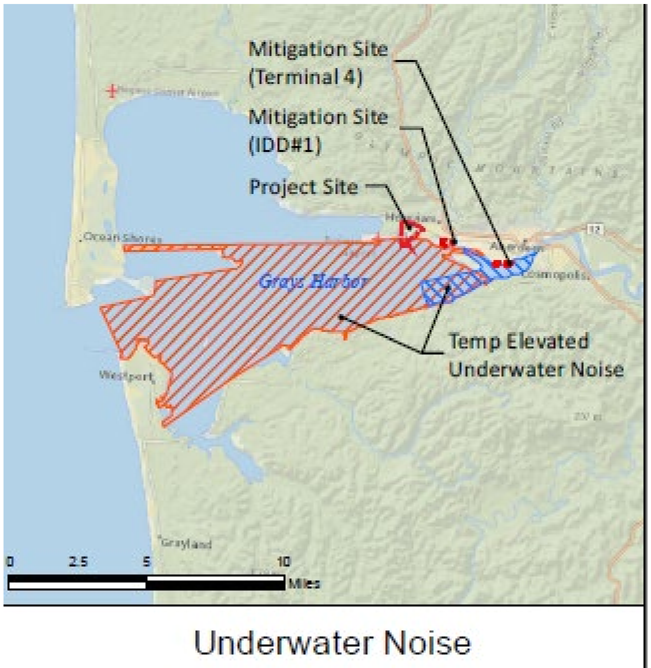

Figure 2. Extent of noise from vibratory pile driving.

The second action area is a triangular surface over the Pacific Ocean economic exclusion zone (EEZ), starting at the mouth of Grays Harbor, where ocean going vehicles loaded at the potash terminal OGVs can collide with marine mammals and turtles (Figure 3). The dimensions of this triangular surface are established by the minimum velocity of OGVs (v nautical miles per hour) and the maximum velocity of ESA listed whales and turtles (u nautical miles per hour) such that the animal can start from the edge of the triangle and swim into the path of and be struck by the OGV sailing straight through the center of the triangle (Koopman, 1956). For an OGV velocity of 10 nautical miles per hour and an animal velocity of 10 nautical miles per hour, the area of the triangle is;

$$\frac{1}{2}\left(\frac{200 \text{ nautical miles}}{10 \text{ nautical miles per hour}} \text{x}10 \text{ nautical miles per hour}\right) = 20{,}000 \text{ square nautical miles.}$$

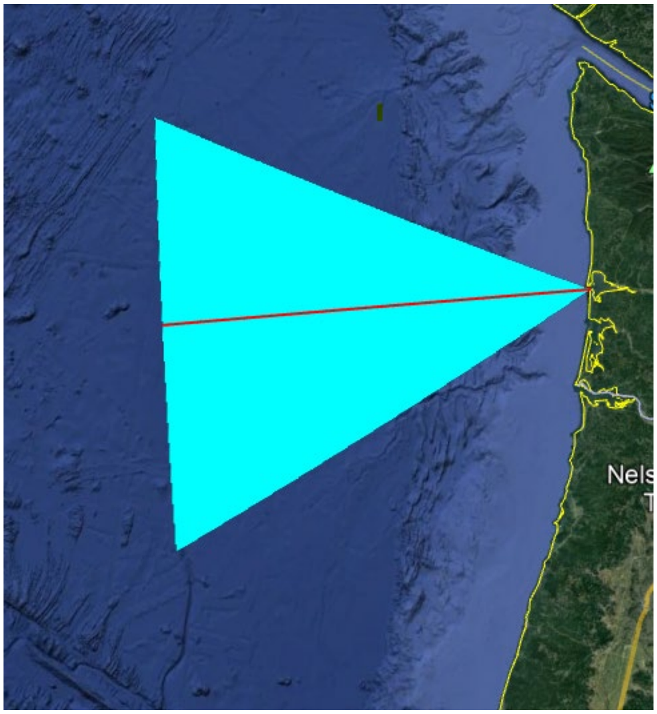

Figure 3. Area of EEZ where marine mammal or turtle could collide with potash OGV

2.4 Environmental Baseline

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

Grays Harbor is an estuarine bay, fed by the Chehalis River and five smaller rivers, located on the southwest Pacific coast of Washington state about 45 miles (72 km) north of the mouth of the Columbia River. It is approximately 15 miles long and 13 miles wide. The city of Aberdeen at the mouth of the Chehelis River has a population of 16,654. The city of Hoquiam along the northwest Grays Harbor bayshore has a population of 8,600. Both cities have slight negative population growth.

The Port of Grays Harbor is the largest coastal shipping port north of California and has become one of the largest centers for the shipment of autos and grains to China and Korea. The Port of Grays Harbor includes three terminals in addition to Terminal 3. Terminal 1 is a barge and bulk liquid loading facility. Terminal 2 is a dry and liquid bulk facility. Terminal 4 serves as the primary roll on/roll off and break bulk cargo terminal. These terminals service an average of about 84 OGVs per year. The USACE regularly dredges the navigation channel and turning basin in the action area to maintain a bottom depth of -36 feet MLLW at the site and is currently deepening the channel to the fully authorized depth of -38 feet MLLW. Before 1989, sludge and effluent discharged by pulp mills contaminated sediments in Grays Harbor with dioxin. The Washington Department of Ecology developed a dioxin total maximum daily load (TMDL) for Grays Harbor and the EPA approved the TMDL in June 1992. Concentrations of dioxin in Grays Harbor sediments are slowly attenuating.

Grays Harbor is critical habitat for the southern DPS of green sturgeon because in summer months, subadult and adult green sturgeon aggregate in Grays Harbor to forage (Lindley et al., 2011). Grays Harbor is not critical habitat for the southern DPS of pacific eulachon. Historically, eulachon spawning was common in the rivers of Grays Harbor but they now only rarely migrate to and spawn in the sloughs of the Chehalis River estuary or the Chehalis system (NMFS, 2017). Grays Harbor is also not critical habitat for ESA listed salmon. Most of the salmon in Grays Harbor are unlisted fish from the rivers that drain into Grays Harbor or unlisted fish produced in Willapa Bay or along the Washington Coast. However, some of the salmon in Grays Harbor are smolts from the Columbia River that follow the Columbia River plume into Willapa Bay and Grays Harbor during downwelling winds (Banas et al., 2004). The most likely out of basin salmon to use Grays Harbor are ocean type Columbia River Chinook salmon. Genetic analysis of 161 Chinook salmon caught in the Central estuary and South Bay showed that 1.2 percent or about 2 Chinook per hectare come from the Columbia River (Sandell et al., 2014).

The ocean action area overlaps fin whale and leatherback sea turtle designated critical habitat and proposed critical habitat for the Mexico and Central America DPS of humpback whales and SRKW. The action area also overlaps the routes of OGVs loaded at major shipping facilities in Puget Sound and the Columbia River. Figure 4 displays one month of commercial ship automated identification system position data.

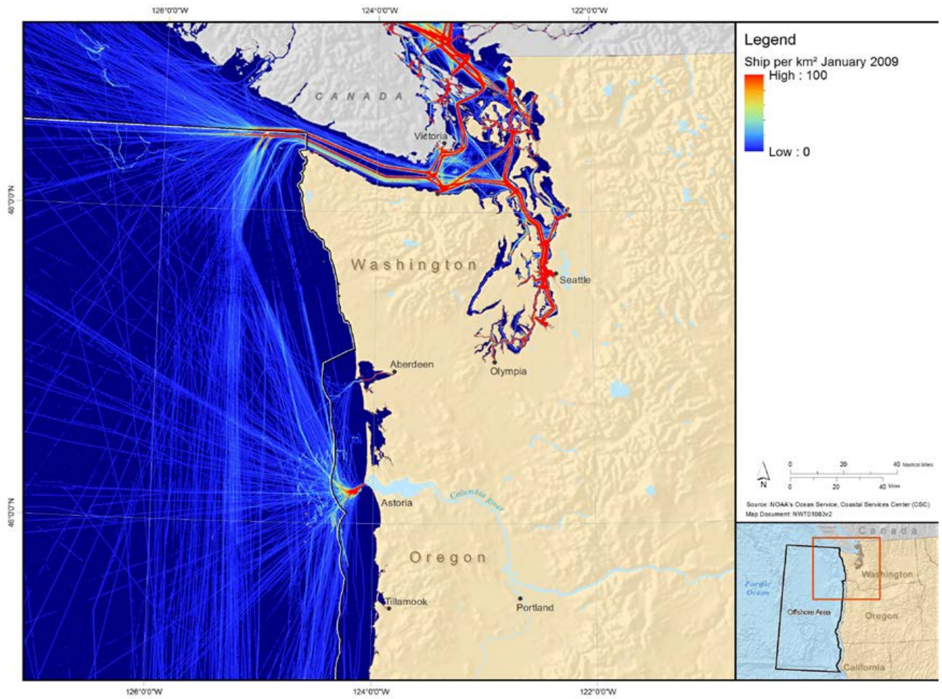

Figure 4. Commercial ship traffic off the Washington and Oregon Coasts

Collisions with commercial ships are an increasing threat to many large whale species, particularly as shipping lanes cross important large whale breeding and feeding habitats or migratory routes. Allen et al. (2012) recorded the noises from 24 ships ranging in length from 10.4 meters to 294.1 meters at hydrophone depths of 5, 15, and 25 meters and calculated source levels to characterize the three-dimensional acoustic environment a baleen whale would encounter during a whale/ship approach. His results indicated that whales near the sea surface may experience greater difficulty localizing oncoming ships than in deep water and that their range of detection may be too small to execute a successful avoidance maneuver.

Douglas et al. (2008) summarized humpback whale ship strike information off the Washington coast and the Strait of Juan de Fuca between 1980-2006 and found only one record of a ship-struck humpback, located on the Pacific coast north of Grays Harbor, Washington. The relatively low rate of ship strikes off the Washington coast despite the high levels of ship traffic in the area was hypothesized to be caused by underreporting of such events and the smaller concentrations of humpbacks in this area compared to locations like Hawaii and Alaska (Douglas et al. 2008). From 1996 to 2002, eight humpback whales were reported struck by vessels in Alaskan waters.

The number of confirmed vessel collisions with ESA-listed species in Oregon and Washington from 2000-2018 are: three sperm whale, three humpback whales, and ten fin whales (Marine Mammal Health and Stranding Response Program database). It is important to note that many strikes may occur and go unnoticed, while others may occur and subsequently not get reported. Carcass recovery rates have been estimated for various cetacean species including a rate of 6.5 percent for killer whales, less than five percent for grey whales, and 3.4 percent for sperm whales. In modelling ship strike mortality for three baleen whales species off the coast of

California, Rockwood et al. (2017) used a high recovery rate of 17 percent based on right whales to produce minimum strike estimates and a five percent recovery (the mean of grey, killer and sperm whales) as a best estimate. The higher rate for right whales is based on them being a more buoyant species (Rockwood et al. 2017).

2.5 Effects of the Action

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

2.5.1 Effects of the Proposed Action in Grays Harbor

The proposed action construction activities that have the potential to affect ESA listed species and critical habitat are the creation of impervious surface, impact pile driving, and dredging.

Effects to Critical Habitat

Grays Harbor is green sturgeon critical habitat. Water quality and prey are physical and biological features of green sturgeon critical habitat likely to be affected by the proposed terminal construction actions. Water quality is likely to be potentially affected by; 1) stormwater, 2) sound pressure waves, 3) suspended sediment, 4) spilled potash, and 5) PAHs from creosote treated piles. Green sturgeon prey are likely to be removed by dredging. For convenience and clarity, we discuss the direct effects of water quality stressors on Chinook salmon, chum salmon and eulachon after the green sturgeon direct effects discussion, without re-deriving the magnitude of the water quality stressor. Table 5 summarizes the effects of the proposed action on green sturgeon critical habitat and the direct effects on green sturgeon, eulachon, and Chinook and chum salmon.

Table 5. Summary of effects of proposed action in Grays Harbor.

Activity	PBF/ Direct	Stressor	Species	Likelihood of PBF exposure	Magnitude of PBF response	Consequence of exposure and response to PBF	Life stage	Likelihood of exposure	Magnitude of response	Consequence at the individual fitness level	Life stage	Likelihood of exposure	Magnitude of response	Consequence at the individual fitness level
Site Stormwater	PBF: water quality	Metals	Green Sturgeon				Juveniles	NA	NA	NA	Adult			
	Direct	Metals	Eulachon	NA	NA	NA	Larvae	NA	NA	NA	Adult			
	Direct	Metals	Salmon	NA	NA	NA	Smolts				Adult	NA	NA	NA
Impact pile driving	PBF: water quality	Sound pressure waves	Green sturgeon				juveniles	NA	NA	NA	adult			
	Direct	Sound pressure waves	Eulachon	NA	NA	NA	larvae	NA	NA	NA	adult			
	Direct	Noise	Salmon	NA	NA	NA	Smolts				Adult	NA	NA	NA
Dredging	PBF: water quality	Sediment	Green Sturgeon				Juveniles	NA	NA	NA	Adult			
	Direct	Sediment	Eulachon	NA	NA	NA	Larvae	NA	NA	NA	Adult			
	Direct	Sediment	Salmon	NA	NA	NA	Smolts				Adult	NA	NA	NA
	PBF: Forage	Sediment removal	Green Sturgeon				Juveniles	NA	NA	NA	Adult			
Accidental Potash spill	PBF: Water quality	Salinity (brine)	Green Sturgeon				Juveniles	NA	NA	NA	Adult			
	Direct	Salinity (brine)	Eulachon	NA	NA	NA	Larvae				Adult			

Activity	PBF/ Direct	Stressor	Species	Likelihood of PBF exposure	Magnitude of PBF response	Consequence of exposure and response to PBF	Life stage	Likelihood of exposure	Magnitude of response	Consequence at the individual fitness level	Life stage	Likelihood of exposure	Magnitude of response	Consequence at the individual fitness level
	Direct and PBF	Salinity (brine)	Salmon	NA	NA	NA	Smolts				Adult	NA	NA	NA

Green Sturgeon Critical Habitat:

Water Quality Stressor: Potash terminal stormwater

Ditches will route stormwater runoff from new potash terminal impervious surface to retention ponds designed to hold the volume of stormwater from a 10-year 24 hour rainstorm. Retention ponds allow suspended sediment and pollutants sorbed to suspended sediment to settle to be bottom of the pond and not be discharged to Grays Harbor. Organic pollutants, such as PAHs, are hydrophobic and readily sorb to the organic carbon fraction of suspended sediment. Metals are both sorbed to sediment particles and dissolved in the water (Muthukrishnan and Selvakumar, 2006).

Likelihood of habitat exposure

The likelihood of discharge of stormwater effluent in the summer and early fall, when green sturgeon are likely to be in Grays Harbor, is low. The ten year, 24 hour rainfall total for Grays Harbor is 6 inches (Hershfield, 1963). The average monthly rainfall between July and October is 3.2 inches. A rainstorm that exceeds the capacity of retention ponds is very unlikely during the summer and early fall as long as retention ponds are properly maintained.

Magnitude of habitat response

The magnitude of response of Grays Harbor water quality to stormwater metals is moderate. Muthukrishnan and Selvakumar (2006) give the following example retention pond urban stormwater metal removal efficiencies in August in Table 6. The last column shows NOAAs Screen Quick Reference Table (SQuiRT) acute toxicity levels for metals in marine waters. In this example, all of the effluent metal concentrations are close to their SQuiRT limits but once in Grays Harbor metals will be mixed to background concentrations by tidal flushing over 5 to 8 hours.

Table 6. Reduction of metal concentrations by stormwater retention ponds.

Metal	Influent (ug/L)	Percent Removed	Effluent (ug/L)	SQuiRT (ug/L)
Copper	38	75	10	4.8
Iron	17	90	1.7	300
Manganese	343	58	143	100
Zinc	316	71	90	90

Consequence of habitat exposure and response/green sturgeon critical habitat effect

During rare summer and fall large rainstorms, the concentration of metals in the water near the outfall may be somewhat elevated and water quality will be temporarily degraded by metals but will return to background within 5 to 8 hours. Because water quality as physical feature of green sturgeon critical habitat returns to baseline levels through dilution, the conservation value of the critical habitat in the action area is not diminished because it is so extremely unlikely that green sturgeon will be in Grays Harbor during a greater than 10 year 24 hour rainstorm..

Likelihood of green sturgeon exposure to stormwater

The likelihood that green sturgeon will be exposed to metals from potash terminal stormwater is low. Sub adult and adult green sturgeon are in Grays Harbor in the summer and fall when the large storms that exceed the capacity of the retention ponds to hold stormwater are extremely rare.

Magnitude of green sturgeon response

The magnitude of response of green sturgeon exposed to elevated metal concentrations near the stormwater outfall is moderate. Upon discharge to Grays Harbor in the summer and fall, dissolved metal concentration are near SQuiRT toxicity thresholds. Metal concentrations will decrease to background levels over 5-8 hours of tidal mixing but green sturgeon near the outfall would be exposed to toxic concentrations of metals.

Consequence of exposure and response on green sturgeon individual fitness

Because the likelihood of a 10 year 24 hour rainstorm during the summer and fall is so low, individual green sturgeon are very unlikely to be exposed to and harmed by stormwater metals from terminal impervious surface.

Likelihood of eulachon exposure to stormwater

The likelihood that eulachon will be exposed to stormwater metals is low. For any eulachon return year, the likelihood of exposure is less than the probability that eulachon return to the Chehalis River (<0.5) times the likelihood that they return during a 10 year, 24 hour rainstorm (<0.1). Eulachon may be exposed to stormwater water metals at the outfall fewer than 5 times per century.

Magnitude of eulachon response

The magnitude of response of eulachon exposed to elevated metal concentrations near the stormwater outfall is moderate. Upon discharge to Grays Harbor in the summer and fall, dissolved metal concentration are near SQuiRT toxicity thresholds. Metal concentrations will decrease to background levels over 5-8 hours of tidal mixing but eulachon near the outfall would be exposed to toxic concentrations of metals.

Consequence of eulachon exposure and response to stormwater metals

Because the combination of a eulachon return to Grays Harbor year and a 10 year 24 hour storm during their return is so rare, the consequence of exposure and response of eulachon to terminal impervious surface stormwater metals is low.

Likelihood of salmonid exposure to stormwater

> The likelihood that LCR and UWR Chinook salmon and CR chum salmon will be exposed to stormwater metals near the potash terminal outfall is low. The outfall is in the inner estuary. Salmon from the Columbia River that follow the Columbia River plume into Grays Harbor were identified from fish captured in the South Bay the central area of the estuary, miles from the outfall.

Magnitude of salmonid response

> The magnitude of response of Chinook and chum salmon to stormwater metals near the outfall is Moderate. Upon discharge to Grays Harbor in the summer and fall, dissolved metal concentration are near SQuiRT toxicity thresholds. Metal concentrations will decrease to background levels over 5-8 hours of tidal mixing but salmon near the outfall would be exposed to toxic concentrations of metals.

Consequence of exposure and response on salmonid individual fitness

> The consequence of exposure and response of Columbia River Chinook and chum salmon to stormwater metals is low because they are extremely unlikely to be exposed to metals near the potash terminal outfall.

Water Quality Stressor: Pile driving

Pile driving degrades water quality by creating noise/pressure waves in the water that can affect green sturgeon behavior and damage their tissues. Pile driving noise and sound pressure waves are only present during pile driving. The instant pile driving stops, water quality returns to normal. Therefore, pile driving effects on critical habitat is only relevant if green sturgeon are present and located within calculated radii from the pile being driven.

Likelihood of habitat exposure

> The likelihood that green sturgeon critical habitat water quality will be periodically degraded by pile driving is high. For the terminal to be constructed, 199 steel pipe piles will be installed with a vibratory pile driver and proofed with an impact pile driver. It will take one day to drive each permanent pile, with 200 days of pile driving over two in water work windows. Forty-eight temporary 24 inch diameter steel pipe piles will be installed and removed with a vibratory pile driver and 1368 timber piles will be removed with a vibratory pile driver.

Magnitude of habitat response

> The likelihood that noise and sound pressure waves produced during impact pile driving will exceed thresholds that alter fish behavior and that are physically injurious to fish is high. The amplitude of the sound pressure wave from each strike of a 48 inch diameter pile within 9 meters of the pile is greater than 206 dB_{peak}. The cumulative sound exposure

level for 5000 strikes to a 48 inch diameter pile within in 2151 meters is greater than 187 dB_{SEL}. The average noise (root mean square) from each strike exceeds 150 dB_{RMS} within 10,000 meter of the pile.

Consequence of habitat exposure and response to pile driving/green sturgeon critical habitat

The consequence of exposure and response of pile driving to water quality is high. The water quality during impact pile driving will be so severely degraded that any green sturgeon within 9 meters of the pile during a single strike will be injured or killed. A green sturgeon within 2,151 meters of the pile for 5000 strikes will be injured or killed. The behavior of green sturgeon within 10,000 meters of the pile will be altered by noise. This indicates that the critical habitat is diminished for its purpose of supporting green sturgeon subadult and adult lifestages for the period of pile driving.

Likelihood of green sturgeon exposure

The likelihood that green sturgeon will be exposed to water quality degraded by pile driving noise and sound pressure waves is moderate. Impact pile driving will be done between October 1 and February 14. Green sturgeon that forage in Grays Harbor during the summer and early fall. Most green sturgeon will have returned to the ocean before October 1 and all are anticipated to have returned to the ocean by November 1 (Lindley et al., 2011).

Magnitude of green sturgeon response

The magnitude of response of green sturgeon to pile driving is moderate. Sturgeon have swim bladders and are sensitive to underwater impulsive sounds (i.e., sounds with a sharp sound pressure peak occurring in a short interval of time) (Caltrans, 2001). As the pressure wave passes through a fish, the swim bladder 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 rapid expansion and contraction of the swim bladder causes cellular damage to organs within close proximity to the swim bladder to rupture (Halvorsen et al., 2012). As a result, exposed fish show blood in the abdominal cavity and maceration of the kidney tissues (Caltrans, 2001; Yelverton et al., 1975). 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. Green sturgeon within 9 meters of a pile being driven by an impact pile driver will be injured or killed from a single strike. Green sturgeon within 2,154 meters of a pile being driven by an impact pile driver will be injured or killed if they are exposed to 5000 strikes.

Consequence of exposure and response individual fitness of green sturgeon

The consequence of exposure and response of green sturgeon to impact pile driving is high because it is likely that some green sturgeon will be foraging in Grays Harbor when pile driving begins on October 1 and it is somewhat likely that green sturgeon will be near enough to pile driving to receive injurious or lethal sound pressure levels. Sub adult and adult green sturgeon may be killed by project pile driving.

Likelihood of eulachon exposure

The likelihood that adult eulachon will be exposed to pile driving is moderate. The in water work window for impact pile driving is October 1 through February 14. Eulachon return to spawn between late November to April, peaking in the early spring. Eulachon do not spawn in the Chehalis River every year but it is conservative to assume that they will return to the Chehalis River during this construction project and be exposed to pile driving noise and sound pressure.

Magnitude of eulachon response

The magnitude of response of eulachon to impact pile driving noise and sound pressure is moderate. Eulachon do not have swim bladders and are less susceptible to pile driving injuries. Eulachon in Grays Harbor are migrating to the Chehalis River so it is likely that a eulachon will swim through the 2154 meter SEL zone quickly, rather than stop and stay near the pile driving to accumulate SEL.

Consequence of exposure and response on individual fitness of eulachon

The consequence of exposure and response of eulachon to pile driving is moderate. If eulachon return to the Chehalis River before February 14 during the pile driving phase of this construction project some will swim within 2154 meters of a pile being impact driven and be injured or killed.

Likelihood of salmonid exposure

The likelihood that listed LCR and UWR Chinook and chum salmon smolts in Grays Harbor will be exposed to pile driving noise is moderate. Ocean type smolts that leave the Columbia River estuary and stay in the plume would follow the plume into Grays Harbor during winter downwelling winds that overlap the pile driving work window (Banas et al., 2004). Columbia River Chinook salmon in Grays Harbor were found in the South Bay and the Central estuary where they would be exposed to noise greater than 150 dB_{RMS}. They were not found in the inner bay where they would be exposed to peak and SEL sound pressure waves.

Magnitude of salmonid response

The magnitude of response of Columbia River Chinook and chum salmon exposed to pile driving noise is low. They may be startled or disoriented by noise causing them to expend energy or be unaware of predators that they would otherwise escape but they will likely be too far from the pile driving to be injured or killed by peak or SEL sound pressure waves.

Consequence of exposure and response on individual fitness of salmonids

The consequence of exposure and response of Columbia River Chinook and chum salmon to pile driving is low. Individual fish may expend additional energy in response to the noise and may be somewhat more vulnerable to predation but they will not be injured or killed by sound pressure waves.

Water Quality Stressor: Dredging/Suspended Sediment

Clamshell or hydraulic dredging will result in a suspended sediment plume around the dredge. Seattle Corps Dredge Material Management Office evaluated dredge sediment and leave surface samples and determined that the sediment meets Sediment Evaluation Framework standards for in water disposal. Dredge sediment will be dumped into the water near the mouth of Grays harbor resulting in another sediment plume as it sinks to the bottom. BHP proposes to use best management practices during maintenance dredging to minimize the mass of suspended sediment in the two mixing zones.

Likelihood of habitat exposure

The likelihood that water quality will be degraded by suspended sediment from dredging is high. Whenever sediment is disturbed some becomes entrained in and moved by the water column. Suspended sediment concentrations from clamshell dredging will likely be higher than suspended sediment from hydraulic dredging because sediment can fall out of the clamshell bucket as it ascends through the water column.

Magnitude of habitat response

The magnitude of water quality response to dredging is moderate. For the average sediment particle size in the dredge material management units (DMMU) proposed for dredging, Collins (1995)[1] estimates a continuous source suspended sediment concentration of 550 milligrams per liter to remove 110,000 cubic yards of sediment in 15 weeks with an eight hour workday. The source concentration decreases exponentially in radial directions and would be less than 166 mg/L at the edge of the dredge site mixing zone 250 feet from the source.

Consequence of exposure and response on habitat/green sturgeon critical habitat

The consequences of water quality exposure and response to dredging is high. The water quality around the dredge mixing zone will be degraded every day that dredging occurs. Water quality will return to normal once dredging is done for the day and then become degraded as soon as dredging resumes the next day. However, green sturgeon are not

---

[1] The equation: $\frac{C}{\rho x 10^{-6}} = .0023 \left(\frac{b}{v_s T}\right)^3$ ¶, where b is the size of the clamshell bucket, v_s is the Stokes law settling velocity of the sediment particles and T is the dredge bucket cycle time

known to be negatively affected by higher levels of turbidity, so this effect on water quality does not degrade critical habitat values for green sturgeon.

Likelihood of green sturgeon exposure

The likelihood that green sturgeon will be exposed to dredge sediment is moderate. Green sturgeon are in Grays Harbor in the summer and early fall. They would be exposed to dredging suspended sediment whenever dredging is done during the that part of the July 16 and February 14 in water work window.

Magnitude of green sturgeon response

The magnitude of response of green sturgeon to dredge suspended sediment is low. Green sturgeon can swim up to 40 meters per minute (Cheong et al., 2006) and can swim through the 200 meter mixing zone in minutes. Sturgeon that remain in the suspended sediment for hours are unlikely to be harmed because sturgeon appear to be attracted to high concentrations of naturally produced suspended sediment (Hatin et al., 2007).

Consequence of exposure and response on individual fitness of green sturgeon

The effect of exposure and response of green sturgeon to dredging and dredge disposal suspended sediment is low because their response to the predicted suspended sediment concentration is low.

Likelihood of eulachon exposure

The likelihood of eulachon exposure to suspended sediment from dredging and dredge disposal is moderate. Eulachon may return to Grays Harbor to spawn in the Chehalis River during the in water work window while BHP is dredging. If so, some eulachon will likely swim through the dredging or dredge disposal mixing zone and be exposed to suspended sediment.

Magnitude of eulachon response

The magnitude of response of eulachon to dredging suspended sediment is low. Eulachon returning to Grays Harbor are migrating to the Chehalis River to spawn and would be expected to swim though he dredge or dredge disposal plume quickly to reach the river. Because their time of exposure to suspended sediment is low, their response will be low.

Consequence of exposure and response on individual fitness of eulachon

The consequence of exposure and response of eulachon to dredge and dredge disposal suspended sediment is low because their magnitude of response is low.

Likelihood of salmonid exposure

> The likelihood of exposure of LCR and UWR Chinook and CR chum salmon smolts to dredge and dredge disposal suspended sediment is low. Columbia River Chinook salmon were found in the South Bay and the Central estuary. They are not found in the inner bay where dredging will take place and so will not be exposed to suspended sediment from dredging.

Magnitude of salmonid response

> The magnitude of response of salmon smolts to predicted concentrations of suspended sediment from dredging and dredge disposal is moderate. Juvenile salmon exposed to 600 milligrams per liter for up to one day experience mild physiological stress (Newcombe and Jenson, 1996).

Consequences of exposure and response on individual fitness of salmonids

> The consequence of exposure and response of Columbia River salmon to suspended sediment is low because the likelihood of exposure is low.

Water Quality Stressor: Spilled potash

A large potash spill from a cargo ship loaded at the proposed terminal would degrade water quality. Potassium in high concentrations is toxic to fish. Potassium concentrations greater than 373 milligrams per liter are toxic to fish (NOAA SQuiRT).

Likelihood of habitat exposure

> The likelihood of water quality degradation by spilled KCl is low because the risk of a loaded ship spilling potash in Grays Harbor is low. Spills would most likely occur if a potash cargo ship collided with another ship and the risk of collision is low because the Federal navigation channel in Grays Harbor is two one way channels.

Magnitude of habitat response

> The magnitude of response of water quality to spilled potash is high. If a cargo ship were to spill 50,000 tons of potash into Grays Harbor over 10 hours, the maximum potassium concentration in the water column of a 40 million cubic meter control volume around the ship would reach 3000 milligrams per liter. Once the spill is over, the potassium concentration would decrease rapidly and return to background over 15 hours.

Consequence of exposure and response on habitat /green sturgeon critical habitat

> The consequence of exposure and response of a OGV potash spill to water quality is low because the liklihood of a spill is low.

Likelihood of green sturgeon exposure

Green sturgeon are present throughout Grays Harbor in the late summer and early fall. Since the proposed potash terminal operates all year, they will be present during potash terminal OGV operations in Grays Harbor.

The likelihood of green sturgeon exposure to a potash spill is low because the likelihood of a spill is low.

Magnitude of green sturgeon response

The magnitude of response of green sturgeon to a large potash spill in Grays Harbor is high. NMFS could find no data on the effect of exposure to fish to 3000 milligrams per liter potassium. Potash is a fungicide used to kill zebra mussles and (Densmore et al., 2018) reported one death from 7 juvenile Chinook salmon living in 800 milligrams per liter KCl for 10 days. However, SQuiRT reports the 96 hour acute toxicity of potassium to be 373 milligrams per liter. It is likely that any fish, including green sturgeon, exposed to 3000 milligrams per liter of potassium for several hours would suffer acute effects up to and including death.

Consequences of exposure and response to individual fitness of green sturgeon

The consequence of exposure and response of green sturgeon to a large potash spill are low because the risk of a potash spill in Grays is low and the effects of a spill are localized to the water around the spill, it is unlikely that green sturgeon will be exposed to high potash concentrations and experience toxic effects.

Likelihood of eulachon exposure

The likelihood of eulachon exposure to a potash spill in Grays Harbor is low because the risk of a spill is low. Adult eulachon migrate through Grays Harbor in the winter and early spring to spawn in the Chehalis River. Since the proposed potash terminal operates all year, eulachon will be in Grays Harbor while loaded ships are sailing through Grays Harbor.

Eulachon spawn in freshwater tributaries to Grays Harbor, far upstream from potential potash spills, so eggs will not be exposed to potash spills.

Eulachon larvae drift downstream and into the Grays Harbor estuary in the spring and the early summer. Since the potash terminal operates all year, eulachon larvae will be in estuary when loaded cargo ships are sailing through Grays Harbor to the ocean. As with green sturgeon and adult eulachon, the likelihood of exposure of eulachon larvae to spilled potash is low because the likelihood of spilled potash is low.

Magnitude of eulachon response

> The effect of eulachon exposure to 3000 milligrams per liter potassium has not been tested. Based on SQuiRT, 3000 milligrams per liter is likely to be acutely toxic to adult eulachon and eulachon larvae with effects up to and including death.

Consequence of exposure and response on the individual fitness level of eulachon

> Because the risk of exposure is so low, the consequence of exposure and response to adult eulachon and eulachon larvae is also low.

Likelihood of salmonid exposure

> The likelihood of LCR and UWR Chinook and chum salmon exposure to high potash concentrations from an OGV spill are low because the likelihood of an OGV spill are low. Ocean type ESA listed Chinook and chum salmon that stay in nearshore waters after entering the ocean are most likely to enter Grays Harbor in the winter during down-welling winds. Since the proposed potash terminal operates year round, they will be present when loaded potash cargo ships are sailing through Grays Harbor to the ocean.

Magnitude of salmonid response

> The magnitude of response of Chinook and chum salmon to a potash spill are high. As with green sturgeon and eulachon, the effect of potassium concentrations up to 3000 milligrams per liter have not been tested on salmon. Potash is a fungicide and (Densmore et al., 2018) exposed juvenile Chinook salmon to 800 milligrams per liter for 10 days without any deaths but it is likely that salmon exposed to 3000 milligrams per liter for several hours would experience acute toxic effects up to and including death.

Consequence of exposure and response on the fitness level of salmonids

> Because exposure to spilled potash is so unlikely, the likelihood that individual fish will be harmed or killed by spilled potash is low.

Water Quality Stressor: PAHs from creosote treated piles

BHP will remove a derelict concrete overwater structure and 1,368 creosote treated timber piles from nearshore waters of Grays Harbor near the mouth of the Chehalis River. Over time, PAHs in creosote slowly partition to the organic carbon fraction of sediment surrounding the pile. While sequestered in creosote or in the sediment surrounding the pile, there is an incomplete exposure pathyway between the PAHs and fish in the water column. The vibratory pile driver causes some of the contaminated sediment surrounding the piles to become suspended in the water column. For each pile removed with a vibratory pile driver, we estimate the suspended sediment concentration to be 25 milligrams per liter within 3 meters of the pile for 0.25 hour (Weston Solutions, 2006). Our very simple and very conservative mass balance (Appendix ??) indicates that the effective concentration of PAHs in the suspended sediment plume will be less than (and likely considerably less than) 1 milligram per liter. While sediment is suspended, fish in the water column can be exposed to PAHs.

Likelihood of green sturgeon exposure

> As with other construction activities, the October 1 start of the in water work window overlaps with adult and sub adult green sturgeon beginning their migration from estuaries in Oregon and Washington. Because green sturgeon are feeding throughout Grays Harbor, it is likely that some green sturgeon will be near this project site during the pile removals. However, the vibratory pile driving noise and activity may discourage green sturgeon from swimming into the suspended sediment plume.

Magnitude of green sturgeon response:

> We estimated above that vibratory removal of creosote treated piles increases the bioavailability to fish of the polynuclear aromatic hydrocarbon (PAH) compounds that have undergone phase transfer from the pile creosote to the sediment surrounding the pile because vibratory pile driving transfers some of this sediment up into the water column. Low molecular weight PAHs are acutely toxic to fish. High molecular weight PAHs are not acutely toxic to fish but can cause cancer and reduced disease resistance in the exposed fish or mutations in their offspring (Johnson et al., 2007a). Exposure to 1 milligram per liter PAH for 15 minutes is not sufficient to cause acute toxicity but exposure to PAHs less than 1 milligram per liter in the water column for may cause toxic effects including cancer and mutations to offspring (add citation).

Consequence of green sturgeon exposure and response

> Because green sturgeon exposure to the PAHs in suspended sediment plumes surrounding piles being removed is unlikely, it is unlikely that green sturgeon will experience any chronic toxic effects from the removal of creosote treated piles.

Likelihood of eulachon exposure

> Although eulachon do not spawn in the Chehalis River every year, the in water work window overlaps the time period when adults would be returning to spawn. Adult eulachon are likely to be exposed to PAHs in suspended sediment plumes surrounding piles being removed.

Magnitude of eulachon response:

> We expect that the concentration of low molecular weight PAH in the water column from creosote pile removal will be too low to cause acute toxicity in exposed eulachon. Over decades the supply of low molecular weight PAHs in creosote piles is reduced by leaching and it is unlikely that the two phase transfer exposure pathway (creosote to sediment to dissolved sediment) described here can supply acutely toxic concentrations of low molecular weight PAHs (Johnson et al., 2007b). We expect that fish exposed to high molecular weight PAHs in the water column will take up some molecules sorbed to dissolved organic matter that passes through their gills or eaten with their prey. Fish can metabolize and excrete PAHs so they don’t bioaccumulate but fish exposed to high molecular weight PAHs will have a slightly increased risk of developing cancer or of producing offspring with mutations that affect their survival if they to spawn (Johnson et

al., 2007a). Exposure to 1 milligram per liter PAH for 15 minutes is not sufficient to cause acute toxicity but exposure to any concentration of PAH in the water column for any period of time is sufficient to contribute to chronic toxic effects accumulated over a lifetime of exposure to PAH hot spots.

Consequence of eulachon exposure and response:

Because eulachon exposed to PAHs at this location are at the end of their life, they will not live long enough to be affected by any resulting chronic toxicity.

Likelihood of salmonid exposure:

ESA listed Chinook and chum salmon from the Columbia River and Chinook salmon from the Willamette River have not been captured in the inner part of Grays Harbor and are believed to stay in the outer bay while in Grays Harbor. Therefore, they are unlikely to be exposed to PAHs in the suspended sediment plumes created at this inner bay location.

Magnitude of salmonid response:

As with green sturgeon and eulachon, the concentration of PAHs in the water column we expect from the removal of creosote treated piles would be to low to cause acute toxicity but is sufficient to cause long term chronic toxic effects such as cancer and mutations to offspring.

Consequence of exposure and response:

Because we do not expect salmonids to be exposed to PAHs in suspended sediment plumes in the inner bay, they will not be affected by this part of the proposed construction.

Forage Stressor: Dredging

Dredging will remove green sturgeon forage species from 19,000 square feet of benthic critical habitat.

Likelihood of habitat exposure

The likelihood that benthic forage will be reduced by dredging is high. Benthic forage will be removed with dredge sediment.

Magnitude of habitat response

The magnitude of the removal of benthic forage is low. The 19,000 square foot potash terminal berth is a very small fraction of Grays Harbor benthic habitat.

Consequence of habitat exposure and response/green sturgeon critical habitat

The consequence of benthic forage reduction is low because the dredge area is less than 0.001 percent of Grays Harbor benthic forage.

Likelihood of green sturgeon exposure

The likelihood that green sturgeon will be exposed to reduced forage from dredging is high because the reduction is make permanent by maintenance dredging.

Magnitude of green sturgeon response

The magnitude of response of green sturgeon to the reduction in benthic forage is low because the reduction is a very small fraction of Grays Harbor benthic forage.

Consequences of exposure and response of fitness of green sturgeon

The consequence of green sturgeon exposure and response to the reduction in benthic forage from dredging is low because the reduction in forage is a small fraction of Grays Harbor benthic forage.

2.5.2 Potash Terminal OGV Operations in the Ocean

Marine Mammals. In this section we analyze the effects of stressors that are a consequence of the proposed action that are likely to adversely affect ESA-listed marine mammals. Vessel strikes from commercial, recreational, and military vessels are known to affect large whales and have resulted in serious injury and occasional fatalities to cetaceans (Berman-Kowalewski and 2010., 2010; Calambokidis, 2012b; Douglas; Laggner, 2009; Lammers et al., 2003). The worldwide number of collisions appears to have increased steadily during recent decades (Laist et al., 2001; Ritter, 2012).

Numerous studies of interactions between surface vessels and marine mammals have demonstrated that free-ranging marine mammals often, but not always (McKenna et al., 2015), engage in avoidance behavior when surface vessels move toward them. It is not clear whether these responses are caused by the physical presence of a surface vessel, the underwater noise generated by the vessel, or an interaction between the two (Au and Green, 2000; Bauer and Herman, 1986; Bryant et al., 1984; Corkeron, 1995; Erbe, 2002; Felix, 2001; Lusseau, 2003; Lusseau, 2006; Magalhaes, 2002; Richter et al., 2003; Scheidat et al., 2002; Watkins, 1986; Williams et al., 2002; Wursig et al., 1998). Several authors suggest that the noise generated during motion is probably an important factor in vessel strikes? (Blane and Jaakson, 1994; Evans et al., 1992). Water disturbance may also be a factor in vessel strikes. These studies suggest that the behavioral responses of marine mammals to surface vessels are similar to their behavioral responses to predators.

The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., sperm whales). In addition, some baleen whales seem generally unresponsive to vessel sound, making them more susceptible to vessel collisions (Nowacek et al., 2004). These species are primarily large, slow moving whales.

Some researchers have suggested the relative risk of a vessel strike can be assessed as a function of animal density and the magnitude of vessel traffic (Fonnesbeck et al., 2008; Vanderlaan and Taggart, 2007; Vanderlaan et al., 2008). Differences among vessel types also influence the probability of a vessel strike. The ability of any ship to detect a marine mammal and avoid a collision depends on a variety of factors, including environmental conditions, ship design, size, speed, and personnel, as well as the behavior of the animal. Vessel speed, size, and mass are all important factors in determining if injury or death of a marine mammal is likely due to a vessel strike. For large vessels, speed and angle of approach can influence the severity of a strike. For example, Vanderlaan and Taggart (2007) found that between vessel speeds of 8.6 and 15 knots, the probability that a vessel strike is lethal increases from 0.21 to 0.79. Large whales also do not have to be at the water's surface to be struck. Silber et al. (2010) found when a whale is below the surface (about one to two times the vessel draft), under certain circumstances (vessel speed and location of the whale relative to the ship's centerline), there is likely to be a pronounced propeller suction effect. This suction effect may draw the whale into the hull of the ship, increasing the probability of propeller strikes.

The Corps did not request authorization under ESA for take of a marine mammal as a result of vessel strikes. There have been new scientific findings regarding acute and chronic disturbance to cetaceans as a result of focused, frequent, and numerous vessels present or transiting a given area that studies have found constitute acute and chronic disturbance to marine mammals.

The normal design speed for a container ship is typically 24 knots (Bonney and Leach, 2010). Even given the advent of "slow steaming" by commercial vessels in recent years due to fuel prices (Barnard, 2016; Maloni et al., 2013), this generally reduces the design speed by only a few knots, given that 21 knots would be considered slow, 18 knots is considered "extra slow," and 15 knots is considered "super slow" (Bonney and Leach, 2010).

Data from the ports of Vancouver, British Columbia; Seattle, Washington; and Tacoma, Washington indicated there were in excess of 7,000 commercial vessel transits in 2017 associated with visits to just those ports (Vancouver Fraser Port Authority 2017; The Northwest Seaport Alliance 2018). Additional commercial traffic in the action area also includes vessels transiting offshore along the Pacific coast, bypassing ports in Canada and Washington; traffic associated with ports to the south along the coast of Washington and in Oregon. This level of commercial vessel traffic for the ports of Vancouver, Seattle, and Tacoma is approximately the same as in 2015.

The proposed action will lead to 110 to 220 annual potash OGV trips across the Pacific Ocean. Annual NOAA Marine Mammal Assessment Reports document marine mammal collision rates based on collisions reported by ships or deduced from an examination of marine mammal corpses that wash up on beaches. Rockwood et al. (2017) postulates that only a fraction of ship strikes are detected and reported and that only a small fraction of struck whales wash up and are discovered on beaches so that the actual collision rate may be significantly higher than the reported collision rate. Rockwood et al. (2017) applied the ship strike model developed by Martin et al. (2016) (based on Koopman (1956) encounter rate theory) to estimate the likely number of west coast humpback, fin and blue whales that collide with ships along the U.S. West Coast.

Exposure Analysis

As described in the Status of the species section of this opinion, each summer and fall, ESA listed whales migrate to water off the coast of Washington and Oregon to feed. Becker et al. (2016) reports the density of blue, fin and humpback whales off the coast of Washington and Oregon. A draft Biological Opinion for Navy training and testing activities in the Northwest Training and Testing offshore area that encompasses the action area includes sperm whale data (Figure 5). These density distributions allow us to use Koopman (1956) to estimate the number of whales that could be encountered[2] by potash OGVs leaving Grays Harbor.

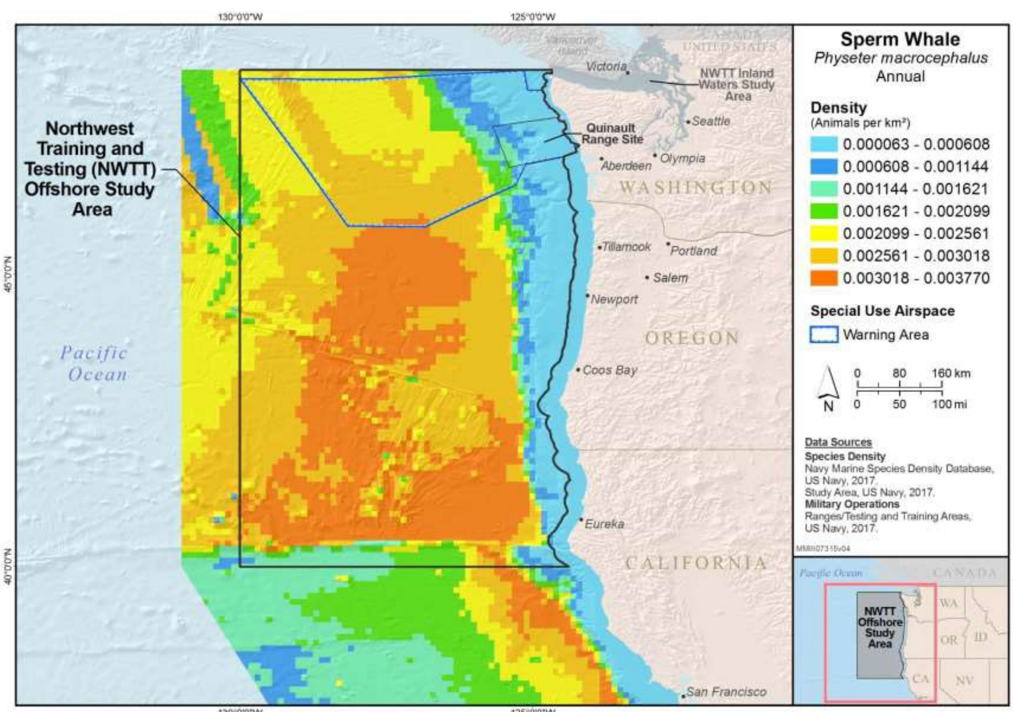

Figure 5. Sperm whale density off the Washington and Oregon Coast.

Magnitude of Response

For an encounter between a whale and a Potash OGV to turn into a strike, the whale must be swimming at or near the surface of the water and not take any action to avoid collision with the OGV. For humpback whales and fin whales, Rockwood et al. (2017) summarizes coeffcients that estimate the fraction of time that these whales spend at or near the surface and the fraction of time they turn to avoid collision. For these two species, we have included a quantitative estimate

[2] To come within ½ the width of the OGV.

of the number of encounters that could be strikes. For the other whales in the action area, we do not know these coefficients and only report encounter rates.

Consequence at the individual fitness level

Vessel collisions with large whales can result in death or serious injury of the animal. Wounds resulting from ship strike may include massive trauma, hemorrhaging, broken bones, or propeller lacerations (Knowlton and Kraus, 2001). Superficial strikes may not kill or result in the death of the animal. The severity of injuries typically depends on the size and speed of the vessel (Conn and Silber, 2013; Knowlton and Kraus, 2001; Laist et al., 2001; Vanderlaan and Taggart, 2007). Impact forces increase with speed, as does the probability of a strike at a given distance (Gende, 2011; Silber et al., 2010).

An examination of all known ship strikes from all shipping sources (civilian and military) indicates vessel speed is a principal factor in whether a vessel strike results in death or serious injury (Knowlton and Kraus, 2001; Laist et al., 2001; Pace and Silber, 2005; Vanderlaan and Taggart, 2007). In assessing records in which vessel speed was known, Laist et al. (2001) found a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision. The authors concluded that most deaths occurred when a vessel was traveling in excess of 13 knots.

Jensen and Silber (2003) detailed 292 records of known or probable ship strikes (inclusive of military and non-military vessels) of all large whale species from 1975 to 2002. Of these, vessel speed at the time of collision was reported for 58 cases. Of these cases, 39 (or 67 percent) resulted in serious injury or death (19 of those resulted in serious injury as determined by blood in the water, propeller gashes or severed tailstock, and fractured skull, jaw, vertebrae, hemorrhaging, massive bruising or other injuries noted during necropsy and 20 resulted in death). Operating speeds of vessels that struck various species of large whales ranged from 2 to 21 knots. The majority (79 percent) of these strikes occurred at speeds of 13 knots or greater. The average speed that resulted in serious injury or death was 18.6 knots. Pace and Silber (2005) found that the probability of death or serious injury increased rapidly with increasing vessel speed. Specifically, the predicted probability of serious injury or death increased from 45 to 75 percent as vessel speed increased from 10 to 14 knots, and exceeded 90 percent at 17 knots. Higher speeds during collisions result in greater force of impact and also appear to increase the chance of severe injuries or death.

In a separate study, Vanderlaan and Taggart (2007) analyzed the probability of lethal mortality of large whales at a given speed, showing that the greatest rate of change in the probability of a lethal injury to a large whale as a function of vessel speed occurs between 8.6 and 15 knots. The chances of a lethal injury decline from approximately 80 percent at 15 knots to approximately 20 percent at 8.6 knots. At speeds below 11.8 knots, the chances of lethal injury drop below 50 percent, while the probability asymptotically increases toward 100 percent above 15 knots. The Jensen and Silber (2003) report notes that the database represents a minimum number of collisions, because the vast majority probably goes undetected or unreported.

For humpback whales and fin whales, where we have estimated a number of strikes, we have used this coefficient to estimate the number of deaths. For sperm whales where we only have a qualitative estimate of the number of strikes, we do not differentiate between injury and death from a strike.

Table 7. Summary of effects of OGV operation in the Pacific Ocean EEZ

Action area	Activity	PBF/ Direct	Stressor	Species	Life stage	Likelihood of exposure	Magnitude of response	Consequence at the individual fitness level	Life stage	Likelihood of exposure	Magnitude of response	Consequence at the individual fitness level
Pacific Ocean EEZ	Transport potash to Asia	Direct	Collision	Humpback whale	Juvenile				Adult			
				Fin whale	Juvenile				Adult			
				Blue whale	Juvenile				Adult			
				Sei whale	Juvenile				Adult			
				Sperm whale	Juvenile				Adult			
				Leatherback sea turtle	Juvenile	NA	NA	NA	Adult			

Species Stressor: OGV collisions

Likelihood of humpback whale exposure

The likelihood that humpback whales will be exposed to collisions with potash OGVs is high. Potash OGVs will make 110 trips per year across the EEZ during the warm six months of the year when the WA/OR/CA stock of humpback whales, including whales from the threatened Mexico population, are distributed along the Washington and Oregon Coasts. (Becker et al., 2016) in the action area. At an average speed of 21 nautical miles per hour, the 110 potash OGVs could encounter 3.5 humpback whales per year. Most of these whales is likely from the delisted Hawaii population but a fraction is likely from the Mexico population and a very small fraction will be from the Central America population.

Magnitude of humpback response

The magnitude of response of humpback whale exposure to potash OGV collisions is high. Whales may be swimming at a depth below the bottom of the OGV or may take action to avoid colliding with the OGVs but at 21 nautical miles per hour, there is a 70 percent probability that a whale will be killed by a collision with an OGV.

Consequence of exposure and response to individual fitness of humpback whales

The consequence of exposure and response to a collision between a potash OGV and a humpback whale to individual fitness is high because the likelihood of exposure is high and the magnitude of response is high. Using coefficients from Rockwood, 2016, potash OGVs could kill 0.9 humpback whales per year.

Likelihood of fin whale exposure

The likelihood that fin whales will be exposed to collisions with potash OGVs is high. Fin whales feed farther offshore than humpback whales. Potash OGVs will make 110 trips per year when an average of 0.0045 fin whales per square nautical mile (Becker et al., 2016) are feeding off the coast of Washington and Oregon. At an average speed of 21 nautical miles per hour, the 110 potash OGVs could encounter 3.7 fin whales per year.

Magnitude of fin whale response

The magnitude of response of fin whale exposure to potash OGV collisions is high. Whales may be swimming at a depth below the bottom of the OGV or may take action to avoid colliding with the OGVs but at 13 nautical miles per hour, there is an 80 percent probability that a fin whale will be killed by a collision with an OGV.

Consequence of exposure and response on fin whale fitness

The consequence of exposure and response to a collision between a potash OGV and a fin whale to individual fitness is high because the likelihood of exposure is high and the magnitude of response is likely mortality. Using coefficients from Rockwood, 2016, potash OGVs could kill 0.7 fin whales per year.

Likelihood of sperm whale exposure

The likelihood that sperm whales will be exposed to collisions with potash OGVs is high. Potash OGVs will make 220 trips per year when sperm whales are feeding off the coast of Washington and Oregon. At an average speed of 21 nautical miles per hour, the 220 potash OGVs could encounter 12.7 sperm whales per year.

Magnitude of fin whale response

The magnitude of response of fin whale exposure to potash OGV collisions is high. We do not have values for encounter rate coefficients that predict the likelihood that sperm whales are swimming at a depth below the bottom of the OGV or that that will take action to avoid colliding with the OGVs. At 21 nautical miles per hour, there is an 80 percent probability that a sperm whale will be killed by a collision with an OGV.

Consequence of exposure and response on Fin whale fitness

> The consequence of exposure and response to a collision between a potash OGV and a sperm whale to individual fitness is high because the likelihood of exposure is high and the magnitude of response is likely mortality. Using the coefficients that Rockwood, (2016) used to predict mortality of humpback whales, potash OGVs could kill up to 3.5 sperm whales per year.

Likelihood of blue whale and sei whale exposure

> The likelihood that blue whales or sei whales will be exposed to potash OGV strikes is low. As described in the Status of the Species section of this Opinion, these whale stocks/populations do not migrate to the action area each year to feed. Individuals from these species are detected in the action area. Because spatial and temporal density is so low, it is logical that the encounter rate between potash OGVs and these whale species would be orders of magnitude lower than the encounter rate estimated for humpback whales and fin whales.

Magnitude of blue whale and sei whale, gray response

> The magnitude of response of right whale, blue whale, sei whale, gray whale or sperm whale response to a potash OGV encounter is high. Whales may be swimming at a depth below the bottom of the OGV or may take action to avoid colliding with the OGVs but at 21 nautical miles per hour, there is an 80 percent probability that a fin whale will be killed by a collision with an OGV.

Consequence of exposure and response on blue whale and sei whale individual fitness is low.

> The consequence of exposure and response to a collision between a potash OGV and a fin whale to individual fitness is low because the likelihood of exposure is low.

Sea turtles. In this section we analyze the effects of stressors that are a consequence of the proposed action that are likely to adversely affect ESA-listed turtles. Sea turtles, including leatherbacks, must surface to breathe and several species are known to bask at the surface for long periods making them more susceptible to ship strikes. Ship strikes have been identified as one of the important mortality factors in several nearshore turtle habitats worldwide (Denkinger et al. 2013). However, available information is sparse regarding the overall magnitude of this threat or the impact on sea turtle populations globally. Although Leatherback turtles can move somewhat rapidly, they apparently are not adept at avoiding ships that are moving at more than 4 km per hour; most ships move far faster than this in open water (Hazel and Gyuris 2006; Hazel et al. 2007; Work et al. 2010). Hazel et al. (2007) suggests that green turtles (and presumably leatherback turtles) may use auditory cues to react to approaching ships rather than visual cues, making them more susceptible to strike as ship speed increases. Since turtles that were previously killed or injured as a result of some other stressor (e.g., fishing net entanglement or disease) may be more susceptible to a ship strike, it is not always known what proportion of ship wounds were sustained ante-mortem versus post mortem (or post injury).

Likelihood of leatherback sea turtle exposure

> The likelihood that leatherback sea turtles will be exposed to collisions with potash OGVs is high. Potash OGVs will make 72 trips per year during the warm 100 days of the year when up to 0.028 leatherback sea turtles per square nautical mile are feeding inside the 200 foot isobaths along the Washington and Oregon EEZ. Based on the solution described in Koopman (1956) (Appendix 2) each potash loaded OGVs would likely come within the critical encounter distance of 0.009 leatherback sea turtles as it crosses the EEZ and 72 potash OGVs per year will come within the critical encounter distance of approximately 0.7 leatherback sea turtles.

Magnitude of leatherback sea turtle response

> The magnitude of response of leatherback sea turtles to exposure to potash OGV collisions is high. Approximately 0.38 leatherback sea turtles per year may come within the critical encounter distance of a potash OGV. Turtles may be swimming at a depth below the bottom of the OGV or may take action to avoid colliding with the OGV but it is likely that a fraction of these encountered turtles will be struck by a potash OGV.

Consequence to individual fitness of leatherback sea turtles

> The consequence of a collision between a potash OGV and a leatherback sea turtle depends on the speed of the OGV. We could find no studies on the relationship between OGV speed and leatherback sea turtle collision survival. It is likely that a fraction of the turtles struck by the OGV would be injured or killed.

Marine mammals are known to be injured and harassed 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.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02 and 402.17(a)). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4). It is reasonable to assume over the anticipated 50 year life of the proposed action that several of these climate-related effects will become exacerbated, including warming water temperature, changing salinity, and increasing acidity. It also is reasonable to assume that increasing acidity could diminish burrowing shrimp and other small crustaceans upon which green sturgeon feed, and that other food webs will be disrupted.

Coastal communities are growing more slowly than the respective states overall, populations are relatively old, and the extractive natural resource industries (fishing, aquaculture, agriculture, forest products) are declining in importance relative to tourism, recreation, and retirement industries (Huppert et al., 2003). These trends suggest human uses of the estuaries are changing in character (Hupert et al. 2003). Residents choose to live in these communities to enjoy the views and scenery, experience rural living, to be near the ocean, and to recreate outdoors (Huppert et al., 2003). However, increased tourism and residential development are non federal activities that can also impact estuary shorelines, water quality, and wildlife (Huppert et al., 2003).

The City of Hoquiam developed a land use plan in 2009 to guide future development. The plan anticipates that over the next 20 years, Hoquiam will have a moderate increase in population of around 23 percent and that as industrial use of the Grays Harbor estuary subside there will be opportuniy to redevelop these lands into valuable commercial and mixed-use developments. It designates appropriate areas for the location of various existing and future uses and activities. These plans postulate that there will be some growth in the future that may affect the quality of habitat within the Grays Harbor estuary. However, these growth plans may or may not come to fruition. Despite changes to less consumptive use of estuary resources, future uses are reasonably certain to continue to have a depressive effect on aquatic habitat quality in the action area. Given the increasing ability for the restoration community at funding and implementing activities, restoration and recovery actions are also reasonably certain to continue. These activities are likely to provide significant benefits to habitat quality, albeit on a project by project basis.

Shipping unrelated to the proposed action is reasonably certain to continue, but we have no information whether it will increase or decrease. Activities that may occur in these areas will likely consist of state government actions related to ocean use policy and management of public resources, such as fishing or energy development projects. Changes in ocean use policies are too uncertain and may be subject to sudden changes as political and financial situations develop.

2.7 Integration and Synthesis

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

Green Sturgeon

Green sturgeon are listed as threatened based on a decline from historic abundance, and low productivity. The main limiting factor to survival and recovery is that potential spawning habitat in the Sacramento River is not being used. There are between 800 and 1,800 spawning adults in the Southern DPS of green sturgeon. Sub adult and adult green sturgeon migrate to the Grays Harbor action area to forage during the summer and early fall, and the action area is critical habitat for green sturgeon.

Green sturgeon are likely to be adversely affected by several effects of the proposed action, including stormwater inputs, pile driving, reduced prey base, and potash spills. With the exception of pile driving, however, we do not expect these other habitat effects, when added to the baseline, to injure or kill any individuals in the action area over the life of the proposed action. In summary, we expect that the potash terminal pile driving may kill a small number of the green sturgeon that use Grays Harbor but other construction stressors are unlikely to injure or kill green sturgeon. Finally, since currently, survival and recovery of green sturgeon is not limited by spawner abundance but rather is limited by the amount of spawning habitat in the Sacramento River that spawners use, the small, potential decrease in spawner abundance from this project is unlikely to translate into lost productivity or to alter the trajectory of their survival or recovery.

Two features of green sturgeon critical habitat will diminish with the above described effects, water quality and forage. Although summer foraging is critical to the life history of green sturgeon, the amount of lost forage is a very small fraction of the total green sturgeon forage supply in Grays Harbor. Water quality impairments through stormwater or potash spills are likely to be dispersed by currents and wave action and a rare occurrence, so that their degrading effect is brief. Therefore the conservation value of the action area is retained despite the effects on features of critical habitat being added to the baseline.

Eulachon

Eulachon are a threatened species, based on declines in abundance from historic levels. The main limiting factor to eulachon survival and recovery appears to be ocean conditions that reduce the number of juveniles that grow into spawning adults. During some years, eulachon migrate through the Grays Harbor action area to spawn in the Chehalis River.

Eulachon that return to Grays Harbor to spawn in the Chehalis River will be exposed adverse effects from stormwater, suspended sediment, and pile driving. Although the effects of the project are likely to kill individual eulachon, the number is expected to be a very small fraction of that year’s spawner abundance and is therefore, when added to the baseline, unlikely to impact the survival or recovery of the species because productivity will not be significantly affected.

Columbia River salmon

Columbia River chum, Lower Columbia Chinook salmon, and Upper Willamette River Chinook are each listed as threatened, based on declines from historic abundance, low productivity, loss of spatial structure and reduced diversity. The main limiting factor to LCR/UWR Chinook salmon and chum salmon survival and recovery is the amount and quality of freshwater spawning and rearing habitat. Once they enter the ocean, Chinook and chum smolts can follow the Columbia River plume into Grays Harbor during winter down-welling conditions. LCR and UWR fall Chinook salmon and chum salmon constitute 1 to 2 percent of the yearlings in Grays Harbor action area in any year. Columbia River salmon have been found in the South Bay and the Central estuary. They have not been found in the Inner Bay where the project is located. We do not expect Columbia River salmon in the Grays Harbor action area to be exposed to stormwater metals, SEL or dredge suspended sediment because we do not expect them to be in the Inner Bay. Columbia River salmon in Grays Harbor may be exposed to noise from pile driving and suspended sediment from dredge disposal and a small number of them may be killed as a result of this exposure. However when added to the baseline, the number that could be killed is far too small to affect the survival or recovery of the species because the reduction in abundance will be insufficient to alter productivity.

Humpback whales – Central America and Mexico DPSs

Worldwide, there are 14 distinct populations of humpback whales. The Mexico population is listed as threatened and the Central America population is listed as endangered. Both populations feed off the West Coast of the United States. The Central America DPS has just below 800 individuals while the Mexico DPS is estimated to have just below 3,000 individuals (Wade 2017). Population growth rates are currently unavailable for the Central America DPS and Mexico DPS of humpback whales. Three human activities are known to threaten humpback whales: whaling, commercial fishing, and shipping.

Humpback whales could be in the ocean action area and may be exposed to encounters with Potash OGVs. Humpback whales in the action area are recognized as part of the California, Oregon, and Washington stock. The humpback whales in the action area potentially belong to one of two ESA-listed DPSs: the threatened Mexico DPS or the endangered Central America DPS. Both of these DPSs may feed seasonally in the action area. Based on our analysis, NMFS anticipates that no more than one humpback whales from the Central America DPS or Mexico DPS may be struck by Potash OGVs per year.

The 1991 humpback whale recovery plan does not outline specific downlisting and delisting criteria. The recovery plan does list several threats known or suspected of impacting humpback whale recovery including subsistence hunting, commercial fishing stressors, habitat degradation, loss of prey species, ship collision, and acoustic disturbance. Of these, ship collisions are relevant to the proposed action.

Based on the evidence available, including the Environmental Baseline and Cumulative Effects, we anticipate at most around 0.12 percent of the humpback whale Central America DPS or 0.033 percent of the humpback whale Mexico DPS, may be killed or seriously injured as a result of the proposed action per year. The loss (or serious injury) of these individuals is not anticipated to result in appreciable reductions in overall reproduction, abundance, or distribution of this species. For this reason, the effects of the proposed action from vessel strikes are not expected to appreciably reduce the likelihood of survival and recovery of Central America DPS and Mexico DPS humpback whales.

Fin whales

The best current abundance estimate for fin whales in California, Oregon, and Washington waters out to 300 nautical miles is 9,029 (CV=0.12) (Nadeem et al. 2016); the minimum population estimate is 8,127 individuals (Carretta 2019). Current estimates indicate approximately 10,000 fin whales in U.S. Pacific Ocean waters, with an annual growth rate of 4.8 percent in the Northeast Pacific stock and a stable population abundance in the California/Oregon/Washington stock (Nadeem et al. 2016). Current threats to fin whales include entanglement in fishing gear, vessel strikes, pollution, and climate change.

Fin whales could be present in the action area and may be exposed to encounters with Potash OGV. Fin whales found in the ocean action area are recognized as part of the California, Oregon, and Washington stock. Based on NMFS's analysis, NMFS anticipates that no more than one fin whale may be struck by Potash OGVs per year.

The 2010 fin whale recovery plan defines three recovery populations by ocean basin (the North Atlantic, North Pacific, and Southern Hemisphere) and sets criteria for the downlisting and delisting of this species. Both downlisting and delisting requirements include abatement of threats associated with fisheries, climate change, direct harvest, anthropogenic noise, and ship collision. Of these, ship collision is relevant to the proposed action. The possibility of one fin whales being struck per year by Potash OGVs would affect about 0.01 percent of the California, Oregon, Washington stock. Based on the evidence available, including the Environmental Baseline and Cumulative Effects, Potash OGV encounters in the action area on an annual basis cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the Status of Listed Resources or Environmental Baseline), would not be expected to appreciably reduce the likelihood of the survival of fin whales in the wild by reducing the reproduction, numbers, or distribution of that species.

Sperm Whale

The California/Oregon/Washington sperm whale stock is estimated to consist of 1,997 individuals (the abundance minimum is 1271 individuals) (Carretta 2019). The species' large population size shows that it is somewhat resilient to current threats. There is insufficient data to evaluate trends in abundance and growth rates of sperm whales at this time. Current threats to sperm whale populations include ship strikes, entanglement in fishing gear, competition for resources due to overfishing, population, loss of prey and habitat due to climate change, and noise.

Sperm whales present in the ocean action area throughout the year are recognized as part of the California/Oregon/Washington stock. Based on our analysis, we anticipates that Potash OGVs will encounter no more than 12 sperm whales per year.

The 2010 sperm whale recovery plan defines three recovery populations by ocean basin (the Atlantic Ocean/Mediterranean Sea, Pacific Ocean, and Indian Ocean) and sets criteria for the downlisting and delisting of this species. Both downlisting and delisting requirements include abatement of threats associated with fisheries, climate change, direct harvest, oil spills, anthropogenic noise, and ship collision. Of these ship collision is relevant to the proposed action. We anticipate around 0.6 percent of sperm whales from the CA/OR/WA stock may be encountered by Potash OGVs per year as a result of the proposed action. The loss (or serious injury) of 28 percent[3] of encountered individuals is not anticipated to result in appreciable reductions in overall reproduction, abundance, or distribution of this species. For this reason, the effects of the proposed action from vessel strikes are not expected to appreciably reduce the likelihood of survival and recovery of sperm whales.

Blue Whale

The minimum population size for Eastern North Pacific Ocean blue whales is 1,551; the more recent abundance estimate is 1,647 whales (Carretta 2019). Current estimates indicate a growth rate of just under three percent per year for the Eastern North Pacific stock. Blue whales are affected by anthropogenic noise, threatened by vessel strikes, entanglement in fishing gear, pollution, harassment due to whale watching, and reduced prey abundance and habitat degradation due to climate change. Because populations appear to be increasing in size, the species appears to be somewhat resilient to current threats.

Blue whales found in the action area are recognized as part of the Eastern North Pacific stock. The 1998 blue whale recovery plan does not outline downlisting or delisting criteria. The recovery plan does list several stressors potentially affecting the status of blue whales in the North Pacific Ocean that are relevant to the proposed action including vessel strikes and vessel disturbance. At the time the recovery plan was published, the effects of these stressors on blue whales in the Pacific Ocean were not well documented, their impact on recovery was not understood, and no attempt was made to prioritize the importance of these stressors on recovery.

Based on our analysis, including the Environmental Baseline and Cumulative Effects, rare encounters with Potash OGVs on an annual basis cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the Status of Listed Resources or Environmental Baseline), would not be expected to appreciably reduce the likelihood of the survival of blue whales in the wild by reducing the reproduction, numbers, or distribution of that species.

Sei Whales

The best abundance estimate for sei whales for the waters of the U.S. West Coast is 519 (CV=0.40) (Carretta, 2019). Population growth rates for sei whales are not available at this time

[3] Based on the mortality coefficients for humpback whales.

as there are little to no systematic survey efforts to study sei whales. Current threats to sei whales include commercial fishing, vessel strikes, and pollution.

Sei whales found in action area are recognized as part of the Eastern North Pacific stock. The 2011 sei whale recovery plan defines three recovery populations by ocean basin (the North Atlantic, North Pacific, and Southern Hemisphere) and sets criteria for the downlisting and delisting of this species. Both downlisting and delisting requirements include abatement of threats associated with fisheries, climate change, direct harvest, anthropogenic noise, and ship collision. Of these, ship collision are relevant to the proposed action.

Based on the evidence available, including the Environmental Baseline, Effects of the Action and Cumulative Effects, rare encounters with Potash OGVs on an annual basis cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the Status of Listed Resources or Environmental Baseline) would not be expected to appreciably reduce the likelihood of the survival of sei whales in the wild by reducing the reproduction, numbers, or distribution of that species

Leatherback sea turtles

The leatherback sea turtle was listed as endangered throughout its entire range on June 2, 1970, under the Endangered Species Conservation Act of 1969, a precursor to the ESA. Pacific leatherbacks are split into western and eastern Pacific subpopulations based on their distribution and biological and genetic characteristics. Only western Pacific leatherbacks are expected to be found in the ocean action area. Western Pacific leatherbacks nest in the Indo-Pacific, primarily in Indonesia, Papua New Guinea and the Solomon Islands. Spotila et al. (2000) estimated that the Pacific leatherback population declined from an estimated 81,000 adult turtles to 2,955 females (adult and subadult) in the two decades from 1980 to 2000. The current overall estimate for Papua Barat, Indonesia, Papua New Guinea, and Solomon Islands is 5,000 to 10,000 nests per year (NMFS and USFWS 2013b). Counts of leatherbacks at nesting beaches in the western Pacific indicate that the subpopulation has been declining at a rate of almost six percent per year since 1984 (Tapilatu et al. 2013). The primary threats to leatherback sea turtles include fisheries bycatch, harvest of nesting females, and egg harvesting. Plastic ingestion is also common in leatherbacks and can block gastrointestinal tracts leading to death.

Based on our Effects Analysis, we anticipate Potash OGVs will encounter 0.7 leatherback sea turtles per year. Based on the evidence available, including the Environmental Baseline and Cumulative Effects, Potash OGV encounters an annual basis, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the Status of Listed Resources or Environmental Baseline), would not be expected to appreciably reduce the likelihood of the survival of the leatherback sea turtle in the wild by reducing the reproduction, numbers, or distribution of the DPS. Therefore, we do not anticipate any measurable or detectable reductions in survival rate or trajectory of recovery of the leatherback sea turtle.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of:

- Southern DPS of green sturgeon
- Eulachon
- LCR Chinook salmon
- UWR Chinook salmon
- CR chum salmon
- CAM or MEX humpback whales
- Fin whales
- Sperm whales
- Blue whales
- Sei whales
- Leatherback sea turtles

The proposed action will not destroy or adversely modify critical habitat for green sturgeon, Central America or Mexico DPS of humpback whales (proposed), or leatherback sea turtles.

2.9 Incidental Take Statement

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

The NMFS has not yet promulgated an ESA section 4(d) rule prohibiting take of threatened eulachon. Anticipating that such a rule may be issued in the future, we have included a prospective incidental take exemption for eulachon. The elements of this ITS for eulachon would become effective on the date on which any future 4(d) rule prohibiting take of eulachon becomes effective. Nevertheless, the amount and extent of eulachon incidental take, as specified in this statement, will serve as one of the criteria for reinitiation of consultation pursuant to 50 CFR § 402.16(a), if exceeded.

This incidental take statement (ITS) provides a take exemption for the action agency and applicant for any take caused by the direct effects of the action. Those direct effects include injury or death caused by stormwater, pile driving, dredging, temporary loss of forage, and harm associated with an increase in suspended sediments.

This ITS provides a take exemption for the action agencies and applicants for any incidental take caused by consequences of the proposed action. This ITS does not include an exemption for any future incidental take of marine mammals caused by third party activities associated with OGV traffic while in the ocean, such as ship strikes on marine mammals from OGVs arriving or departing from the CET for the primary reason that the ESA does not allow NMFS to exempt incidental take of marine mammals where an authorization of the take is required and may be obtained under the MMPA.

Further, when an action will result in incidental take of ESA-listed cetaceans, ESA section 7(b)(4) requires that such taking be authorized under the MMPA section 101(a)(5) before the Secretary can issue an ITS for ESA-listed cetaceans and that an ITS specify those measures that are necessary to comply with Section 101(a)(5) of the MMPA. Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS, including those specified as necessary to comply with the MMPA, Section 101(a)(5). Accordingly, the terms of this ITS and the exemption from Section 9 of the ESA become effective only upon the issuance of MMPA authorization to take the cetaceans identified here. Absent such authorization, this ITS is inoperative for ESA-listed cetaceans.

2.9.1 Amount or Extent of Take

In the biological opinion, NMFS determined that because species will co-occur with effects of the proposed action and actions caused by the proposed action, incidental take is reasonably certain to occur as follows:

1. Green sturgeon and eulachon will be harmed, injured or killed by:

    a) Stormwater discharge from new impervious surfaces;
    b) Sound pressure waves and noise from pile driving;
    c) Suspended sediment initial and maintenance dredging of the terminal berthing slip (green sturgeon will be further harmed by loss of forage from this dredging);
    d) A large potash spill into Grays Harbor.

2. LCR Chinook, UWR Chinook ,and CR chum will be harmed, injured or killed by:

a) Noise from pile driving;
a) Suspended sediment and from initial and maintenance dredging of the terminal berthing slip;
b) A large potash spilled into Grays Harbor.

3. Leatherback sea turtles will be injured or killed by encounters with potash OGVs.

Take in the form of harm, caused by the effects of this action, cannot be accurately quantified as a number of fish. This is because the distribution and abundance of these species occurring within any particular portion of Grays Harbor affected by the proposed activities are not predictable, being affected by factors such as habitat quality, competition, and predation. In such circumstances, we use take surrogates causally linked to the expected level and type of incidental take from the proposed action. For the habitat-related effects of the proposed action, the best available surrogates are as follows:

a) Stormwater harming sturgeon and eulachon. The proposed action will treat stormwater from the terminal site with retention ponds. The best available incidental take surrogate associated with effluent from stormwater retention pond is the level of water quality impairment occurring when the retention ponds are properly functioning. This proper function can be assured by adequate stormwater retention pond inspection, and maintenance according to the designers recommendations. This surrogate is connected causally to the amount of take that will occur because compliance with the design maintenance recommendations correlates with the level of stormwater treatment assumed in this Opinion. The compliance with the design maintenance recommendations can also be easily monitored, allowing the surrogate to serve as a clear reinitiation trigger.

b) Sound pressure waves and noise impacts injuring or killing sturgeon, eulachon, or salmonids. The proposed action will require up to 5,000 impact hammer strikes on steel pile per day. The best available incidental take surrogate associated with is the 2,154 meter radius around the pile from 5,000 strikes where the cumulative sound pressure wave work exceeds 187 dB_{SEL}. This surrogate is connected causally to the amount of take that will occur because increasing the number of impact hammer strikes on steel pile translates into an increase in the radial zone where green sturgeon may be injured or killed. Impact pile driving strikes can also be easily monitored allowing the surrogate to serve as a clear reinitiation trigger. Although this surrogate is somewhat coextensive with the proposed action, it nevertheless serves as a meaningful reinitiation trigger because implementation monitoring, which occurs continuously during pile driving, will document any exceedance and if reinitiation is warranted.

c) Suspended sediment/dredging harming sturgeon, eulachon, and salmonids. The best available incidental take surrogate associated with construction and maintenance dredging – both from suspended sediment and from reduced forage base - is the benthic area disturbed. Because the amount of take from both exposure to suspended sediment from dredging and dredge disposal and the amount of benthic forage removed by dredging increases with the dredge area disturbed, this surrogate is proportional to extent of incidental take attributable to this project. The dredge area for the marine terminal berth is 19,000 square meters. This metric can also be easily monitored, allowing the surrogate to serve as a clear reinitiation trigger. Although this surrogate is somewhat coextensive with the proposed action, it nevertheless serve as a meaningful reinitiation trigger because implementation monitoring, which occurs continuously during construction and maintenance dredging, will document any exceedance and if reinitiation is warranted.

d) Potash spill harming sturgeon, eulachon, and salmonids. The best available incidental take surrogate for take from a large potash spill into Grays Harbor is the annual number of OGVs loaded at the terminal. The likelihood that a catastrophic event will cause a large potash spill increases as the number of OGVs filled at the terminal and operating in Grays Harbor increases. The maximum number of OGVs to be filled at the terminal in a year is 220. This surrogate can be monitored and serve as a clear reinitiation trigger. Although the surrogate is somewhat coextensive with the proposed action, it nevertheless serves as a meaningful reinitiation trigger because monitoring will document any exceedance and if reinitiation is warranted.

The proposed action is reasonably certain to harm individual leatherback sea turtles due to shipping associated with operation of the proposed action. The best available incidental take surrogate associated with shipping is the number of vessels calling on the terminal per year, 220. This surrogate is connected causally to the amount of take that will occur because an increase in vessel calls translates into a proportional increase in the risk of ship strike to these species. While somewhat coextensive with the proposed action, this metric serves as a valid reinitiation trigger because although it is not anticipated, the facility has the potential capacity for greater than 220 vessels per year and can also be easily monitored.

2.9.2 Effect of the Take

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

2.9.3 Reasonable and Prudent Measures

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

1. Minimize incidental take from stormwater discharge.
2. Minimize incidental take from pile driving.
3. Minimize incidental take from dredging.
4. Conduct monitoring sufficient to document the proposed action does not exceed the parameters analyzed in the effects section or the extent of take described above, and report monitoring results to NMFS.

2.9.4 Terms and Conditions

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

1. To implement reasonable and prudent measure #1 (stormwater), the Corps and the Applicants shall ensure:

    a. Stormwater from all impervious surfaces is infiltrated or treated in retention ponds prior to discharge into Grays Harbor.

    b. Conduct routine maintenance throughout the year to ensure that stormwater treatment facilities function as appropriate to remove stormwater pollutants. Record the dates and types of maintenance done, to include in reporting.

2. To implement reasonable and prudent measure #2 (in-water pile driving), the Corps and the Applicants shall ensure:

    a. Impact pile driving is done between October 1 and February 14

    b. Only use impact pile driving when absolutely necessary.

    c. When using an impact hammer to drive or proof steel piles surround the pile with a confined or unconfined bubble curtain that distributes small air bubbles around 100 percent of the piling perimeter for the full depth of the water column (Appendix 1).

    d. For impact pile driving during the month of October, monitor sound pressure levels and use the pile driving sound calculator to ensure cumulative levels do not exceed 187 dB_{SEL} at 2154 meters from the pile being driven. If sound pressure levels approach cumulative effects, cease driving for the day.

3. To implement reasonable and prudent measure #3 (dredging suspended sediment), Corps, and the Applicants shall ensure:
    a. Dredging will be done between July 16 and February 14.
    b. For hydraulic dredging,
        i. The cutterhead will remain on the bottom to the greatest extent possible.
        ii. Use a buffer plate or other means to reduce flow discharge of the hydraulic dredge at the placement area.
    c. For clamshell dredge,
        i. Close the bucket smoothly when at the bottom.
        ii. Slow the velocity (cycle time) of the ascending loaded clamshell bucket through the water column to decrease suspended sediment.
        iii. Pause the dredge bucket near the bottom while descending and near the waterline while ascending.
    d. Visually monitor that suspended sediment plumes dissipate to the background turbidity level within 1,000 feet of the dredge.
    e. If suspended sediment plumes extend beyond 1000 feet,
        i. Cease hydraulic dredging until suspended sediment returns to background levels at 1000 feet

ii. Reduce clamshell dredging cycle time until suspended sediment returns to background levels at 1000 feet

4. To implement reasonable and prudent measure #4 (monitoring and reporting), the Corps, and the Applicants shall ensure the following monitoring will occur:

   a. All stormwater retention pond maintenance, according to 1b. above (Corps, Applicants);
   b. Sound pressure levels when using an impact hammer, according to 2d. above (Corps, Applicants); and
   c. Suspended sediment plumes during dredging, according to 3d above (Corps, Applicants);
   d. The Applicants will ensure a monitoring report is submitted to NMFS by September 1 of each year that describes the previous year's implementation of the proposed action. At a minimum, the report will document:

      i. The number of impact hammer strikes;
      ii. The approximate volume and area of sediment dredged;
      iii. The number of potash OGVs loaded;
      iv. All information in 4a. through 4c. above.

2.10 Conservation Recommendations

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

The following are NMFS' recommendations:

- 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.
  - Keep a sharp look-out for whales; including posting extra crew on the bow to watch, if possible.
  - Reduce speeds while in the advisory zones, or in areas of high seasonal or local whale abundance.
  - If practicable, re-route vessels 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).

2.11 Reinitiation of Consultation

This concludes formal consultation for Proposed Grays Harbor Potash Export Facility.

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

2.12 "Not Likely to Adversely Affect" Determinations

Puget Sound Chinook salmon and steelhead and their critical habitat

The construction and operation of the potash terminal will result in 500 additional Burlington Northern Santa Fe BNSF unit trains per year carrying 8 million metric tons of potash to the terminal. The BNSF railroad tracks run along 60 miles of the Puget Sound shoreline from Bellingham, Washington to Tacoma, Washington and crosses 33 rivers and streams that produce Puget Sound Chinook salmon and Puget Sound steelhead. These BNSF trains will travel along or across 30,000 miles of Puget Sound Chinook salmon and Puget Sound steelhead critical habitat per year.

Freight trains derail at a rate of 0.3 derailments per 1 million miles. Extrapolating that to the 30,000 miles in Puget Sound the likelihood of derailment along these miles represent 0.01 derailments per year or 1 potash unit train derailment every 100 years along Puget Sound. The likelihood of a derailment that exposes Puget Sound salmon and steelhead to spilled potash is insignificant.

If a train did derail into Puget Sound, each unit train railcar carries 114 tons of potash. If two railcars derail and spill ~230 tons of potash into Puget Sound, the potash will be quickly mixed into the water column by waves and diffusion. The background concentration of potassium in seawater is 400 grams per cubic meter. If we imagine and 230 cubic meter control volume around the spill site, for example a semicircular wedge with a radius of 220 meters and an average depth of 3 meters, the potassium concentration in the water column would reach 1,400 grams per cubic meter. With a mixed diurnal tidal cycle, the concentration would drop below 800 grams per cubic meter within 4 hours tidal exchange and return to the background concentration within 12 hours. Water quality would be temporarily degraded by high potassium concentrations for approximately 12 hours. Densmore et al. (2018) exposed seven juvenile Chinook salmon to up to 800 milligrams per liter for 4 days. One fish died and there was no strong evidence of significant physiological impairment in the survivors. Smolts in Puget Sound would presumably have even greater tolerance to high potassium concentrations. The likelihood that listed Puget Sound salmon and steelhead will be exposed to a railroad potash spill is insignificant because spills into critical habitat will likely have a recurrence interval of greater than 100 years.

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 vessels 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 in 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.

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 ocean portion action area is small (less than 7 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 indicate that occurrence is likely to be rare in the action area. In addition, the increase in the amount of OGV traffic in the ocean portion of the action area is small. 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 ocean portion of the action area is small. 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.

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. Due to the rare occurrence of North Pacific right whales in the action area it is extremely unlikely there would be an interaction between North Pacific right whales and OGVs from the CET. Therefore, the risk of ship strikes and effects from vessel sound on North Pacific right whales is discountable.

Western North Pacific Gray Whales

Off the Oregon and Washington coasts, the occurrence of Eastern North Pacific gray whales is common, with the most recent population estimate (2015/2016) during southbound surveys being 26,960 (2018 Stock Assessment Report). 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.

Western North Pacific gray whales feed during summer and fall in the Okhotsk Sea off northeast Sakhalin Island, Russia, and in the Bering Sea off southeastern Kamchatka (2018 Stock Assessment Report). The Western North Pacific gray whales are rare, with a population estimate of only 290 individuals (2018 Stock Assessment Report). Recently, information from tagging, photo-identification, and genetic studies show that Western North Pacific 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 2011, Mate *et al.* 2011, Weller *et al.* 2012). Although there is potential for Western North Pacific gray whales to occur in the action area, the available data on their migration patterns and low abundance indicate their occurrence is rare.

Due to the rare occurrence of Western North Pacific gray whales in the action area, it is extremely unlikely there would be an interaction between Western North Pacific gray whales and OGVs from the CET. Therefore, the risk of ship strikes and effects from vessel sound on Western North Pacific gray whales is discountable.

Southern Resident Killer Whales

There are only two confirmed cases of southern resident killer whale injuries and deaths due to boat strikes since 2005 (Carretta *et al*. 2019). There was documentation of a whale-boat collision in Haro Strait (Puget Sound) in 2005 which resulted in a minor injury to a whale. In 2006, whale L98 was killed during a vessel interaction. It is important to note that L98 had become habituated to regularly interacting with vessels during its isolation in Nootka Sound. Both of these collisions were from small vessels. There are two other cases that may or may not be caused by boat strike, but for purposes of this biological opinion (assuming worst-case scenario) we will assume they are. In 2012, a moderately decomposed juvenile female (L-112) was found dead near Long Beach, WA. A full necropsy determined the cause of death was blunt force trauma to the head, however the source of the trauma could not be established (Carretta *et al*. 2019). Similarly, in 2016, a young adult male (J34) was found dead in the northern Georgia Strait. His injuries were consistent with those incurred during a vessel strike, though a final determination has not been made (Carretta *et al*. 2019).

From 1982-2016, there were 49 confirmed sightings of southern resident killer whales in coastal waters off the western U.S. No documented southern resident killer whale deaths or strandings have occurred near the action area. The relatively small action area, low presence of killer whale in the action area, and the lack of interactions with large ships through reporting or the stranding network, with none near the action area, leads us to conclude that risk of collision from vessels is discountable. The sound from OGVs is largely low frequency sound that does not overlap with the most sensitive hearing range of killer whales. Vessel sound may still be audible to the whales, but any disturbance from the sound of passing OGVs is expected to be short-term, transitory, and insignificant. Therefore, acoustic effects of the proposed action will be insignificant on southern resident killer whales and proposed southern resident killer whale critical habitat.

The proposed action may affect southern resident killer whales indirectly by reducing availability of their primary prey, Chinook salmon. The proposed activities are not expected to produce a measurable effect on the abundance, distribution, diversity, or productivity of Chinook salmon at either the population or species level. 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 from zero by multiple decimal places (based on NMFS previous analyses of the effects of in-river salmon harvest on Southern Resident killer whales, e.g. NMFS No. WCR-2017-7164). Because the reduction is so small, there is also a low probability that any juvenile Chinook salmon killed by the proposed activities would have later (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 and an insignificant effect on proposed southern resident killer whale critical habitat.

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

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council [PFMC] 2005), coastal pelagic species (CPS) (PFMC 1998), and Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The proposed action and action area for this consultation are described in the Introduction to this document. The action area includes areas designated as EFH for various life-history stages of groundfish, coastal pelagic species, and Pacific salmon (PFMC 2005, PFMC 1998, PFMC 2014). In addition, the Grays Harbor estuary is a Habitat Area of Particular Concern because estuaries are nutrient-rich and biologically-productive, providing a critical nursery ground for many species managed by the PFMC.

3.2 Adverse Effects on Essential Fish Habitat

The ESA portion of this document describes the adverse effects of this proposed action on Chinook salmon, green sturgeon, and eulachon. This ESA analysis of effects is also relevant to EFH. Based on information provided by the action agency and the analysis of effects presented in the ESA portion of this document, we conclude the proposed action will adversely affect designated EFH due to construction and operation of the proposed action.

Potential adverse effects to groundfish, coastal pelagic, and Pacific salmon EFH include:

- Suspended sediment from pile driving;
- Suspended sediment from initial and maintenance dredging and in water dredge sediment disposal;
- Introduction of exotic, invasive species from ballast water;
- Entrainment and impingement in OGV intake port;
- Entrainment of food organism in OGV intake port;

- Habitat and food source effects related to construction and maintenance of the terminal berth slip;
- Shading effects from over-water structures;
- Stormwater discharge from impervious surfaces;
- Acoustic effects from impact driving in-water pile;
- Entrainment from dredging;
- Potash spills;
- Fuel or oil spills at sea.

3.3 Essential Fish Habitat Conservation Recommendations

The following conservation measures are necessary to avoid, mitigate, or offset the impact of the proposed action on the above described impacts to EFH. Eight of these conservation recommendations are a subset of the ESA terms and conditions.

The Corps and the Applicants should minimize adverse effects from in-water pile driving by implementing the following recommendations:

a) An impact hammer is only used if absolutely necessary;
b) When using an impact hammer to drive or proof steel piles, surround the pile with a confined or unconfined bubble curtain that distributes small air bubbles around 100 percent of the piling perimeter for the full depth of the water column;
c) Monitor sound pressure levels and use the impact pile driving calculator to ensure cumulative levels do not exceed 187 dB at 5124 meters from the piles being driven. If sound pressure levels approach cumulative effects, cease driving for the day.

The Corps, and the Applicants should minimize adverse effects from suspended sediment by ensuring that if the suspended sediment plume is visible 1,000 feet from the dredge, dredging should cease or slow down until suspended sediment returns to background levels at 1000 feet:

The Corps and the Applicants should minimize adverse effects from dredging by implementing the following:

a) For hydraulic dredging, the cutterhead will remain on the bottom to the greatest extent possible;
b) It may only be raised 3 feet off the bottom for brief periods when the cutterhead has to be purged.

The Corps and the Applicant should minimize adverse effects from stormwater by implementing the following:

a. Stormwater from all impervious surfaces is infiltrated or treated in retention ponds prior to entering Grays Harbor;

b. Conduct routine maintenance throughout the year to ensure that stormwater retention ponds function as appropriate to remove stormwater pollutants. Record the dates and types of maintenance done.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, approximately 18,000 acres of designated EFH for Pacific Coast salmon,.

3.3 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' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

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

3.4 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 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion is the U.S. Army Corps of Engineers. Other interested users could include BHP. Individual copies of this opinion were provided to the Corps and BHP. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

5. REFERENCES

Abatzoglou, J.T., Rupp, D.E., and Mote, P.W. (2014). Seasonal Climate Variability and Change in the Pacific Northwest of the United States. J Climate *27*, 2125-2142.

Adams, J., Felis, J., Mason, J.W., and Takekawa, J.Y. (2014). Pacific Continental Shelf Environmental Assessment (PaCSEA): Aerial Seabird and Marine Mammal Surveys off Northern California, Oregon, and Washington, 2011–2012 (Camarillo, CA: Bureau of Ocean Energy Management).

Au, W.W.L., and Green, M. (2000). Acoustic interaction of humpback whales and whale-watching boats. Mar Environ Res *49*, 12.

Azzellino, A., Gaspari, S., Airoldi, S., and Nani, B. (2008). Habitat use and preferences of cetaceans along the continental slope and the adjacent pelagic waters in the western Ligurian Sea. Deep-Sea Res Pt I *55*, 296-323.

Banas, N.S., Hickey, B.M., MacCready, P., and Newton, J.A. (2004). Dynamics of Willapa Bay, Washington: A highly unsteady, partially mixed estuary. J Phys Oceanogr *34*, 2413-2427.

Barlow, J. (2010). Cetacean abundance in the California Current from a 2008 ship-based line transect survey., pp. 19.

Barlow, J., Calambokidis, J., Falcone, E.A., Baker, C.S., Burdin, A.M., Clapham, P.J., Ford, J.K.B., Gabriele, C.M., LeDuc, R., Mattila, D.K*., et al.* (2011). Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. Mar Mammal Sci *27*, 793-818.

Barnard, B. (2016). Carriers stick with slow-steaming despite fuel-price plunge. In The Journal of Commerce (New York, NY: The JOC Group Inc.).

Barton, A., Hales, B., Waldbusser, G.G., Langdon, C., and Feely, R.A. (2012). The Pacific oyster, Crassostrea gigas, shows negative correlation to naturally elevated carbon dioxide levels: Implications for near-term ocean acidification effects. Limnol Oceanogr *57*, 698-710.

Bauer, G., and Herman, L.M. (1986). Effects of vessel traffic on the behavior of humpback whales in Hawaii (Honolulu, Hawaii: National Marine Fisheries Service).

Becker, E.A., Forney, K.A., Fiedler, P.C., Barlow, J., Chivers, S.J., Edwards, C.A., Moore, A.M., and Redfern, J.V. (2016). Moving Towards Dynamic Ocean Management: How Well Do Modeled Ocean Products Predict Species Distributions? Remote Sens-Basel *8*.

Benson, S.R., Dutton, P.H., Hitipeuw, C., B. Samber, Bakarbessy, J., and Parker, D. (2007a). Postnesting migrations of leatherback turtles (Dermochelys coriacea) from Jamursba-Medi, Bird's Head Peninsula, Indonesia. Chelonian Conservation and Biology *6(1)*, 5.

Benson, S.R., Eguchi, T., Foley, D.G., Forney, K.A., Bailey, H., Hitipeuw, C., Samber, B.P., Tapilatu, R.F., Rei, V., Ramohia, P*., et al.* (2011). Large-scale movements and high-use areas of western Pacific leatherback turtles, Dermochelys coriacea. Ecosphere *2*.

Benson, S.R., Forney, K.A., Harvey, J.T., Carretta, J.V., and Dutton, P.H. (2007b). Abundance, distribution, and habitat of leatherback turtles (Dermochelys coriacea) off California, 1990-2003. Fish B-Noaa *105*, 337-347.

Berman-Kowalewski, M., and 2010. (2010). Association between blue whale (Balaenoptera musculus) mortality and ship strikes along the California coast. Aquat Mamm *36*, 7.

Bettridge, S., Baker, C.S., Barlow, J., Clapham, P.J., Ford, M., Gouveia, D., Mattila, D.K., R. M. Pace, I., Rosel, P.E., Silber, G.K*., et al.* (2015). Status Review of the Humpback Whale (Megaptera novaeangliae) under the Endangered Species Act (La Jolla, CA: Southwest Fisheries Science Center).
Blane, J.M., and Jaakson, R. (1994). The impact of ecotourism boats on the St. Lawrence beluga whales (Delphinapterus leucas). Environmental Conservation *21*, 2.
Bonney, J., and Leach, P.T. (2010). Slow Boat From China. In Maritime News.
Bryant, P.J., Lafferty, C.M., and Lafferty, S.K. (1984). The Gray Whale, Eschrichtius robustus (New York: Academic Press).
Calambokidis, J. (2012a). Summary of Ship-Strike Related Research on Blue Whales in 2011 (Olympia, WA: Cascadia Research).
Calambokidis, J. (2012b). Summary of ship-strike related research on blue whales in 2011.
Calambokidis, J., and Barlow, J. (2013). Updated abundance estimates ofblue and humpback whales off the US west coast incorporating photo-identifications from 2010 and 2011 (Pacific Scientific Review Group), pp. 7.
Calambokidis, J., Barlow, J., Ford, J.K.B., Chandler, T.E., and Douglas, A.B. (2009a). Insights into the population structure of blue whales in the Eastern North Pacific from recent sightings and photographic identification. Mar Mammal Sci *25*, 816-832.
Calambokidis, J., Barlow, J.K., Flynn, K., Dobson, E., and Steiger., G.H. (2017). Update on abundance, trends, and migrations of humpback whales along the U.S. West Coast (SC/A17/NP/13) (Cambridge, United Kingdom: International Whaling Commission).
Calambokidis, J., Falcone, E., Douglas, A., Schlender, L., and Huggins, J. (2009b). Photographic identification o fHumpback and blue whales off the U. S. west coast: Results and updated abundance estimates from 2008 field season. (Southwest Fisheries Science Center), pp. 18.
Calambokidis, J., Steiger, G.H., Curtice, C., Harrison, J., Ferguson, M.C., Becker, E., DeAngelis, M., and Van Parijs, S.M. (2015). Biologically Important Areas for Selected Cetaceans Within US Waters - West Coast Region. Aquat Mamm *41*, 39-53.
Campbell, G.S., Thomas, L., Whitaker, K., Douglas, A.B., Calambokidis, J., and Hildebrand, J.A. (2015). Inter-annual and seasonal trends in cetacean distribution, density and abundance off southern California. Deep-Sea Res Pt Ii *112*, 143-157.
Carretta, J.V., Forney, K.A., M.Oleson, E., Weller, D.W., Lang, A.R., Baker, J., Muto, M.M., Hanson, B., Orr, A.J., Huber, H*., et al.* (2017). U.S. Pacific Marine Mammal Stock Assessments: 2016 (U.S. Department of Commerce).
Carretta, J.V., Forney, K.A., Oleson, E.M., Weller, D.W., Lang, A.R., Baker, J., Muto, M.M., Hanson, B., Orr, A.J., Huber, H*., et al.* (2018). U.S. Pacific marine Mammal Stock Assessments: 2017.
Carretta, J.V., Forney, K.A., Oleson, E.M., Weller, D.W., Lang, A.R., Baker, J., Muto, M.M., Hanson, B., Orr, A.J., Huber, H*., et al.* (2019). U.S. Pacific Marine Mammal Stock Assessments: 2018 (NOAA Technical Memorandum) (La Jolla, CA: U.S. Department of Commerce).
Carretta, J.V., K.A. Forney, E.M. Oleson, D.W. Weller, A.R. Lang, J. Baker, M.M. Muto, B. Hanson, A.J. Orr, H. Huber, M.S. Lowry, J. Barlow, J.E. Moore, D. Lynch, L. Carswell, R.L. Brownell (2019). U.S. Pacific Marine Mammal Stock Assessments: 2018 (U.S. Department of Commerce).

Carretta, J.V., Oleson, E., Weller, D.W., Lang, A.R., L., A.F., Baker, J., Hanson, B., Martien, K., Muto, M.M., Lowry, M.S., *et al.* (2013). U.S. Pacific Marine Mammal Stock Assessments: 2012 (National Marine Fisheries Service).

Cascadia Research (2017). Examination of fin whale reveals it was killed by collision with ship.

Chan, E.H., and Liew, H.C. (1996). Decline of the leatherback population in Terengganu, Malaysia. 1956-1995. Chelonian Conservation and Biology *2*, 7.

Cheong, T.S., Kavvas, M.L., and Anderson, E.K. (2006). Evaluation of adult white sturgeon swimming capabilities and applications to fishway design. Environ Biol Fish *77*, 197-208.

Cogan, J. (2015). 2015 Whale Sightings in the Salish Sea: Central Salish Sea and Puget Sound (Southern Resident Killer Whale Project) (Friday Harbor, WA: Center for Whale Research).

Collins, M.A. (1995). Dredging-Induced Near-Field Resuspended Sediment Concentrations and Source Strengths (U.S. Army Corps of Engineers).

Conn, P.B., and Silber, G.K. (2013). Vessel speed restrictions reduce risk of collision-related mortality for North Atlantic right whales. Ecosphere *4*.

Corkeron, P.J. (1995). Humpback whales (Megaptera novaeangliae) in Hervey Bay, Queensland: Behaviour and responses to whale-watching vessels. Canadian Journal of Zoology *73*, 9.

Crozier, L.G., Scheuerell, M.D., and Zabel, R.W. (2011). Using Time Series Analysis to Characterize Evolutionary and Plastic Responses to Environmental Change: A Case Study of a Shift toward Earlier Migration Date in Sockeye Salmon. Am Nat *178*, 755-773.

Dalla Rosa, L., Ford, J.K.B., and Trites, A.W. (2012). Distribution and relative abundance of humpback whales in relation to environmental variables in coastal British Columbia and adjacent waters. Cont Shelf Res *36*, 89-104.

Densmore, C.L., Iwanowicz, L.R., Henderson, A.P., Reed-Grimmett, V.S.B.M., and Sanders, L.R. (2018). An Evaluation of the Toxicity of Potassium Chloride, Active Compound in the Molluscicide Potash, on Salmonid Fish and Their Forage Base (U. S. Geological Service).

Dominguez, F., Rivera, E., Lettenmaier, D.P., and Castro, C.L. (2012). Changes in winter precipitation extremes for the western United States under a warmer climate as simulated by regional climate models. Geophys Res Lett *39*.

Doney, S.C., Ruckelshaus, M., Duffy, J.E., Barry, J.P., Chan, F., English, C.A., Galindo, H.M., Grebmeier, J.M., Hollowed, A.B., Knowlton, N., *et al.* (2012). Climate Change Impacts on Marine Ecosystems. Annu Rev Mar Sci *4*, 11-37.

Douglas, A.B. Incidence of ship strikes of large whales in Washington State. J Mar Biol Assoc Uk *88*, 11.

Drake, J., Emmett, R., fresh, K., Gustafson, R., Rouse, M., Teel, D., Wilson, M., Adams, P., Spangler, E.A.K., and Spangler, R. (2008). Summary of scientific conclusions ofthe review of the status of eulachon(Thaleichthyspacificus)in washington, Oregon and California (Seattle, WA: U. S. Department of Commerce, Northwest Fisheries Science Center).

Dutton, D.L., Hitipeuw, C., Zein, M., Benson, S.R., Petro, G., Pita, J., Rei, V., Ambio, L., and Bakarbessy, J. (2007). Status and genetic structure of nesting populations of leatherback turtles (Dermochelys coriacea) in the western Pacific. Chelonian Conservation and Biology *6*, 6.

Eckert, K.L., Wallace, B.P., Frazier, J.G., Eckert, S.A., and Pritchard, P.C.H. (2012). Synopsis of the biological data on the leatherback sea turtle (Dermochelys coriacea) (Washingto, D. C.: U.S. Department of Interior, Fish and Wildlife Service).

Eckert, S.A. (1998). Perspectives on the use of satellite telemetry and other electronic technologies for the study of marine turtles, with reference to the first year long tracking of leatherback sea turtles. In Proc Of the 17th Annual Sea Turtle Symposium, pp. 44.

Eckert, S.A., and Lien, J. (1999). Recommendations for eliminating incidental capture and mortality of leatherback sea turtles, Dermochelys coriacea, by commercial fisheries in Trinidad and Tobago (A report to the Wider Caribbean Sea Turtle Conservation Network (WIDECAST)), pp. 7.

Emmons, C.K., Hanson, M.B., and Lammers, M.O. (2019). Monitoring the occurrence of Southern Resident killer whales, other marine mammals, and anthropologic sound in the Pacific Northwest (Seattle, WA: National Marine Fisheries Service, Northwest Fisheries Science Center).

Erbe, C. (2002). Underwater noise of whale-watching boats and potential effects on killer whales (Orcinus orca), based on an acoustic impact model. Mar Mammal Sci *18*, 22.

Erickson, D.L., and Hightower, J.E. (2007). Oceanic distribution and behavior of green sturgeon. Am Fish S S *56*, 197-+.

Evans, P.G.H., Canwell, P.J., and Lewis, E. (1992). An experimental study of the effects of pleasure craft noise upon bottle-nosed dolphins in Cardigan Bay, West Wales. European Research on Cetaceans. Paper presented at: Proceedings of the Sixth Annual Conference of the European Cetacean Society (San Remo, Italy).

Falcone, E.A., Diehl, B., Douglas, A., and Calambokidis, J. (2011). Photo-Identification of Fin Whales (Balaeanoptera physalus) along the US West Coast, Baja California, and Canada (Olympia, WA: Cascadia Research Collective).

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

Felix, F. (2001). Observed changes of behavior in humphack whales during whalewatching encounters off Ecuador. Paper presented at: 14th Biennial Conference on the Biology of Marine Mammals (Vancouver, Canada).

Fonnesbeck, C.J., Garrison, L.P., Ward-Geiger, L.I., and Baumstark, R.D. (2008). Bayesian hierarchichal model for evaluating the risk of vessel strikes on North Atlantic right whales in the SE United States. Endanger Species Res *6*, 7.

Gannier, A., and Praca, E. (2007). SST fronts and the summer sperm whale distribution in the north-west Mediterranean Sea. J Mar Biol Assoc Uk *87*, 187-193.

Gende, S.M. (2011). A Bayesian approach for understanding the role of ship speed in whale-ship encounters. Ecological Applications *21*, 8.

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

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

Hamann, M., Limpus, C., Hughes, G., Mortimer, J., and Pilcher, N. (2006). Assessment of the conservation status of the leatherback turtle in the Indian Ocean and SouthEast Asia. In Indian Ocean and SouthEast Asia (IOSEA) Species Assessment: Volume I IOSEA Marine Turtle Memorandum of Understanding Secretariat (Bangkok, Thailand).

Hatin, D., Lachance, S., and Fournier, D. (2007). Effect of dredged sediment deposition on use by Atlantic sturgeon and lake sturgeon at an open-water disposal site in the St. Lawrence estuarine transition zone. Am Fish S S *56*, 235-+.

Hazel, J., Lawler, I.R., and Marsh, H. (2007). Vessel speed increases collision risk for the green turtle Chelonia mydas. Endanger Species Res *3*, 8.

Hershfield, D.M. (1963). Rainfall Frequency Atlas of the Unites States for Durations from 30 Minutes to 24 Hours and Return Periods from I to 100 Years (U.S. Department of Commerce).

Horwood, J. (2009). Sei Whale Balaenoptera borealis. Encyclopedia of Marine Mammals, 2nd Edition, 1001-1003.

Huff, D.D., Lindley, S.T., Wells, B.K., and Chai, F. (2012). Green Sturgeon Distribution in the Pacific Ocean Estimated from Modeled Oceanographic Features and Migration Behavior. Plos One *7*.

Huppert, D.D., Johnson, R.L., Leahy, J., and Bell, K. (2003). Interactions between human communities and estuaries in the Pacific Northwest: Trends and implications for management. Estuaries *26*, 994-1009.

IPCC (2014). Climate Change 2014: Synthesis Report. In Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, R.K. Pachauri, and L.A. Meyer, eds. (Geneva, Switzerland: Intergovernmental Panel on Climate Change), pp. 499-524.

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

ISAB (editor) (2007). Climate change impacts on Columbia River Basin fish and wildlife. In Climate Change Report, I.S.A. Board, ed. (Portland, Oregon: Northwest Power and Conservation Council).

Jensen, A.S., and Silber, G.K. (2003). Large whale ship strike database (U.S. Department of Commerce).

Jepson, M.A., Keefer, M.L., and Caudill, C.C. (2015). Migratory behavior, run timing and distribution of radio-tagged adult winter steelhead, summer steelhead, spring Chinook salmon and coho salmon in the Willamette River: 2011-2014 (U. S. Armycorps of Engineers), pp. 117.

Jepson, M.A., Keefer, M.L., Caudill, C.C., Clabough, T.S., and Sharpe, C.S. (2013). Migratory behavior, run timing and distribution of radio-tagged adult winter steelhead, summer steelhead and spring Chinook salmonin the Willamette River-2012 (U. S. ArmyCorps of Engineers), pp. 103.

Johnson, L.L., Arkoosh, M.R., Bravo, C.F., Collier, T.K., Krahn, M.M., Meador, J.P., Myers, M.S., Reichert, W.L., and Stein, J.E. (2007a). The Effects of Polycyclic Aromatic Hydrocarbons in Fish from Puget Sound, Washington In The Toxicology of Fishes.

Johnson, L.L., Ylitalo, G.M., Arkoosh, M.R., Kagley, A.N., Stafford, C., Bolton, J.L., Buzitis, J., Anulacion, B.F., and Collier, T.K. (2007b). Contaminant exposure in outmigrant juvenile

salmon from Pacific Northwest estuaries of the United States. Environ Monit Assess *124*, 167-194.
Joint Columbia River Management Staff (2009). 2010 joint staff report concerning stock status and fisheries forsturgeon and smelt (Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife).
Knowlton, A.R., and Kraus, S.D. (2001). Mortality and serious injury of northern right whales (Eubalaena glacialis) in the western North Atlantic Ocean. Journal of Cetacean Research and Management Special Issue *2*, 15.
Koopman, B.O. (1956). The Theory of Search .1. Kinematic Bases. Oper Res *4*, 324-346.
Kunkel, K.E., Stevens, L.E., Stevens, S.E., Sun, L., Janssen, E., Wuebbles, D., Redmond, K.T., and Dobson, J.G. (2013). Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 6. Climate of the Northwest U.S. (National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, Washington, D.C.), pp. 83.
Lagerquist, B.A., Mate, B.R., Ortega-Ortiz, J.G., Winsor, M., and Urban-Ramirez, J. (2008). Migratory movements and surfacing rates of humpback whales (Megaptera novaeangliae) satellite tagged at Socorro Island, Mexico. Mar Mammal Sci *24*, 815-830.
Laggner, D. (2009). Blue whale (Baleanoptera musculus) ship strike threat assessment in the Santa Barbara Channel, California (Evergreen State College).
Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S., and Podesta, M. (2001). Collisions between ships and whales. Mar Mammal Sci *17*, 40.
Lammers, A., Pack, A., and Davis, L. (2003). Historical evidence of whale/vessel collisions in Hawaiian waters (1975-present). (Ocean Science Institute).
Lawson, P.W., Logerwell, E.A., Mantua, N.J., Francis, R.C., and Agostini, V.N. (2004). Environmental factors influencing freshwater survival and smolt production in Pacific Northwest coho salmon (Oncorhynchus kisutch). Canadian Journal of Fisheries and Aquatic Sciences *61*, 360-373.
Limpus, C.J. (2009). A biological review of Australian marine turtles. 1. Loggerhead turtle Caretta caretta (Linnaeus).
Lindley, S.T., Erickson, D.L., Moser, M.L., Williams, G., Langness, O.P., McCovey, B.W., Belchik, M., Vogel, D., Pinnix, W., Kelly, J.T., *et al.* (2011). Electronic Tagging of Green Sturgeon Reveals Population Structure and Movement among Estuaries. T Am Fish Soc *140*, 108-122.
Lindley, S.T., Moser, M.L., Erickson, D.L., Belchik, M., Welch, D.W., Rechisky, E.L., Kelly, J.T., Heublein, J., and Klimley, A.P. (2008). Marine migration of North American green sturgeon. T Am Fish Soc *137*, 182-194.
Lusseau, D. (2003). Effects of tour boats on the behavior of bottlenose dolphins: Using Markov chains to model anthropogenic impacts. Conserv Biol *17*, 8.
Lusseau, D. (2006). The short-term behavioral reactions of bottlenose dolphins to interactions with boats in Doubtful Sound, New Zealand. Mar Mammal Sci *22*, 16.
MacFadyen, A., Hickey, B.M., and Cochlan, W.P. (2008). Influences of the Juan de Fuca Eddy on circulation, nutrients, and phytoplankton production in the northern California Current System. J Geophys Res-Oceans *113*.
Magalhaes, S. (2002). Short-term reactions of sperm whales (Physeter macrocephalus) to whale-watching vessels in the Azores. Aquat Mamm *28*, 7.

Maloni, M., Paul, J.A., and Gligor, D.M. (2013). Slow steaming impacts on ocean carriers and shippers. Maritime Economics & Logistics *15*, 20.

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

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

Martin, J., Sabatier, Q., Gowan, T.A., Giraud, C., Gurarie, E., Calleson, C.S., Ortega-Ortiz, J.G., Deutsch, C.J., Rycyk, A., and Koslovsky, S.M. (2016). A quantitative framework for investigating risk of deadly collisions between marine wildlife and boats. Methods Ecol Evol *7*, 42-50.

McElhany, P., Ruckelshaus, M.H., Ford, M.J., Wainwright, T.C., and Bjorkstedt, E.P. (2000). Viable salmonid populations and the recovery of evolutionarily significant units (U. S. Department of Commerce), pp. 156.

McKenna, M.F., Calambokidis, J., Oleson, E.M., Laist, D.W., and Goldbogen, J.A. (2015). Simultaneous tracking of blue whales and large ships demonstrates limited behavioral responses for avoiding collision. Endanger Species Res *27*, 219-232.

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

Meyer, J.L., Sale, M.J., Mulholland, P.J., and Poff, N.L. (1999). Impacts of climate change on aquatic ecosystem functioning and health. J Am Water Resour As *35*, 1373-1386.

Monnahan, C.C., Branch, T.A., and Punt, A.E. (2015). Do ship strikes threaten the recovery of endangered eastern North Pacific blue whales? Mar Mammal Sci *31*, 279-297.

Morreale, S., Standora, E., Paladino, F., and Spotila, J. (1994). Leatherback migrations along deepwater bathymetric contours. In Proc 13th Annual Symposium Sea Turtle Biology and Conservation, pp. 109.

Moser, M.L., and Lindley, S.T. (2007). Use of Washington estuaries by subadult and adult green sturgeon. Environ Biol Fish *79*, 243-253.

Mote, P.W., Rupp, D.E., Li, S.H., Sharp, D.J., Otto, F., Uhe, P.F., Xiao, M., Lettenmaier, D.P., Cullen, H., and Allen, M.R. (2016). Perspectives on the causes of exceptionally low 2015 snowpack in the western United States. Geophys Res Lett *43*, 10980-10988.

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

Muthukrishnan, S., and Selvakumar, A. (2006). Evaluation of retention pond and constructed wetland BMPs for treatin particulate bound heavy metals in urban stormwater runoff. In World environmental and water resource congress 2006: Examining the confluence of environmental and water concerns, R. Graham, ed. (Omaha, NE: American Society of Civil Engineers).

Myers, J.M., busack, C., Rawding, D., Marshall, A.R., Teel, D.J., Doornik, D.M.V., and Maher, M.T. (2006). Historical population structure of Pacific salmonids in the Willamette River and lower Columbia River basins (U. S. Department of Commerce), pp. 311.

Nadeem, K., Moore, J.E., Zhang, Y., and Chipman, H. (2016). Integrating population dynamics models and distance sampling data: a spatial hierarchical state-space approach. Ecology *97*, 1735-1745.

National Marine Fisheries Service, and U.S. Fish and Wildlife Service (2020). Endangered Species Act status review of the leatherback turtle (Dermochelys coriacea). Report to the National Marine Fisheries Service Office of Protected Resources and U.S. Fish and Wildlife Service.

National Oceanic and Atmospheric Administration (2017). 2016 West Coast Entanglement Summary. . (Seattle, WA: National Marine Fisheries Service).

Nel, R. (2012). Assessment of the conservation status of the leatherback turtle in the Indian Ocean South-East Asia: 2012 update (IOSEA Marine Turtle MOU Secretariat Bangkok, Thailand), pp. 41.

NMFS (1991). Final Recovery Plan for the Humpback Whale (*Megaptera novaeangliae*) (National Marine Fisheries Service Office of Protected Resources).

NMFS (2012). Final Biological Report, Final Rule to Revise the Critical Habitat Designation for Leatherback Sea Turtles (National Marine Fisheries Service Southwest Fisheries Science Center).

NMFS (2013). ESA recovery plan for Lower Columbia River coho salmon, Lower Columbia River Chinook salmon, Columbia River chum salmon and Lower Columbia River steelhead. (Seattle, WA: National Marine Fisheries Service, Northwest Region).

NMFS (2015). Southern Distinct Population Segment of the North American Green Sturgeon (Acipenser medirostris) 5-Year Review: Summary and Evaluation (Long Beach, CA: National Marine Fisheries Service, West Coast Region), pp. 42.

NMFS (2016). 5-Year Review: Summary and Evaluation of Upper Willamette River Steelhead, Upper Willamette River Chinook (Portland, OR: National Marine Fisheries Service, West Coast Region).

NMFS (2017). Recovery Plan forthe Southern Distinct Population Segment of Eulachon (Thaleichthys pacificus). (Portland, OR: National Marine Fisheries Service, West Coast Region,Protected Resources Division).

NMFS (2018). Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (Acipenser medirostris) (Sacramento, CA: National Marine Fisheries Service).

NMFS (2019). HUMPBACK WHALE (Megaptera novaeangliae): California/Oregon/Washington Stock (Silver Springs, MD: National Marine Fisheries Service).

NMFS and USFWS (1998). Recovery plan for U.S. Pacific populations of the leatherback turtle (Dermochelys coriacea). (Silver Springs, MD: National Marine Fisheries Service and U.S. Fish and Wildlife Service).

NOAA Fisheries (2011). Biennial report to Congress on the recovery program for threatened and endangered species October 1, 2008 – September 30, 2010 (Washington, D.C.: National Oceanic and Atmospheric Administration, National Marine Fisheries Service).

Nowacek, D.P., Johnson, M.P., and ., P.L.T. (2004). North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alerting stimuli. Paper presented at: Proceedings of the Royal Society of London Series B Biological Sciences.

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

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

ODFW and NMFS (2011b). Upper Willamette River conservation and recovery plan for Chinook salmon and steelhead (Oregon Department of Fish and Wildlifeand National Marine Fisheries Service, Northwest Region).

Oleson, E.M., Calambokidis, J., Falcone, E., Schorr, G., and Hildebrand, J.A. (2009). Acoustic and visual monitoring for cetaceans along the outer Washington coast (San Diego, CA: University of California San Diego Scripps Institution of Oceanography and Cascadia Research Collective.).

Oleson, E.M., and Hildebrand, J. (2012). Marine Mammal Demographics Off the Outer Washington Coast and Near Hawaii. (Monterey, CA: U.S. Naval Postgraduate School).

Pace, R., and Silber, G. (2005). Simple analyses of ship and large whale collisions: Does speed kill? (National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources).

Perry, S.L., DeMaster, D.P., and Silber, G.K. (1999). The great whales: History and status of six species listed as endangered under the U.S. Endangered Species Act of 1973. Mar Fish Rev *61*, 74.

Petro, G., Hickey, F.R., and Mackay, K. (2007). Leatherback turtles in Vanuatu. Chelonian Conservation and Biology *6*, 2.

Pilcher, N. (2012). Community-based conservation of leatherback turtles along the Huon coast, Papua New Guinea, pp. 8.

Pritchard, P.C.H. (1982). Nesting of the Leatherback Turtle, Dermochelys-Coriacea in Pacific Mexico, with a New Estimate of the World-Population Status. Copeia, 741-747.

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

Reeder, W.W., Ruggiero, P.R., Shafer, S.L., Snover, A.K., Houston, L.L., P.Glick, Newton, J.A., and Capalbo, S.M. (2013). Coasts: Complex Changes Affecting the Northwest's Diverse Shorelines. In Climate chante in teh Northwest: Implications for our Landscapes, Waters, and Communities, M.M. Dalton, P.W. Mote, and A.K. Snover, eds. (Washington, DC: Island Press).

Richter, C.F., Dawson, S.M., and Slooten, E. (2003). Sperm whale watching off Kaikoura, New Zealand: effects of current activities on surfacing and vocalisation patterns (Wellington, New Zealand: Department of Conservation).

Ritter, F. (2012). Collisions of sailing vessels with cetaceans worldwide: First insights into a seemingly growing problem. Journal of Cetacean Research and Management *12*, 8.

Rockwood, R.C., Calambokidis, J., and Jahncke, J. (2017). High mortality of blue, humpback and fin whales from modeling of vessel collisions on the US West Coast suggests population impacts and insufficient protection. Plos One *12*.

Sandell, T., Fletcher, J., McAninch, A., and Wait, M. (2014). Grays Harbor Juvenile Fish Use Assessment: 2013 Annual Report (Wild Fish Conservancy Northwest).

Scheidat, M., Castro, C., Gonzalez, J., and Williams, R. (2002). Behavioural responses of humpback whales (Megaptera novaeangliae) to whalewatching boats near Isla de la Plata, Machalilla National Park, Ecuador. Journal of Cetacean Research and Management *6*, 5.

Scheuerell, M.D., and Williams, J.G. (2005). Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (Oncorhynchus tshawytscha). Fish Oceanogr *14*, 448-457.

Schorr, G.S., Falcone, E.A., Calambokidis, J., and Andrews, R.D. (2010). Satellite tagging of fin whales off California and Washington in 2010 to identify movement patterns, habitat use and possible stock boundaries (Olympia, WA: Cascadia Research Collective).

Silber, G., Slutsky, J., and Bettridge, S. (2010). Hydrodynamics of a ship/whale collision. Journal of Experimental Marine Biology and Ecology *391*.

Spotila, J.R., Dunham, A.E., Leslie, A.J., Steyermark, A.C., Plotkin, P.T., and Paladino, F.V. (1996). Worldwide Population Decline of Demochelys coriacea: Are Leatherback Turtles Going Extinct? Chelonian Conservation and Biology *2*, 13.

Spotila, J.R., Reina, R.D., Steyermark, A.C., Plotkin, P.T., and Paladino, F.V. (2000). Pacific leatherback turtles face extinction. Nature *405*, 529-530.

Sunda, W.G., and Cai, W.J. (2012). Eutrophication Induced CO2-Acidification of Subsurface Coastal Waters: Interactive Effects of Temperature, Salinity, and Atmospheric P-CO2. Environ Sci Technol *46*, 10651-10659.

Tague, C.L., Choate, J.S., and Grant, G. (2013). Parameterizing sub-surface drainage with geology to improve modeling streamflow responses to climate in data limited environments. Hydrol Earth Syst Sc *17*, 341-354.

Tapilatu, R.F., Dutton, P.H., Tiwari, M., Wibbels, T., Ferdinandus, H.V., Iwanggin, W.G., and Nugroho, B.H. (2013). Long-term decline of the western Pacific leatherback, Dermochelys coriacea: a globally important sea turtle population. Ecosphere *4*.

TEWG (2007). An assessment of the leatherback turtle population in the Atlantic Ocean (Turtle Expert Working Group).

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

USDC (2010). Endangered and threatened wildlife and plants, final rulemaking to establish take prohibitions for the threatened southern distinct population segment of North American green sturgeon (U.S. Department of Commerce, National Marine Fisheries Service).

USDC (2014). Endangered and threatened wildlife: Final rule to revise the Code of Federal Regulations for species under thejurisdiction of theNational Marine Fisheries Service (U. S. Department of Commerce), pp. 20802-20817.

Vanderlaan, A.S.M., and Taggart, C.T. (2007). Vessel collisions with whales: The probability of lethal injury based on vessel speed. Mar Mammal Sci *23*, 144-156.

Vanderlaan, A.S.M., Taggart, C.T., Serdynska, A.R., Kenney, R.D., and Brown, M.W. (2008). Reducing the risk of lethal encounters: Vessels and right whales in the Bay of Fundy and on the Scotian Shelf. Endanger Species Res *4*, 1.

Wainwright, T.C., and Weitkamp, L.A. (2013). Effects of Climate Change on Oregon Coast Coho Salmon: Habitat and Life-Cycle Interactions. Northwest Sci *87*, 219-242.

Watkins, W.A. (1986). Whale Reactions to Human Activities in Cape-Cod Waters. Mar Mammal Sci *2*, 11.

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

Weston Solutions (2006). Jimmycomelately Piling Removal Monitoring Project (Port Gamble, WA: Weston Solutions).

Whitehead, H. (2009). Sperm whale, Physeter macrocephalus. In Encyclopedia of Marine Mammals W.F. Perrin, B. Wursig, and J.G.M. Thewissen, eds. (Cambridge, MA: Academic Press), pp. 1091–1097.

Whitehead, H., Coakes, A., Jaquet, N., and Lusseau, S. (2008). Movements of sperm whales in the tropical Pacific. Mar Ecol Prog Ser *361*, 291-300.

Williams, R., Bain, D.E., Ford, J.K.B., and Trites, A.W. (2002). Behavioural responses of male killer whales to a 'leapfrogging' vessel. Journal of Cetacean Research and Management *4*, 5.

Williams, R., Thomas, L., and . (2007). Distribution and abundance of marine mammals in the coastal waters of British Columbia, Canada. Journal of Cetacean Research and Management, 13.

Winder, M., and Schindler, D.E. (2004). Climate change uncouples trophic interactions in an aquatic ecosystem. Ecology *85*, 2100-2106.

Wursig, B., Lynn, S.K., Jefferson, T.A., and Mullin, K.D. (1998). Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquatic Mammals *24*, 9.

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

6. APPENDICES

Appendix 1

Unconfined Bubble Curtain Specifications:
1. General - An unconfined bubble curtain is composed of an air compressor(s), supply lines to deliver the air, distribution manifolds or headers, perforated aeration pipe, and a frame. The frame facilitates transport and placement of the system, keeps the aeration pipes stable, and provides ballast to counteract the buoyancy of the aeration pipes in operation.

2. The aeration pipe system shall consist of multiple layers of perforated pipe rings, stacked vertically in accordance with the following:

Water depth (m)	Number of Layers
0 to less than 5	2
5 to less than 10	4
10 to less than 15	7
15 to less than 20	10
20 to less than 25	13

3. The pipes in all layers shall be arranged in a geometric pattern which shall allow for the pile being driven to be completely enclosed by bubbles for the full depth of the water column and with a radial dimension such that the rings are no more than 0.5 meters from the outside surface of the pile.

4. The lowest layer of perforated aeration pipe shall be designed to ensure contact with the substrate without burial and shall accommodate sloped conditions.
5. Air holes shall be 1.6 mm (1/16-inch) in diameter and shall be spaced approximately 20 mm (3/4 inch) apart. Air holes with this size and spacing shall be placed in four adjacent rows along the pipe to provide uniform bubble flux.

6. The system shall provide a bubble flux of 3.0 cubic meters per minute per linear meter of pipe in each layer (32.91 cubic feet per minute per linear foot of pipe in each layer). The total volume of air per layer is the product of the bubble flux and the circumference of the ring:

$V_t = 3.0\ m^3/min/m$ * Circum of the aeration ring in m
or
$V_t = 32.91\ ft^3/min/ft$ * Circum of the aeration ring in ft

7. Meters shall be provided as follows:
   a. Pressure meters shall be installed at all inlets to aeration pipelines and at points of lowest pressure in each branch of the aeration pipeline.
   b. Flow meters shall be installed in the main line at each compressor and at each branch of the aeration pipelines at each inlet. In applications where the feed line from the compressor is continuous from the compressor to the aeration pipe inlet the flow meter at the compressor can be eliminated.

c. Flow meters shall be installed according to the manufactures recommendation based on either laminar flow or non-laminar flow.

Performance: In Washington, unconfined bubble curtains have achieved a maximum of 17 dB attenuation and more typically range between 9 to 12 dB. Should hydroacoustic monitoring reveal that an unconfined bubble curtain is not achieving (to be determined based on site and project specific considerations), the NMFS and/or USFWS staff person on the project should be contacted immediately regarding modifications to the proposed action. Should attenuation rates continue at less than (to be determined based on site and project specific considerations), reinitiation of consultation may be necessary.

Confined Bubble Curtain Specifications:

1. General - A confined bubble curtain is composed of an air compressor(s), supply lines to deliver the air, distribution manifolds or headers, perforated aeration pipe(s), and a means of confining the bubbles.

a. The confinement (e.g. fabric, plastic or metal sleeve, or equivalent) shall extend from the substrate to a sufficient elevation above the maximum water level expected during pile installation such that when the air delivery system is adjusted properly, the bubble curtain does not act as a water pump (i.e., little or no water should be pumped out of the top of the confinement system).

b. The confinement shall contain resilient pile guides that prevent the pile and the confinement from coming into contact with each other and do not transmit vibrations to the confinement sleeve and into the water column (e.g. rubber spacers, air filled cushions).

2. In water less than 15 meters deep, the system shall have a single aeration ring at the substrate level. In waters greater than 15 meters deep, the system shall have at least two rings, one at the substrate level and the other at mid-depth.

3. The lowest layer of perforated aeration pipe shall be designed to ensure contact with the substrate without sinking into the substrate and shall accommodate for sloped conditions.

4. Air holes shall be 1.6 mm (1/16-inch) in diameter and shall be spaced approximately 20 mm (3/4 inch) apart. Air holes with this size and spacing shall be placed in four adjacent rows along the pipe to provide uniform bubble flux.

5. The system shall provide a bubble flux of 3.0 cubic meters per minute per linear meter of pipe in each layer (32.91 cubic feet per minute per linear foot of pipe in each layer). The total volume of air per layer is the product of the bubble flux and the circumference of the ring:

$V_t = 3.0\ m^3/min/m$ * Circ of the aeration ring in m

or

$V_t = 32.91\ ft^3/min/ft$ * Circ of the aeration ring in ft

6. Meters shall be provided as follows:

   a. Pressure meters shall be installed at all inlets to aeration pipelines and at points of lowest pressure in each branch of the aeration pipeline.

   b. Flow meters shall be installed in the main line at each compressor and at each branch of the aeration pipelines at each inlet. In applications where the feed line from the compressor is continuous from the compressor to the aeration pipe inlet the flow meter at the compressor can be eliminated.

c. Flow meters shall be installed according to the manufactures recommendation based on either laminar flow or non-laminar flow.

Performance: In Washington, few projects have used confined bubble curtains so there is a lack of data. Based on performance in other locations, the effectiveness of a confined system could range from 9 dB to 30 dB. Should hydroacoustic monitoring reveal that a confined bubble curtain is not achieving (to be determined based on site and project specific considerations), the NMFS and/or USFWS staff person on the project should be contacted immediately regarding modifications to the proposed action. Should attenuation rates continue at less than (to be determined based on site and project specific considerations), re-initiation of consultation may be necessary.

Appendix 2

Estimation of whale and leatherback sea turtle collisions

We estimated the density distribution along an east to west line across the EEZ (N(x), whales per 100 square kilometers per mile) of humpback whales, fin whales and blue whales in the EEZ off of the coast of Grays Harbor from Figure 3 in (Rockwood et al., 2017). We converted this density to whales per square mile per mile by dividing it by 38.6 square miles per 100 square kilometers.
(Koopman, 1956) assumes that targets (in this case, whales and turtles) are moving at a constant speed u in a random direction φ with respect to the OGV. Whales can swim up to 30 miles per hour, and cruise at 12 miles per hour. We set the velocity u at 2 miles per hour for humpback and fin whales (Lagerquist et al., 2008; Schorr et al., 2010) and 1 miles per hour for turtles (higher velocities increase the number of encounters and mortalities). We set the speed of the OGV v at 15 miles per hour. We set the width of the OGV to 60 meters so the radius R of the encounter circle is 30 meters or 0.02 miles.

The EEZ is 200 miles wide. OGVs at 15 miles per hour travel one mile in 0.067 hours. The BA proposes up to 220 OGVs per year. Fin whales are in the EEZ off of the coast of Washington all year and are exposed to all 220 potash OGVs. Humpback whales and blue whales are only in the EEZ off the coast of Washington for six months of the year and are exposed to 110 potash OGVs.
The frame of reference moves with the potash OGV at 15 miles per hour. The relative velocity of the whale $\boldsymbol{w}$ is the vector sum of the OGV velocity and the actual whale velocity. From the law of cosines, the magnitude of **w** is:

$$w = \sqrt{u^2 + v^2 - 2uvcos\varphi}¶$$

Since the direction of each whale is random, the number of whales in each mile swimming in a direction between track angles φ and φ+dφ is $\frac{N(x)d\varphi}{2\pi}$. For any whale direction φ, the only whales that can enter the OGV encounter circle per hour are in the ocean area $2Rw$ so the number of whales between φ and φ+dφ that can enter the encounter circle per mile is $2TRwN(x)\frac{d\varphi}{2\pi}$ where

T is the time it takes for the OGV to travel one mile (.067 hours). The total number of whales that can enter the encounter circle per hour is:

$$N_o = \frac{R}{\pi}\int_0^{200} TN(x)\int_0^{2\pi} wd\varphi dx$$

Although the integral $\int_0^{2\pi} wd\varphi$ has an infinite series solution, we evaluated it in an Excel spreadsheet with $\Delta\varphi = \frac{2\pi}{32}$ and then summed $TN(x)\int_0^{2\pi} wd\varphi$ in one mile steps over the 200 mile width of the EEZ.