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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-2019-03469

December 20, 2019

Timothy Konnert
Division of Hydropower Licensing
Federal Energy Regulatory Commission
Washington D.C. 20426

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, Letter of Concurrence and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the PacWave South Wave Energy Test Site (FERC No.: 14616), Newport, Oregon (Pacific Ocean HUC# 171002050800)

Dear Mr. Konnert:

Thank you for your letter of September 17, 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 Federal Energy Regulatory Commission's (FERC) issuance of a 25-year operating license to the Oregon State University's (OSU) PacWave South Wave Energy. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).

In this opinion, we concluded that the proposed action is not likely to jeopardize the continued existence of following species:

- Chinook Salmon (*Oncorhynchus tshawytscha*) evolutionarily significant units (ESU)
    - Lower Columbia River
    - Upper Columbia River spring-run
    - Upper Willamette River spring-run
    - Snake River spring/summer-run
    - Snake River fall-run
    - California Coastal spring-run
    - Sacramento River winter-run
    - Central Valley spring-run
- Coho salmon (*O. kisutch*) ESU's
    - Lower Columbia River
    - Oregon Coast (OC)
    - Southern Oregon Northern California Coast
    - Central California Coast
- Southern DPS North American green sturgeon (*Acipenser medirostris*)
- Southern DPS Pacific eulachon (*Thaleichthys pacificus*)

We also concur with FERC's determination that the proposed action is not likely to adversely affect the following species or designated critical habitats (if designated):

- Steelhead (*O. mykiss*) distinct population segments (DPS's)
    - Lower Columbia River
    - Middle Columbia River
    - Upper Columbia River
    - Upper Columbia River
    - Upper Willamette River
    - Snake River Basin
    - Northern California
    - Central California Coastal
    - California Central Valley
    - South-Central California Coast
- Snake River sockeye salmon (*O. nerka*)
- Columbia River chum salmon (*O. keta*)
- Marine mammals:
    - Blue whales
    - Fin whales
    - Humpback whales
    - Sei whales
    - Southern Resident killer whales
    - Sperm whales
    - Western North Pacific Gray whales
- Marine turtles:
    - Green sea turtles
    - Olive Ridley sea turtles
    - Loggerhead sea turtles
    - Leatherback sea turtles
- Designated critical habitat for green sturgeon
- Designated critical habitat for OC coho salmon
- Designated critical habitat for leatherback sea turtles
- Designated critical habitat for Southern Resident Killer Whales and Humpback Whales

As required by section 7 of the ESA, we are providing an incidental take statement (ITS) with the opinion. The ITS describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this program. The ITS also sets forth nondiscretionary terms and conditions, including reporting requirements, that the Federal action agencies must comply with to carry out the reasonable and prudent measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of the listed species considered in this opinion.

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 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, including five conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects on EFH.

Section 305(b)(4)(B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving these recommendations. If the response is inconsistent with the EFH conservation recommendations, the action agency must explain why the recommendations will not be followed, including the scientific justification for any disagreements over the effects of the program and the recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, we established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we request that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

Please contact Jeff Young, fish biologist in the Oregon Coast Branch of the Oregon Washington Coastal Area Office at 541.957.3389 or jeff.young@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: James Hastreiter (FERC)
Delia Kelly (ODFW)

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

Issuance of a Federal Energy Regulatory Commission License to Oregon State University for the PacWave South Wave Energy Test Site
(FERC No.: 14616), Newport, Oregon

NMFS Consultation Number: WCRO-2019-03469

Action Agency: FERC

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Chinook Salmon (*Oncorhynchus tshawytscha*)					
Lower Columbia River	Threatened	Yes	No	N/A	N/A
Upper Columbia River	Threatened	Yes	No	N/A	N/A
Upper Willamette River	Threatened	Yes	No	N/A	N/A
Snake River	Threatened	Yes	No	N/A	N/A
Snake River	Threatened	Yes	No	N/A	N/A
California Coastal	Threatened	Yes	No	N/A	N/A
Sacramento River	Threatened	Yes	No	N/A	N/A
Central Valley	Threatened	Yes	No	N/A	N/A
Coho Salmon (*O. kisutch*)					
Lower Columbia River	Threatened	Yes	No	N/A	N/A
Oregon Coast	Threatened	Yes	No	No	No
Southern Oregon Northern California Coast	Threatened	Yes	No	N/A	N/A
Central California Coast	Threatened	Yes	No	N/A	N/A
Steelhead (*O. mykiss*)					
Lower Columbia River	Threatened	No	No	N/A	N/A
Middle Columbia River	Threatened	No	No	N/A	N/A
Upper Columbia River	Threatened	No	No	N/A	N/A
Upper Willamette River	Threatened	No	No	N/A	N/A
Snake River Basin	Threatened	No	No	N/A	N/A
Northern California	Threatened	No	No	N/A	N/A
Central California Coastal	Threatened	No	No	N/A	N/A
California Central Valley	Threatened	No	No	N/A	N/A
South-Central California Coast	Threatened	No	No	N/A	N/A
North American green sturgeon (*Acipenser medirostris*)					
Southern DPS	Threatened	Yes	No	No	No
Pacific Eulachon (*Thaleichthys pacificus*)					
Southern DPS	Threatened	Yes	No	N/A	N/A
Killer whale (*Orcinus orca*)					
Southern Resident DPS	Endangered	No	No	No	No

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Humpback whale (*Megaptera novaengilae*)					
Mexico DPS	Threatened	No	No	No	No
Central America DPS	Endangered	No	No	No	No
Blue whale (*Balaenoptera musculus*)	Endangered	No	No	N/A	N/A
Fin whale (*Balaenoptera physalus*)	Endangered	No	No	N/A	N/A
Sei whale (*Balaenoptera borealis*)	Endangered	No	No	N/A	N/A
Sperm whale (*Physeter catodon*)	Endangered	No	No	N/A	N/A
Western North Pacific gray whale (*Eschrichtius robustus*)	Endangered	No	No	N/A	N/A
Leatherback turtle (*Dermochelys coriacea*)	Endangered	No	No	No	No
Green turtle (*Chelonia mydas*)	Threatened	No	No	No	No
Northern DPS Loggerhead turtle (*Caretta caretta*)	Endangered	No	No	N/A	N/A
Olive ridley turtle (*Lepidochelys olivacea*)	Endangered	No	No	N/A	N/A

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
Pacific Coast groundfish	Yes	Yes
Coastal pelagic species	Yes	Yes
Highly migratory 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: December 20, 2019

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1. INTRODUCTION

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

1.1 Background

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

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

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

The Federal Energy Regulatory Commission (FERC), under the authority of the Federal Power Act (FPA), may issue licenses for terms of up to 50 years for the construction, operation, and maintenance of non-federal hydroelectric projects. Oregon State University (OSU) is requesting a 25-year license to construct and operate the PacWave South Wave Energy Test Site (proposed action). Under section 7 of the ESA, federal action agencies are required to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species. Issuance of a license for the construction and operation of PacWave South requires FERC to consult with NMFS on the effects of the proposed action on ESA-listed species and their designated critical habitat.

1.2 Consultation History

In January 2013, OSU formed a collaborative workgroup (CWG) comprised of NMFS, state and Federal agencies, and non-governmental organizations representing stakeholders to identify regulatory and environmental concerns, including potential effects on ESA-listed species and critical habitats. The CWG met quarterly to focus on how the proposed action would meet regulatory standards and undertake approval processes under the FPA and other Federal and state approvals (including ESA and MSA). The CWG developed a collaborative process through the FPA's alternative licensing process to work through regulatory processes including ESA and MSA. In a notice dated May 27, 2014, FERC designated OSU as its non-federal representative for carrying out consultation pursuant to section 7 of the ESA.

Between January 2013 and February 2019, we met with the CWG and stakeholders 31 times to discuss the proposed action and provide assistance in developing CWG products that OSU filed with the final license application to FERC. The CWG products include site characterization studies; resource issues OSU should analyze in the preliminary draft environmental assessment (PDEA); monitoring plans; protection, mitigation, and enhancement measures; and the adaptive management framework. Additional the CWG process, on multiple occasions we provided comments to OSU on draft documents or solicitation for comments from FERC, which we summarized in the following list.

- On June 5, 2014, OSU distributed a scoping document to identify issues and alternatives of the proposed action. We provided comments in writing to OSU on August 4, 2014.
- The OSU provided a PDEA for review on March 24, 2015. We provided comments on the draft document to OSU on May 22, 2015, which included a species list in response to a request from OSU to identify species under our jurisdiction that might occur in the project area. Our letter identified 35 ESA-listed species and critical habitats for 32 of those species (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
Upper Columbia River spring-run	E 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	ESA section 9 applies
Snake River spring/summer-run	T 6/28/05; 70 FR 37160	10/25/99; 64 FR 57399	6/28/05; 70 FR 37160
Snake River fall run	T 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	6/28/05; 70 FR 37160
California coastal spring-run	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Sacramento River winter-run	E 1/04/94; 59 FR 440	6/16/93; 58 FR 33212	6/28/05; 70 FR 37160
Central Valley spring-run	T 4/14/14; 79 FR 20802	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
Coho salmon (*O. kisutch*)			
Lower Columbia River	T 6/28/05; 70 FR 37160	2/24/16; 81 FR 9252	6/28/05; 70 FR 37160
Oregon Coast	T 6/20/11; 76 FR 35755	2/11/08; 73 FR 7816	2/11/08; 73 FR 7816
Southern OR/Northern CA Coast	T 6/28/05; 70 FR 37160	5/5/99; 64 FR 24049	6/28/05; 70 FR 37160
Central California Coast	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Sockeye salmon (*O. nerka*)			
Snake River	E 8/15/11; 70 FR 37160	12/28/93; 58 FR 68543	ESA section 9 applies
Steelhead (*O. mykiss*)			
Lower Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Middle Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	2/1/06; 71 FR 5178
Snake River Basin	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Northern California	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Central California Coastal	T 4/14/14; 79 FR 20802	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160

Species	Listing Status	Critical Habitat	Protective Regulations
California Central Valley	T 4/14/14; 79 FR 20802	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
South-Central California Coast	T 4/14/14; 79 FR 20802	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
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
Eulachon (*Thaleichthys pacificus*)			
Southern DPS	T 3/18/10; 75 FR 13012	10/20/11; 76 FR 65324	Not applicable
Killer whale (*Orcinus orca*)			
Southern Resident DPS	E 11/18/05; 70 FR 69903	11/29/06; 71 FR 69054	ESA section 9 applies
Humpback Whale			
Mexico DPS	T 9/8/16; 81 FR 62259	Not applicable	ESA section 9 applies
Central America DPS	E 9/8/16; 81 FR 62259	Not applicable	ESA section 9 applies
Blue Whale (*Balaenoptera musculus*)	E 12/02/70; 35 FR 18319	Not applicable	ESA section 9 applies
Sei Whale (*Balaenoptera borealis*)	E 12/02/70; 35 FR 18319	Not Applicable	ESA section 9 applies
Sperm whale (*Physeter catodon*)	E 12/02/70	Not Applicable	ESA section 9 applies
Leatherback turtle (*Dermochelys coriacea*)	E 6/02/70 ; 39 FR 19320	1/26/12; 77 FR 4170	ESA section 9 applies
Green turtle (*Chelonia mydas*)	ET 7/28/78 43 FR 32800	9/02/98; 63 FR 46693	ESA section 9 applies
Olive ridley turtle (*Lepidochelys olivacea*)	ET 7/28/78 43 FR 32800	Not Applicable	ESA section 9 applies
Northern DPS Loggerhead turtle (*Caretta caretta*)	T 7/28/78 43 FR 32800	Not Applicable	7/28/78; 43 FR 32800

We also identified the action area as designated EFH under the MSA for Pacific salmon, Pacific Coast groundfish, coastal pelagic species, and highly migratory species.

- On January 7, 2016, OSU submitted their draft biological assessment (BA) to NMFS for review. We met with OSU on February 2, 2016 to discuss our comments and provided additional comments on February 3, 2016.
- On April 20, 2018, FERC issued a notice requesting preliminary terms, conditions, and recommendations on the draft PDEA (including the BA) and comments on OSU's draft license application. We responded on July 18, 2018 with filing our preliminary comments and recommended terms and conditions on the PDEA and draft license application with FERC. We followed up with additional comments on September 10, 2018.
- On August 19 and 20, 2019, we met with OSU's consultant to provide additional comments on the BA provided in the final license application to FERC filed on May 31, 2019.

On September 17, 2019 we received a letter and BA requesting initiation of formal consultation under section 7 of the ESA for the effects of FERC's issuance of a 25-year license to OSU for the proposed action. In their request, FERC determined that the proposed action was not likely to adversely affect (NLAA):

- Snake River sockeye salmon (*Oncorhynchus nerka*)
- Columbia River chum salmon (*O. keta*)
- Steelhead (*O. mykiss*) distinct population segments (DPS):
    - Lower Columbia River (LCR)

- Middle Columbia River (MCR)
    - Upper Columbia River (UCR)
    - Upper Willamette River (UWR)
    - Snake River (SR)
    - South-Central California Coast (SCCC)
    - Central California Coast (CCC)
    - Northern California (NC)
    - California Central Valley (CCV)
- Southern Resident killer whales (*Orcinus orca*)
- Blue whales (*Balaenoptera musculus*)
- Fin whales (*Balaenoptera physalus*)
- Humpback whales (*Megaptera novaengliae*)
    - Mexico DPS
    - Central America DPS
- Sei whales (*Balaenoptera borealis*)
- Sperm whales (*Phseter macrocephalus*)
- Western North Pacific gray whales (*Eschrichtius robustus*)
- Green sea turtles (*Chelonia mydas*)
- Olive Ridley sea turtles (*Lepidochelys olivacae*)
- Loggerhead sea turtles (*Caretta caretta*)
- Leatherback sea turtles (*Dermochelys coriacea*)

The FERC also determined that the proposed action was likely to adversely affect the following species:

- Chinook salmon (*O. tshawytscha*) ESUs:
    - Lower Columbia River
    - Upper Columbia River spring-run
    - Upper Willamette River spring-run
    - Snake River spring/summer-run
    - Snake River fall-run
    - California Coastal (CC) spring-run
    - Sacramento River winter-run
    - Central Valley (CV) spring-run
- Coho salmon (*O. kisutch*) ESUs
    - Lower Columbia River
    - Oregon Coast (OC)
    - Southern Oregon Northern California Coast (SONCC)
    - Central California Coast
    - Southern DPS North American green sturgeon (*Acipenser medirostris*) (hereafter referred to as ‘green sturgeon’)
    - Southern DPS Pacific eulachon (*Thaleichthys pacificus*) (here after referred to as ‘eulachon’)

The FERC also determined that the proposed action was NLAA critical habitat designated for green sturgeon and leatherback sea turtles. The FERC did not analyze effects on designated critical habitat, for which Yaquina Bay is designated for OC coho salmon. Therefore, we include designated critical habitat for OC coho salmon, which the proposed action may affect in our NLAA section of this opinion.

In their EFH assessment, FERC determined that the proposed action would not adversely affect EFH for Pacific salmon, Pacific Coast groundfish, coastal pelagic species, and highly migratory species. Upon receipt of the consultation request letter and the BA, we initiated formal consultation on September 17, 2019.

During the CWG process and development of environmental documents for environmental reviews including ESA and MSA, OSU reviewed approximately 400 scientific references listed in Section 8.0 of the BA. These references describe the use and distribution of ESA-listed species and EFH in the action area, describe the environmental characteristics relative to the habitat needs of ESA-listed species and EFH in the action area, and support the analysis of effects developed by OSU in the BA. Because of our close involvement during the CWG process and development of these documents, we believe that this information represents the best available scientific and commercial information relative to the proposed action and its effects on marine habitat and ESA-listed species.

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). For EFH, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910). The proposed action is the FERC's issuance of a 25-year license to OSU for construction and operation of the PacWave South Wave Energy Test Site (PacWave South). The purpose of the proposed action is to conduct research and testing needed to advance the development of marine renewable energy technologies that will contribute to reduce our reliance on non-renewable energy resources. The proposed action will allow OSU to work with developers to conduct full-scale, open-ocean testing of wave energy converters (WEC) in support of this need.

PacWave South would occupy approximately 2 square nautical miles (nm^2) in Federal waters about 6 nautical miles (nm) off the coast of Newport, Oregon (Figure 1). PacWave South would consist of four test berths that would support the testing of up to 20 WECs including their associated moorings, anchors, subsea connectors and hubs, subsea power and communication cables, and utility connection and monitoring facilities (Figure 2) and transfer power to a grid connection point with the Central Lincoln People's Utility District (CLPUD) in Lincoln County, Oregon. In addition, the proposed action includes protection, enhancement and mitigation measures; monitoring plans; and adaptive management framework to gather information about environmental effects of full scale WEC testing and power transfer on marine habitat and species, including ESA- listed species addressed in this opinion.

Risk to the marine environment and marine organisms from wave energy generation is not well known. Through informal consultation, NOAA and OSU have identified poorly understood environmental effects needing to be addressed to allow testing wave energy devices in the ocean.

There is limited scientific information relative to the effects of installation and operation of WECs and their infrastructure on marine species and habitat and the proposed monitoring and adaptive management framework will contribute to addressing those data gaps.

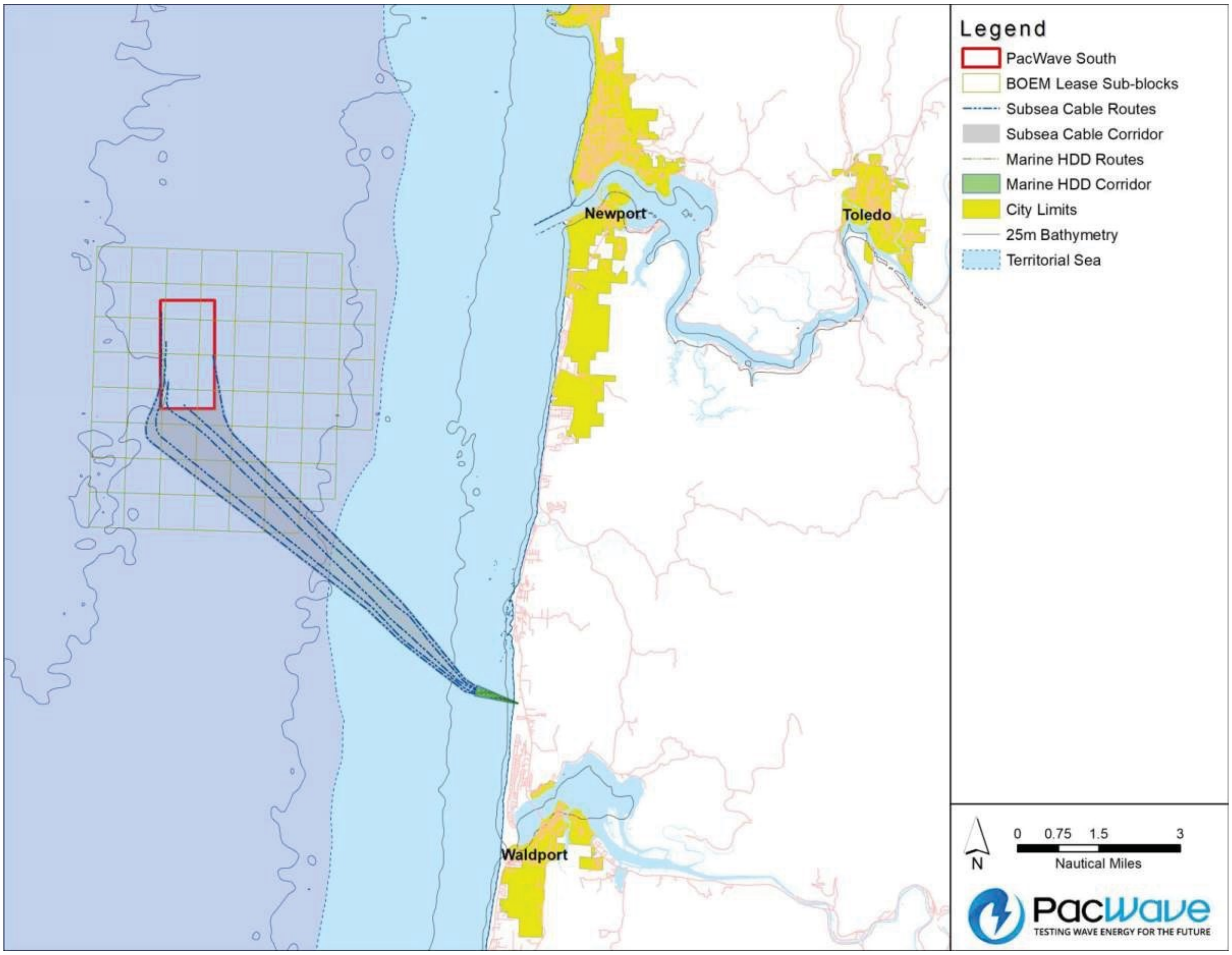

Figure 1. Location of OSU's proposed PacWave South wave energy PacWave South.

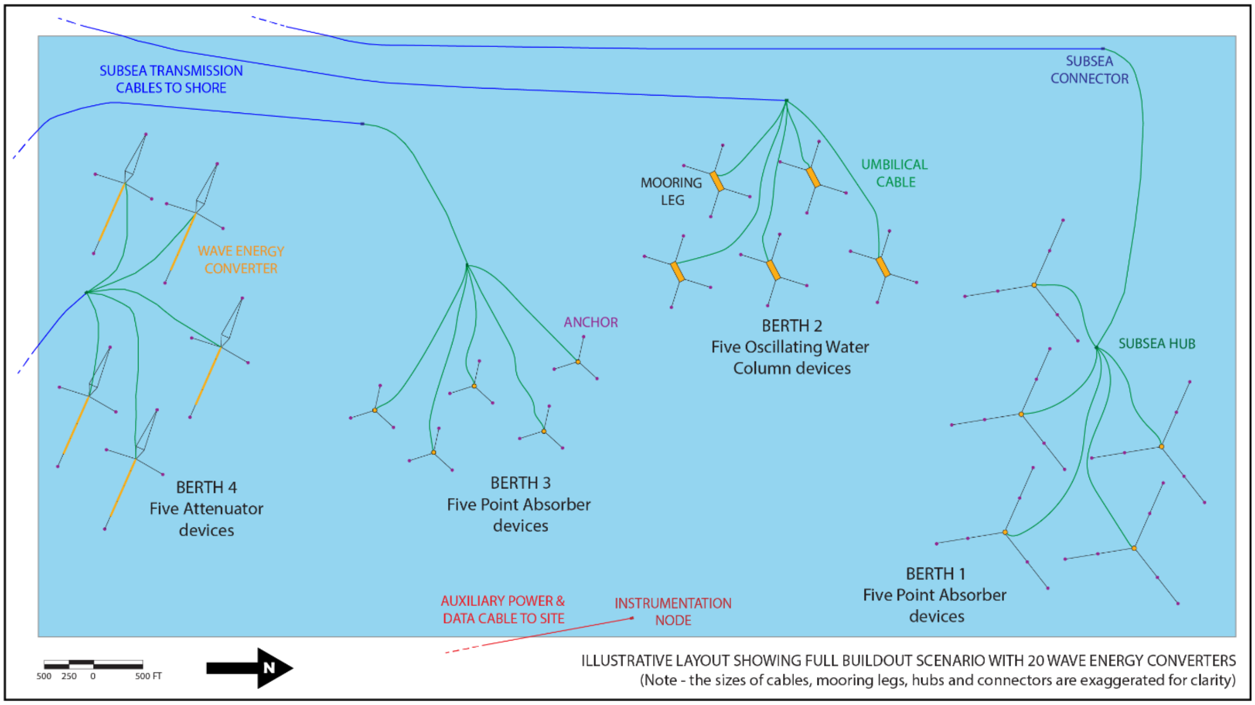

Figure 2. Conceptual overview of PacWave South after construction.

<u>1.3.1 Wave Energy Converters</u>

At PacWave South, OSU will test WECs singly or in arrays (as shown in Figure 2) of up to 20 WECs at one time. The number of WECs deployed at PacWave South will vary throughout the 25-year license term. During the initial years (i.e., the first 5 years) of operation, OSU would likely deploy fewer WECs (e.g., one at each berth). The average WEC deployment timeframes are likely to range from 1 to 5 years with 5-year deployment periods most likely during the initial stage the proposed action. The types of WECs OSU will test include the following:

- <u>Point absorbers</u>: Floating or submerged structures with components at or near the ocean surface that capture energy from the motion of waves, which drives a generator. Point absorbers might be partly or fully submerged.
- <u>Attenuators</u>: Structures that respond to the curvature of the waves rather than the wave height. These WECs may consist of a series of semi-submerged sections linked by hinged joints. As waves pass along the length of the WEC, the sections move relative to one another. The WEC captures this wave-induced motion and is used to drive a generator.
- <u>Oscillating water columns (OWC)</u>: Structures that are partially submerged and hollow (i.e., open to the sea below the water line), enclosing a column of air above the water. Waves cause the water under the device to rise and fall, which in turn compresses and decompresses the air column above. This action forces air in and out through a turbine, which usually has the ability to rotate regardless of the direction of the airflow (i.e., a bi-directional turbine).

- Hybrids: These WEC types use two or more of the above-listed technology types. For example, some WECs that are the relative size and shape of a point absorber may generate power through movements that resemble an attenuator. Another example is a class of WECs with moving masses that are internal to a hull with no external moving parts exposed to the ocean. An example of this technology is the Vertical Axis Pendulum, which consists of a structural hull that contains all moving parts; inside, a pendulum rotates and converts the kinetic energy of the ocean waves into electrical power.

The OSU would deploy the WECs from 50 to 200 meters or more apart from each other in a berth. The PacWave South would have a maximum installed capacity of 20 megawatts (range 750 kilowatts to 20 megawatts). The characterization of power and generation produced by the PacWave South would similarly vary with time, including the average capacity factor, availability, and value of installed capacity.

1.3.2 Ocean Equipment Storage and Installation

Fabrication of proposed action's components (i.e., WECS, subsea power cables, anchor and mooring systems, navigational buoys, and monitoring equipment) will occur at land-based facilities and transported to the staging area. The Port of Newport, Oregon will be the main staging area, but equipment staging may include Port of Toledo or other nearby ports. Once at the staging area, OSU will moor one or more WECs at a time dockside in Newport or Toledo prior to transport to PacWave South. To transport and install equipment to PacWave South, OSU would use research vessels, larger specialized work vessels, tugs, barges, and smaller watercraft.

Anchor, mooring, and WEC installation and removal

Installation of anchors and mooring systems would occur prior to WEC deployment. Anchoring WECs will require anchor and mooring lines and recovery lines for anchor and mooring system removal. The OSU will install anchors using vessel(s) with adequate assets and load-handling capabilities. Smaller anchors and mooring systems installed by OSU will use a vessel such as their 82-feet, 510-horsepower *R/V Pacific Storm*. Larger anchors or mooring systems of higher complexity would likely require tugboats and multi-purpose, offshore work vessels. The OSU previously chartered the 159-feet, 486-ton, *NRC Quest* for operations at PacWave North (NMFS No.: NWR-2012-0253). While the number of vessels needed for anchor installation or removal would depend on the number and size of anchors installed, these activities typically require two to four vessels.

Anchor installation varies with the anchor type used to anchor the WEC and its mooring system. Types of anchors OSU will use include drag anchors, suction piles, and gravity anchors. Drag anchor installation will occur by positioning the anchor orientation at the seafloor and then tensioning the mooring line using a vessel. During the tensioning, the flukes penetrate the seafloor, and as tension increases, the anchor embeds itself to deeper depths. For drag embedment anchors, a second vessel would likely be required to install the anchors.

Suction piles are an anchor type that use suction to penetrate the seafloor, which provides a stable anchoring point. For suction anchor deployment, OSU will use a floating crane to lift and lower the pile to the sea floor. Often, suction equipment, a remotely operated vehicle, control cabin, and launch cradle are also needed. Sound and Sea Technology (2009) best describes the installation of suction piles:

> "Initial penetration of the suction caisson into the seabed occurs due to its own weight. Subsequent penetration is caused by "suction" created by pumping water out from the inside of the pile. The pile seals with the seafloor and then a pump pulls water out of the upper end of the enclosed volume. This produces suction, forcing the bucket into the seabed. In clays, the pressure is sufficient to bring the suction pile to a substantial depth. In sands, water inflow reduces the effective stresses in the sand near the pile rim, allowing the pile to penetrate the seafloor. Once installed to sufficient depth, the pumps are removed and the valves are sealed, with the sand quickly regaining its bearing capacity. Suction piles can easily be removed by reattaching the pumps and pumping water back into the bucket cavity, forcing it out of the seabed (Sound and Sea Technology 2009)."

Gravity anchors are heavy objects placed on the seafloor that resist vertical and lateral loading. They are typically made of concrete, steel, or both, and are placed directly on the seafloor (Sound & Sea Technology 2009). The OSU will install gravity anchors by lowering them to the seafloor using a boat- or barge-mounted crane or winch system.

Generally, OSU will deploy WECs by towing or barging them to PacWave South and then attaching them to the anchoring and mooring system (Table 2). In most cases, OSU will use two or three vessels to deploy a WEC, although for some WECs they will use a single vessel. Examples of vessels that OSU may use for WEC deployment include OSU's *R/V Pacific Storm* and tug boats such as the 38-foot, 465-hp *Thea Knutson*, operated by Wiggins Tow & Barge. Once OSU attaches the WEC to its mooring system, they will attach an umbilical cable to connect it to the subsea connector, possibly through a hub. Connecting to the subsea connector would likely require that OSU winch the connector up onto the deck of a vessel with sufficient lift capacity. Therefore, if a test berth had five WECs, there would be five umbilical cables connecting to the hub, and the hub connected to the subsea connector.

Table 2. The OSU's proposed WEC types and their associated mooring and anchoring configurations and materials for deployment. Approximated water depth for each type is 250 feet.

Mooring configuration and materials	**Point Absorber**	**Point Absorber**	**Attenuator**	**Oscillating Water Column**
Configuration	Single leg	Multi-leg catenary	Multi-leg catenary	Multi-leg taut
Line length per leg	~300 feet	~600 feet	~400 feet	~350 feet
Line material	Chain/wire rope	Chain/synthetic rope	Chain/synthetic rope	Wire/synthetic rope
Number of legs	1	3	4	4
Number of anchors/leg	1	2	1	1

Mooring configuration and materials	Point Absorber	Point Absorber	Attenuator	Oscillating Water Column
Anchor type (Qty.)	Suction (1)	Drag (3); Gravity (3)	Drag (3), (1)	Gravity (4)
Anchor size (feet)	D(6) x H(5)	Drag: L(12) x W(13) x H(8) Gravity: L(8) x W(6) x H(4)	3 – L(16) x W(18) x H(11) 1 – L(22) x W(24) x H(15)	D(34) x H(25)
Anchor material	Steel	Drag (steel); Gravity (steel and concrete)	Steel	Steel and concrete

D = Diameter; H = Height; L = Length; W = Width

Installation of an anchor and mooring system could take up to 7 days and an additional 1 to 2 days to connect the WEC to the mooring. For an array of WECs (multiple WECs at one berth) this process would need to be repeated for each device. This time would not necessarily be continuous as weather could delay completion; however, actual at-sea activities would unlikely take more than nine days to install one mooring system and WEC. Although it is uncertain, it is possible that WEC and mooring system turnover could affect two berths per year (OSU 2019).

Anchor deployment periods will align with WEC test durations, so they will likely be in place for 3-5 years at a time. Anchors could be in place up to 25 years if the anchors will be used for multiple WEC tests throughout the 25-year license period. The OSU may install marker buoys between WECs if anchors are not removed at the same time as the WECs. Although anchor deployment and recovery would occur periodically over the duration of the license period, OSU will limit the frequency of anchor deployment and recovery to the extent possible. Additionally, WEC operation and testing will occur for multi-year test periods. Thus, it is unlikely that OSU would adjust or replace anchor systems during a WEC test due to the high costs associated with installing and removing them. Finally, OSU would aim to reuse anchors wherever possible.

Retrieval of anchors would occur by winching the anchor up to the surface and onto a vessel using the mooring system itself or a recovery line. The OSU may install recovery lines at the time of deployment and activate them by acoustic releases when retrieval is underway. The OSU may also attach recovery lines to the anchor at the time of recovery using a remotely operated underwater vehicle (ROV). The OSU will remove embedment anchors by pulling the mooring line in a perpendicular direction to lift the anchor out of the sediment in the opposite direction in which it was installed. For removal of suction anchors, OSU will pump water into the anchor chamber, creating positive pressure, and pull up the mooring line raising the caisson from the sediment. Once the anchor is free of the seafloor, OSU will raise the anchor to the deck of the vessel and transport it to shore. For removal of gravity anchors, the anchor will be raised from the seafloor and hoisted on board a vessel, or remain suspended from the vessel and be transported to a port or sheltered location on a route chosen to ensure it did not come in contact with the sea floor during transit. A shore-side crane or an inshore crane vessel would then recover the anchor from the vessel.

Subsea cable installation

The OSU will install one subsea cable for each test berth at PacWave South (four total) and an auxiliary cable, which will allow increased monitoring capabilities at PacWave South. The subsea transmission cables would transmit power back to shore and allow for the monitoring and control of WECs via fiber optic elements incorporated into the transmission cables themselves. The OSU anticipates that the subsea transmission cables would be three-conductor, alternating current (AC) cables with a rated voltage of 35 kilovolts (kV). At present, OSU is considering cables with copper conductors of 70-square millimeters (mm^2) or 50 mm^2, which are slightly less than 4 inches in diameter and weigh between 7 and 8 pounds per foot. All the cables would have standard industrial shielding and armoring (e.g., galvanized steel wires). Electric fields from energized AC cable conductors are shielded effectively by metallic sheathing and armoring. The subsea cables will run from PacWave South to a proposed onshore connection facility.

The subsea cable route (Figure 1) would be about 8.3 nautical miles long, of which about 3.7 nautical miles will be on the Outer Continental Shelf, 4.0 nautical miles in the Territorial Sea and 0.6 nautical miles of horizontally directionally drilled (HDD) conduit in the nearshore zone. The OSU will bury the subsea cables from 1 to 2 meters below the seafloor using jet plowing or a similar technique. Jet plowing uses a plowshare and high-pressure water jets to fluidize a trench in the seafloor. Using a barge or a dynamically positioned cable ship and towed jet plow device, OSU will simultaneously lay and embed the subsea cables. In areas with unsuitable seafloor conditions for burial, OSU will lay the cables on the seafloor and protect them using split pipe, concrete mattresses, or other cable protection systems. In PacWave South, the umbilical cables and a 300-meter segment of the subsea cables would remain unburied to allow for access during WEC deployment and removal, and maintenance activities. The subsea cables will enter HDD conduits at approximately the 10-meter isobath and continue to shore passing under the beach and dune systems and into the parking lot at Driftwood Beach State Recreation Site. Minimum spacing between each cable at the edge of the PacWave South would be at least 100 meters. The minimum spacing between each cable at the HDD conduits would be approximately 15 meters, resulting in a cable corridor that converges from at least 400 meters at the offshore PacWave South to a minimum of 60 meters at the nearshore HDD conduits. Subsea cable installation would take approximately 30 days for all five cables assuming no weather delays, and 10 days for post-installation inspections. Installing the subsea cables will occur 24 hours a day until installation is completed.

For the HDD from the shore out to approximately the 10-meter isobath, OSU will use a “drill and leave” technique where the drill pipe will be left in place and used as the cable conduit. The HDD laydown area would be in the Driftwood Beach State Recreation Site. Each bore would be spaced about 20 feet apart at the shore side end. The four transmission cables and auxiliary cable will each run through separate HDD conduits to individual beach manholes, where the subsea cables will transition to terrestrial cables. The beach manholes will measure approximately 10 x 10 x 10 feet. The OSU will conduct HDD per the requirements of an HDD contingency plan that they will develop prior to HDD. Each HDD bore will likely take up to one month to complete. The onshore cable landing installation will occur over a period of 6 to 8 months.

1.3.3 Upland Cable Installation and Facilities Construction

Terrestrial cables

From the beach manholes at Driftwood Beach State Recreation Site, OSU will conduct up to five HDD bores to a utility connection and monitoring facility (UCMF). From the beach manholes, the cables will run southeast, under the southern portion of the Driftwood Beach State Recreation Site. The HDD cable conduits would then run under small sections of six private properties located on either side of Highway 101, and then to the UCMF. From the UCMF, OSU will install an additional HDD conduit to the grid connection point with the Central Lincoln People's Utility District (CLPUD) overhead distribution lines. The total distance of the terrestrial cables would be about 0.5 miles (Figure 3).

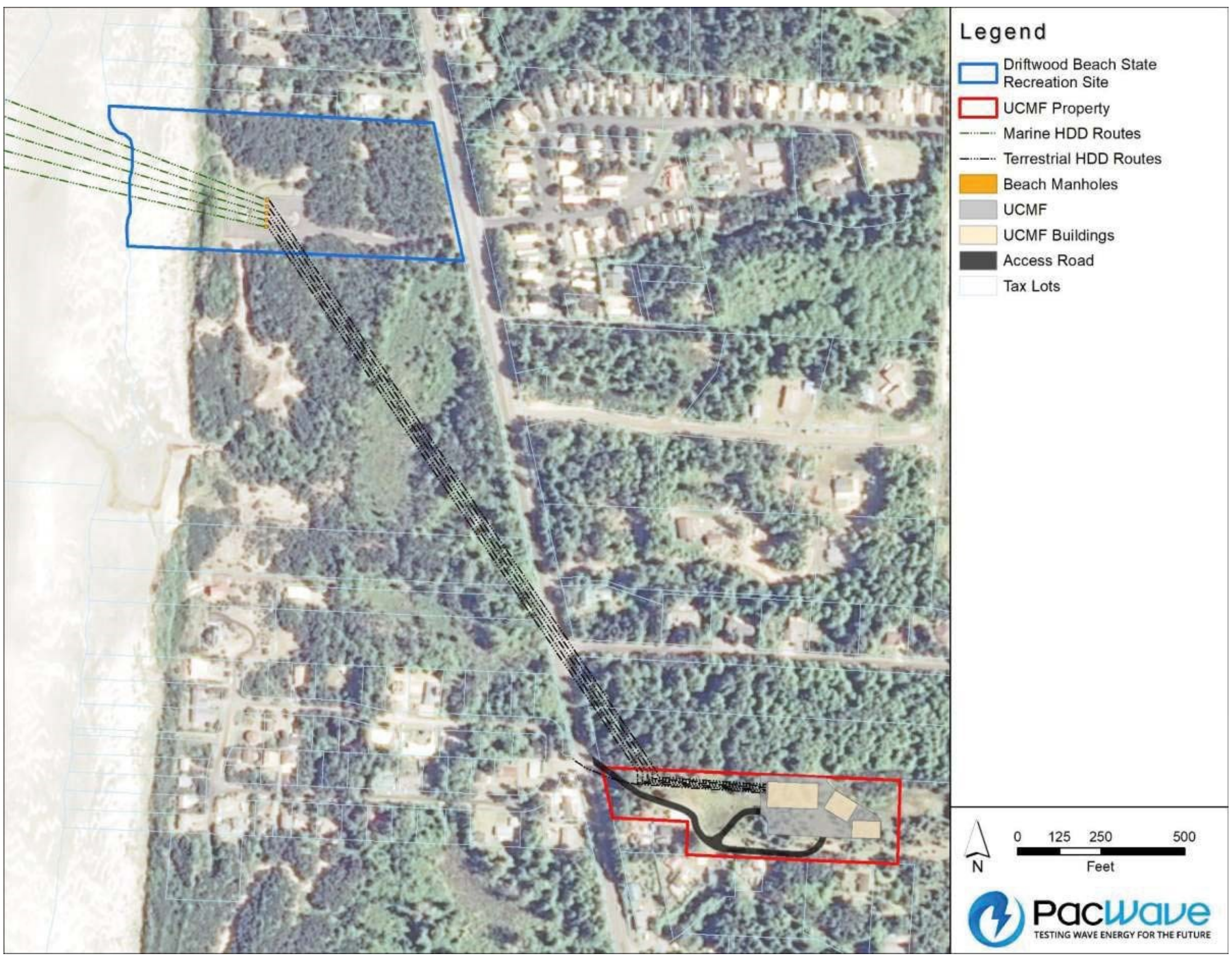

Figure 3. Terrestrial area of PacWave South showing cable and grid connections at Driftwood Beach State Recreation Area and the proposed utility connection and monitoring facility.

Utility connection and monitoring facility

To conduct power monitoring, conditioning, and other electrical operations, OSU will construct a UCMF approximately 0.3 miles south of Driftwood Beach State Recreation Site. The UCMF will include three single-story buildings of 11,250; 4,800; and 4,250 square feet, respectively. Additionally, OSU will pave the gravel road (16,000 square feet) to the UCMF and construct a parking/laydown area (16,000 square feet). The total area of new impervious surfaces at the UCMF would be 1.2 acres. The OSU will also re-pave the parking lot at Driftwood Beach State Recreation Site. The OSU will prepare a stormwater management plan in preparation for construction of the UCMF and paving of the recreation site that would include a design that incorporates best management practices and low impact development treatment facilities for stormwater.

1.3.4 Operation, Maintenance, and Monitoring

As part of the proposed action, OSU developed plans for operations and maintenance (including emergency response) and benthic sediments, organism interaction, acoustics, and electromagnetic field monitoring at PacWave South. The plans are summarized below. Details for each plan can be found in the applicable appendices of the applicant prepared environmental assessment (OSU 2019) provided in OSU's final license application to FERC (FERC No.: 14616).

- Operations and maintenance (O&M) plan (OSU 2019, appendix F) – The plan describes anticipated O&M activities associated with PacWave South offshore and terrestrial project infrastructure. Activities include continuous onshore system monitoring, preventative maintenance and site inspections, routine and unplanned maintenance, supporting documentation, management and storage of spare parts and equipment, and special environmental considerations during O&M. Operations and maintenance will require routine offshore site inspections and ROV inspections during environmental monitoring. Inspections will include WECs, anchor and mooring systems, environmental monitoring equipment, and subsea cable and connectors.
- Emergency response and recovery plan (OSU 2019, appendix G) – The plan addresses major types of emergency conditions that could occur during normal operation and maintenance activities at PacWave South. The plan identifies roles and responsibilities and lines of communication with regulatory agencies and establishes response actions for emergency situations. The plan's purpose is to minimize hazards to human health and safety and the environment from system failures. The plan includes procedures and actions for when WECs have move outside their operation boundary, offshore or onshore electric fault, fluid leaks or spills from WECs, navigation lighting failure, damage to subsea or terrestrial cables, and vessel collision with WEC components.
- Environmental monitoring plans (OSU 2019, appendix H) – The overall goal of the environmental monitoring plans is to track changes in benthic and marine habitats and the potential effects on marine organisms associated with such habitat changes. The plans include monitoring of benthic sediments (appendix H-1), organism interactions (appendix H-2), acoustics (appendix H-3), and electromagnetic fields (EMF) (appendix H-4) (OSU 2019). Environmental monitoring will include:

- Box core sampling inside and outside of PacWave South, and along the cable route corridor using a Gray-O-Hare 0.1 square meter box core. Sampling will occur annually from April to June and from August to October.
- Surveys of subsurface components (WECs, anchoring and mooring systems, and one cable route) using an ROV equipped with live feed video cameras and a Tritech Gemini multibeam imaging sonar. Surveys will occur annually from mid-March to mid-June and late August to Late October.
- Deployment of drifting, moored, and seafloor hydrophones and EMF monitoring equipment.

Operations and maintenance and deployment and retrieval of monitoring equipment at the offshore PacWave South will require vessel transit to and from PacWave South on a routine basis as described in each of the plans.

1.3.5 Protection, Mitigation, and Enhancement and Adaptive Management

Protection, mitigation, and enhancement measures

The OSU proposed that the following protection, mitigation, and enhancement measures (PMEs) would be incorporated into the license for the construction and operation of the PacWave South in order to facilitate the safe and compliant deployment of WECs and to minimize impacts on the environment. The PMEs are summarized below. For more detailed information on the PMEs, see appendix I in OSU (2019).

- Measures 1-5: Measures that are implemented pursuant to the framework (OSU 2019a, appendix J) in conjunction with a group of key agency stakeholders. These measures address potential impacts of the proposed action where there is uncertainty regarding whether impacts will occur and how to address them, and where a number of agency stakeholders have authority or interest regarding potentially affected resources, thus requiring a formal structure within which adaptive management decisions will be made. Monitoring plan implementation requirements are also included in this category because the committee has authority to review and revise these monitoring plans pursuant to the framework.
- Measures 6-9: Measures that are implemented adaptively in consultation with a specific agency or agencies that have regulatory authority over the resources that may be affected. These measures address potential impacts of the proposed action where there is uncertainty regarding whether impacts will occur and how to address them, but where there is a primary agency with authority over the potentially affected resources and therefore a multi-agency decision making structure is not necessary or appropriate. Each of these measures include adaptive management concepts through direct consultation with, and approval of, the named agency, as provided in the specific measures.
- Measures 10-20: Prescriptive PM&E measures that are not expected to change or require adaptation for the term of the license. These measures include both best management practices and measures specifically crafted to address potential or likely impacts of the proposed action where there is greater certainty regarding how to avoid, minimize or mitigate for any impact that may occur

Adaptive management framework

The adaptive management framework (AMF) includes implementation of the protection, mitigation, and enhancement measures (PMEs) described above; conducting monitoring via the proposed monitoring plans for benthic sediments, organism interactions, acoustics, and electromagnetic field (EMF) (Appendix H, OSU 2019) per the PMEs; review of the monitoring plan results to determine if action needs to be taken to mitigate effects that exceed expected effects relative to the monitoring plans above; ensure implementation of mitigation actions to offset effects that are exceeded, and modifications to monitoring plans, if warranted. Under the AMF, OSU will develop the adaptive management committee (AMC), whose responsibilities are to evaluate monitoring plan results and relevant new information to determine if mitigation measures are needed and if modifications to monitoring plans are required. In addition, the AMC will make decisions regarding whether to adopt additional mitigation measures under PMEs to bring effects within the criteria identified in the PMEs. Other PMEs will be managed in accordance with their terms in coordination with the specified resource agency involved, as appropriate.

1.3.6 Proposed Environmental Measures

The OSU proposed environmental measures that relate to ESA-listed fish, marine mammals, and sea turtles and are intended to avoid, minimize or mitigate potential effects to those resources. The proposed environmental measures are discussed in Section 2.4 of the BA (Appendix A, OSU 2019) provided by FERC in their consultation request.

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

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

The FERC determined the proposed action is not likely to adversely affect species listed above in the "Consultation History" section 1.2 or designated critical habitat for green sturgeon and leatherback sea turtles. Our concurrence is documented in the "Not Likely to Adversely Affect" Determinations section 2.12.

The FERC did not address designated critical habitat for OC coho salmon in their BA, for which we believe the project may affect in the Yaquina River estuary. We address OC coho salmon critical habitat in the "Not Likely to Adversely Affect" Determinations Section 2.12.

Due to recent proposals to list designated critical habitat for Southern Resident killer whales (84 FR 49214)[1] and humpback whales (84 FR 54354),[2] we address critical habitat for these species in the "Not Likely to Adversely Affect" Determinations 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 revisions to the ESA consultation regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulatory revisions (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.

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[1] Email from Justin Klure (Pacific Energy Ventures, LLC; OSU) to Keith Kirkendall on September 25, 2019 requesting conference on Southern Resident killer whale proposed critical habitat.
[2] Emails from Justin Klure (Pacific Energy Ventures, LLC; OSU) to Keith Kirkendall on October 15, 2019 requesting conference on humpback whale proposed critical habitat.

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

2.2 Rangewide Status of the Species and Critical Habitat

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

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

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

Decreases in summer precipitation of as much as 30% by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote et al. 2013). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2013).

Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Winder and Schindler 2004, Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright and Weitkamp 2013; Raymondi et al. 2013).

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

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

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. Acidification also affects sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012, Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011, Reeder et al. 2013). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007).

Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Tillmann and Siemann 2011, Reeder et al. 2013).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these 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 ESA-listed Species

Table 4, below provides a summary of listing and recovery plan information, status summaries and limiting factors for the species addressed in this opinion. Supplementary information in support of these summaries and listing classifications can be found in recovery plans and status reviews for these species, which we incorporate by reference in Table 4 below. Acronyms appearing in the table include DPS (Distinct Population Segment), ESU (Evolutionarily Significant Unit), ICTRT (Interior Columbia Technical Recovery Team), MPG (Multiple Population Grouping), NWFSC (Northwest Fisheries Science Center), TRT (Technical Recovery Team), and VSP (Viable Salmonid Population).

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

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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River spring/summer-run Chinook salmon	Threatened 6/28/05	NMFS 2017a	NWFSC 2015	This ESU comprises 28 extant and four extirpated populations. All expect one extant population (Chamberlin Creek) are at high risk. Natural origin abundance has increased over the levels reported in the prior review for most populations in this ESU, although the increases were not substantial enough to change viability ratings. Relatively high ocean survivals in recent years were a major factor in recent abundance patterns. While there have been improvements in abundance and productivity in several populations relative to prior reviews, those changes have not been sufficient to warrant a change in ESU status.	• Degraded freshwater habitat • Effects related to the hydropower system in the mainstem Columbia River, • Altered flows and degraded water quality • Harvest-related effects • Predation

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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River fall-run Chinook salmon	Threatened 6/28/05	NMFS 2017b	NWFSC 2015	This ESU has one extant population. Historically, large populations of fall Chinook salmon spawned in the Snake River upstream of the Hells Canyon Dam complex. The extant population is at moderate risk for both diversity and spatial structure and abundance and productivity. The overall viability rating for this population is 'viable.' Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of listing and compared to prior status reviews. The single extant population in the ESU is currently meeting the criteria for a rating of 'viable' developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Dam complex.	• Degraded floodplain connectivity and function • Harvest-related effects • Loss of access to historical habitat above Hells Canyon and other Snake River dams • Impacts from mainstem Columbia River and Snake River hydropower systems • Hatchery-related effects • Degraded estuarine and nearshore habitat.
California Coastal Chinook salmon	Threatened 6/28/05	NMFS 2016	Williams et al. 2016	This ESU historically supported 16 independent populations of fall-run Chinook salmon (11 functionally independent and 5 potentially independent), six populations of spring-run Chinook salmon, and an unknown number of dependent populations. Based on data available, eight of the 16 populations were classified as data deficient, one populations was classified as being at a moderate/high risk of extirpation, and six populations were classified as being a high risk of extirpation. There has been a mix in population trends, with some population escapement numbers increasing and others decreasing. Overall, there is a lack of compelling evidence to suggest that the status of these populations has improved or deteriorated appreciably since the previous status review.	• Logging and road construction altering substrate composition, increasing sediment load, and reducing riparian cover • Estuarine alteration resulting in lost complexity and habitat from draining and diking • Dams and barriers diminishing downstream habitats through altered flow regimes and gravel recruitment • Climate change • Urbanization and agriculture degrading water quality from urban pollution and agricultural runoff • Gravel mining creating barriers to migration, stranding of adults, and promoting poor spawning locations • Alien species (i.e. Sacramento pikeminnow) • Small hatchery production without monitoring the effects of hatchery releases on wild spawners

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Sacramento River winter-run	Endangered 1/04/94	NMFS 2014	Williams et al. 2016	This ESU comprises four populations, all blocked from their historic spawning grounds. The overall ESU viability assessment, with the single spawning population on the mainstem Sacramento River. Poor early life stage survival during the most recent consecutive drought years of 2012 through 2015, coupled with poor ocean conditions and hatchery production practices may further affect survival-to-adulthood and risk of extinction. Re-establishing winter-run Chinook salmon in their historical spawning and rearing habitat can improve ESU viability. Projects to reintroduce winter-run Chinook salmon into Battle Creek and upstream from Shasta Reservoir are in the planning phases, and if successful, would significantly benefit the ESU.	• Dams – Shasta and Keswick dams block all historic spawning and rearing habitat for this ESU • Diversions – routing of upper Sacramento River-origin water through agricultural fields and create false attraction cues • Urbanization and rural development • Logging • Grazing • Agriculture – impaired water quality from pesticide and herbicide reduces habitat quality • Mining – historic hydraulic mining from the California Gold Rush era • Estuarine modified and degraded, thus reducing developmental opportunities for juvenile salmon • Fisheries – maximum allowable impact rates range from 12.9 percent to 19 percent (2012 to 2015) • Hatcheries • Natural factors (e.g. ocean conditions)

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Central Valley spring-run	Threatened 4/14/14	NMFS 2014	Williams et al. 2016	This ESU historically supported 18 or 19 independent populations with some smaller dependent populations, and four diversity groups. Only three populations are extant (Mill, Deer, and Butte Creeks on the Upper Sacramento River) which only represent one diversity group (Northern Sierra Nevada). Spatial diversity is increasing with presence (at low numbers in some cases) in all diversity groups. Recolonization of the Battle Creek population with increasing abundance of the Clear Creek population is benefitting ESU viability. The reappearance of phenotypic spring-run to the San Joaquin River tributaries may be the beginning of natural recolonization processes in once extirpated rivers. Active reintroduction efforts on the Yuba and San Joaquin Rivers show promise. The ESU is trending positively towards achieving at least two populations in each of the four historical diversity groups necessary for recovery.	• Dams block access to 90 percent of historic spawning and summer holding areas along with altering river flow regimes and temperatures • Diversions • Urbanization and rural development • Logging • Grazing • Agriculture • Mining – historic hydraulic mining from the California Gold Rush era • Estuarine modified and degraded, thus reducing developmental opportunities for juvenile salmon • Fisheries • Hatcheries • Natural factors (e.g. ocean conditions)

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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Oregon Coast coho salmon	Threatened 6/20/11; reaffirmed 4/14/14	NMFS 2016b	NWFSC 2015	This ESU comprises 56 populations including 21 independent and 35 dependent populations. The last status review indicated a moderate risk of extinction. Significant improvements in hatchery and harvest practices have been made for this ESU. Most recently, spatial structure conditions have improved in terms of spawner and juvenile distribution in watersheds; none of the geographic area or strata within the ESU appear to have considerably lower abundance or productivity. The ability of the ESU to survive another prolonged period of poor marine survival remains in question.	• Reduced amount and complexity of habitat including connected floodplain habitat • Degraded water quality • Blocked/impaired fish passage • Inadequate long-term habitat protection • Changes in ocean conditions
Southern Oregon/ Northern California Coast coho salmon	Threatened 6/28/05	NMFS 2014	NMFS 2016c	This ESU comprises 31 independent, 9 independent, and 5 ephemeral populations all grouped into 7 diversity strata. Of the 31 independent populations, 24 are at high risk of extinction and 6 are at moderate risk of extinction. The extinction risk of an ESU depends upon the extinction risk of its constituent independent populations; because the population abundance of most independent populations are below their depensation threshold, the SONCC coho salmon ESU is at high risk of extinction and is not viable	• Lack of floodplain and channel structure • Impaired water quality • Altered hydrologic function • Impaired estuary/mainstem function • Degraded riparian forest conditions • Altered sediment supply • Increased disease/predation/competition • Barriers to migration • Fishery-related effects • Hatchery-related effects

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Central California Coast coho salmon	Endangered 4/2/2012	NMFS 2012a	Williams et al. 2016	This ESU comprises of 76 populations. Historically, the ESU had 11 functionally independent populations and one potentially independent population organized into four stratums. Most independent populations remain at critically low levels, with those in the southern Santa Cruz Mountains strata likely extirpated. Data suggests some populations show a slight positive trend in annual escapement, but the improvement is not statistically significant. Overall, all populations remain, at best, a slight fraction of their recovery target levels, and, aside from the Santa Cruz mountains strata, the continued extirpation of dependent population continues to threaten the ESU's future survival and recovery	• Logging • Agriculture • Mining • Urbanization • Stream modifications – including altered stream bank and channel morphology, elevated water temperature, lost spawning and rearing habitat, habitat fragmentation, impaired gravel and wood recruitment from upstream sources, degraded water quality, lost riparian vegetation, and increased erosion into streams from upland areas • Dams • Wetland loss • Water withdrawals (including unscreened diversions for irrigation)
Southern DPS of green sturgeon	Threatened 4/7/06	NMFS 2018b	NMFS 2015c	The Sacramento River contains the only known green sturgeon spawning population in this DPS. The current estimate of spawning adult abundance is between 824-1,872 individuals. Telemetry data and genetic analyses suggest that Southern DPS green sturgeon generally occur from Graves Harbor, Alaska to Monterey Bay, California and, within this range, most frequently occur in coastal waters of Washington, Oregon, and Vancouver Island and near San Francisco and Monterey bays. Within the nearshore marine environment, tagging and fisheries data indicate that Northern and Southern DPS green sturgeon prefer marine waters of less than a depth of 110 meters.	• Reduction of its spawning area to a single known population • Lack of water quantity • Poor water quality • Poaching

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Southern DPS of eulachon	Threatened 3/18/10	NMFS 2017c	Gustafson et al. 2016	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. Sub populations for this species include the Fraser River, Columbia River, British Columbia and the Klamath River. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River. Despite a brief period of improved returns in 2001-2003, the returns and associated commercial landings eventually declined to the low levels observed in the mid-1990s. 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.	• 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

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). For the proposed action the action area includes the PacWave South test site (2 nm^2; 1,695 acres) about 6 nautical miles off the coast of Newport, Oregon; subsea cables from the test site to a connection point at Driftwood Beach State Recreation Site; and the terrestrial cable route from the Driftwood Beach State Recreation Site parking lot to the UCMF property. Additionally, from the UCMF, OSU would also bury a conduit by HDD west to, and under, Highway 101 to the grid connection point with the CLPUD. The action area is defined by the following:

- *Upland analysis area* – This area includes the Driftwood Beach State Recreation Site, the wetland and stream habitat features along the HDD cable route corridor, the UCMF site, and the area potentially disturbed by HDD to the CLPUD grid connection point.
- *Estuarine analysis area* – The Yaquina Bay estuary from the mouth at the Pacific Ocean up to the Port of Toledo where WEC mooring and vessel mooring and traffic associated with WEC installation and operations and maintenance would occur.
- *Marine analysis area* – An area of the Pacific Ocean including, but not limited to the test site and cable route corridor that is defined by underwater noise produced by WECs and vessel traffic associated with cable and WEC installation. This includes benthic habitat affected by the installation and presence of subsea cables and installation and removal of WEC anchoring and mooring systems. It also includes a fan shaped area beginning at the mouth of Buckley Creek extending into the ocean 300 feet.

2.4 Environmental Baseline

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).

PacWave South occupies 2 nm^2 of the Pacific Ocean 6 nm off the coast of Newport, Oregon, as well as the buried subsea cables from the test site to a terrestrial cable connection point at Driftwood Beach State Recreation Site in Seal Rock, Lincoln County, Oregon. The ocean surrounding the action area provides marine habitat that supports diverse assemblages of marine species including ESA-listed salmonids, green sturgeon, and eulachon. PacWave South ranges in depth from 65 m to 79 m while the subsea cable route corridor ranges from sea level to 79 m. The Oregon coast near Newport is a high wave-energy, dynamic ocean environment. General marine habitat features around the action area include soft bottom subtidal, some hard bottom, open water pelagic, and surf zone habitats. The terrestrial area surrounding the action area consists of coastal beaches and dunes, and low mountains of the Coast Ranges, covered in Douglas fir and Sitka spruce, along with residential housing (OSU 2019).

The potential effects of global climate change have emerged as a critical concern for ESA-listed species and has contributed to the baseline condition of the action area. Climate change continues to actively alter environments as temperature and precipitation patterns change and become more variable. The year 2015 broke numerous global records, including highest greenhouse gas concentration, highest land and sea surface temperatures, highest upper ocean heat content and sea level, and smallest maximum ice extent in the Arctic (Bluden and Arndt 2016). Global temperatures recorded between January and June 2016 (1.05 °C above the 20th century average) were 0.85 °C above those set in 2015 (0.20 °C above the 20th century average) (NMFS 2016). In marine habitats, the temperature of marine waters is increasing globally at a rate of 0.06 °C per decade (NMFS 2016). The timing of peak abundances of many larval fishes in the California Current, including those commonly consumed by juvenile coho salmon and other salmonids (Daly et al. 2009), are becoming earlier as surface temperatures increase (Asch 2015). This ecosystem, like other eastern boundary currents, is dependent on wind-driven upwelling for its extremely high productivity (Bakun 1990, Chavez and Messie 2009, Checkley and Barth 2009). Minor changes to the timing, intensity, or duration of upwelling can have extensive effects on productivity of the ecosystem (Black et al. 2014 and Peterson et al. 2014), including the overlap of ESA-listed salmonids upon their outmigration with important marine prey organisms. Upon outmigration into the ocean, ESA-listed salmonids may encounter forage communities that are not typical and do not support their growth and development from smolts to adults, resulting in reduced growth, survival, and fitness of individual salmonids. 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).

2.4.1 Marine Action Area

Past and present activities in the marine analysis that affect marine habitat in the marine action area include natural and anthropogenic activities. The coastal marine action area is indicative of a dynamic nearshore ecological zone that naturally would be characterized by a disturbance-based benthic ecosystem. Anthropogenic activities that occur in the action area include recreational and commercial fishing, oceanographic monitoring, and commercial and recreational vessel traffic. These activities introduce stressors to the natural marine environment that result in changes to benthic habitats, changes in species assemblages, water quality contaminants, and noise pollution.

Benthic habitat

Changes in benthic habitats have likely resulted from commercial fishing and other bottom disturbing activities, whereas fishing gear can alter benthic habitat features that are important for benthic species that are prey organisms for ESA-listed species. Modification to benthic habitat can change the species assemblage's diversity and abundance within the modified area. In the action area, many macrofaunal (i.e., macroinvertebrate and fish) species are prey organisms for ESA-listed salmonids, green sturgeon, and eulachon. The current condition of benthic sediment and macrofauna was assessed in Appendix D of OSU (2019), which concluded that benthic sediments are similar to those characterized for the Yaquina dredged material disposal sites off of Newport, Oregon (USACE and EPA 2011), that is the sediment at PacWave south is almost entirely medium sand with grain sizes varying with depth. Similarly, macrofaunal assemblages collected have been consistent across PacWave North and South, varying in response to depth and median sediment grain size with a stronger relation to grain size (Appendix D, OSU 2019). The fish assemblages in this area are typical for sedimentary (sand and/or mud) areas on the Oregon mid to inner shelf.

To further describe the benthic infauna, the EPA (2011) provided results from field surveys conducted at or near the EPA designated dredged material disposal sites in March 1984, May 1986, October 1989, May 1999, September 1999, June 2000, September 2000, June 2008, and August 2008. Dominant species and groups included gammaridean amphipods, sand dollars *Dendraster eccentricus*, surface-dwelling gastropods, *Olivella spp*., and various species of polychaete worms. The benthic invertebrate fauna densities and diversities collected during these studies were typical of the nearshore sandy substrate along the Oregon coast (EPA 2011). Demersal fish and epibenthic species captured near the Yaquina disposal sites included several commercially important species such as sole, flounder, lingcod, and Dungeness crab (EPA 2008 and EPA 2011).

Vessel traffic and navigation

Waters near PacWave South are used by a variety of recreational, charter, and commercial boats. Vessel traffic is often concentrated near the mouth of the Yaquina River and near the Port of Newport (Figure 4). The Yaquina River supports commercial traffic, primarily fishing vessels, research vessels from NOAA and OSU, and occasional lumber cargo vessels. To avoid conflicts between commercial crab fishermen and ocean going tugs that are towing barges, the Washington Sea Grant program helped broker an agreement that provided navigable towboat and barge lanes through the crabbing grounds between Cape Flattery and San Francisco. Based on the 2012 edition of the Washington Sea Grant Tow Lane Charts, the Project's WEC deployment area would be located in the southern corner of the existing tow lane off the coast of Newport, however, OSU has been working with the crabbers and tow boat operators and has secured an agreement to adjust the tow lanes to avoid PacWave South.

The U.S. Army Corps of Engineers (USACE) maintains the Yaquina Bay federal navigation channel to federally authorized depths by periodically dredging naturally occurring sedimentary material. Dredge material from this area has been placed at one of the two USACE designated Ocean-Dredged Material Disposal Sites (ODMDS North and South) located off the coast of Newport in the Yaquina Bay area. The ODMDS sites are located about 6 nautical miles northeast of PacWave South and about 10 nm north of the subsea cable route. The test site would be marked to aid navigation for vessel traffic and fishing activities, but OSU is not seeking a closure of the area.

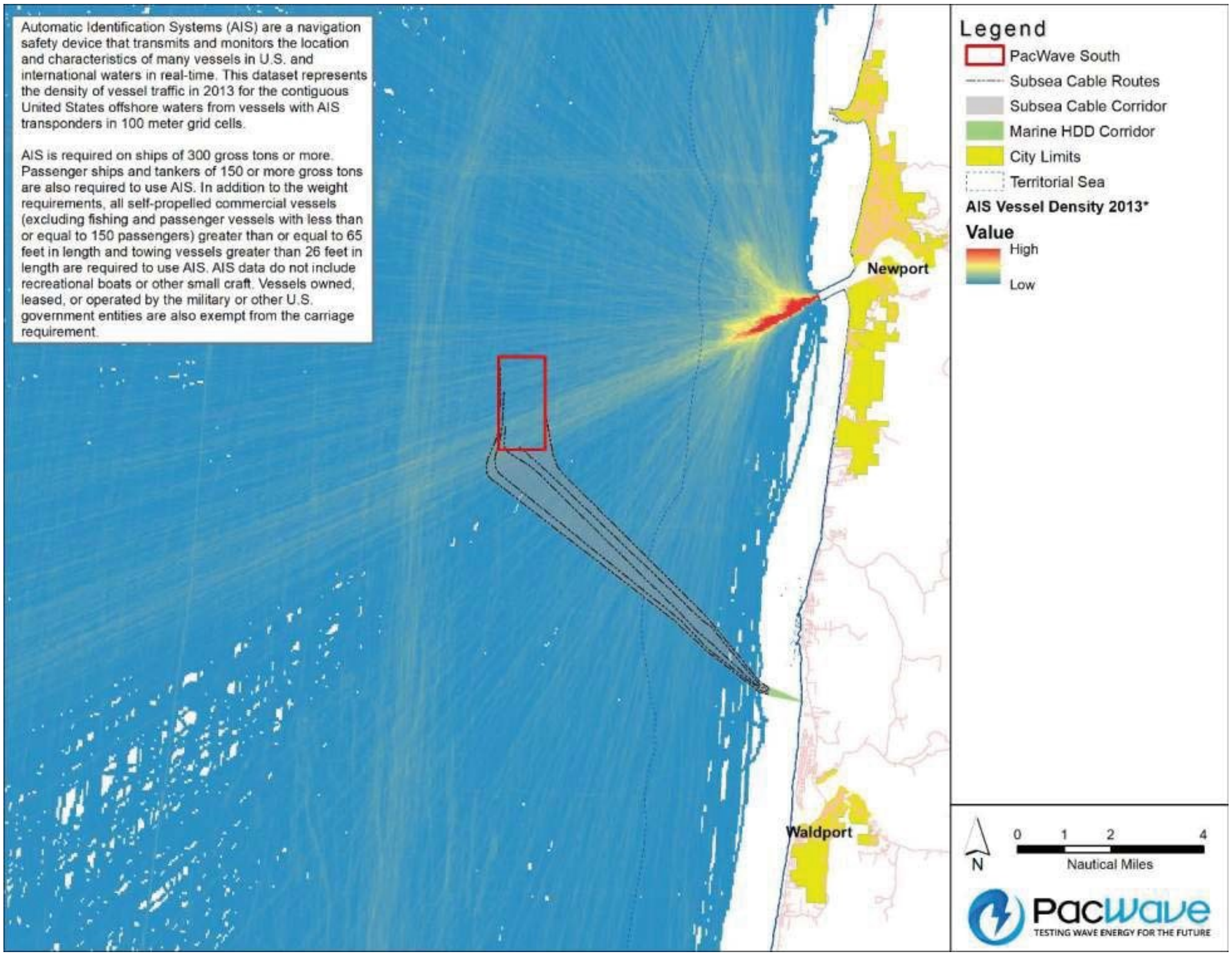

Figure 4. Vessel traffic in PacWave South and vicinity.[3]

Acoustic environment

Ambient sound in the marine environment originates from both natural and anthropogenic sources, such as commercial and recreational vessel traffic, wave action, marine life, atmospheric sound, and others. Sound in the ocean may affect marine species in a variety of ways, ranging from no effect to acute lethal effects. The PacWave South area and surrounding region experience considerable vessel traffic related noise from the Port of Newport, which is home to the west coast's largest commercial fishing fleet, as well as a seasonably active sport fishing community. Energetic weather conditions (surf, wind, rain) and acoustically active marine mammals also make significant contributions to ambient noise levels. Increases in acoustic noise at high enough sound pressure levels can result in behavior modification (150 dB) resulting in reduced growth and survival and physical injury from peak sound pressure levels (SPL) (206 dB) and cumulative sound exposure level (SEL) (183 dB for fish <2 grams and 187 for fish >2 grams).

[3] Source: NOAA Office of Coastal Management, available via the Marine Cadastre (www.MarineCadastre.gov).

A year-long acoustic monitoring study to describe long-term baseline ambient noise levels near Newport, Oregon was conducted adjacent to the PacWave North site from March 2010 through April 2011 (Haxel et al. 2013). The strongest and most persistent ambient sounds (generally < 50 Hz) were generated by surf breaking inshore of the acoustic recording device, with noise energy levels scaling with wave heights, and therefore seasonally stronger in the fall, winter and spring than in summer (Haxel et al. 2013). Locally generated ship noise (e.g., originating from the Port of Newport) was the most dominant and persistent acoustic feature (generally >50 Hz); ambient sound levels increased with increasing vessel activity, particularly in summer associated with sport fishing and in winter with commercial crabbing (Haxel et al. 2013). However, distant commercial shipping noise was nearly continuous (Haxel et al. 2013). Biological sounds emanating from baleen whales (i.e., blue, fin, and humpback) tend to be the loudest (188 dB rms re 1 µPa@ 1 m) but the lowest frequency (12-100 hHz) from September to early January, peaking in mid-October through November (Haxel et al. 2013). In 2015, Haxel (2019) collected baseline ambient noise levels over an approximately 6-week period in the southern region of the PacWave South area for site characterization. Sound pressure levels (SPL) root mean square (RMS) from 7 Hz-13 kHz were used to generate a cumulative distribution function of noise levels where the 50th percentile (101 dB RMS re:1 µPa) was representative of a “typical” background sound level at PacWave South. Baseline monitoring recorded minimum SPL RMS levels for this time period of 83 dB RMS re:1 µPa, while local vessels generated the maximum RMS sound pressure level (138 dB RMS re:1 µPa) from a total of 61,380 SPL RMS values. Despite the measured maximum value of 138 dB, less than 1 percent of the measurements surpassed the 116 dB level at PacWave South (Haxel 2019).

It is notable that the summer baseline measurements at PacWave South were virtually identical to the year-long acoustic monitoring conducted at PacWave North. This is likely because of the relative close proximity of PacWave North and the PacWave South (approximately 8 nm), coupled with the fact that the two areas are used almost identically by commercial and recreational users and that there are no differences between them on which to conclude noise levels would differ.

Chemical contaminants

In the action area chemical contaminants are introduced into the natural environment by vessel traffic and long-term presence of navigation and ocean monitoring infrastructure. Chemicals also occur naturally in the marine aquatic and benthic habitats. Contaminants in the action area likely include organic compounds, polycyclic aromatic hydrocarbons, (PAHs) and metals. Contaminants such as these can result in lethal and sublethal effects on marine fish and their prey species.

Water quality data taken in proximity to PacWave South are available in the Oregon Department of Environmental Quality (ODEQ) Laboratory Analytical Storage and Retrieval (LASAR) Database, and sediment quality data were reported during studies performed prior and subsequent to designation of the dredged material disposal areas offshore of Newport. Also, on June 10, 2003, ODEQ collected water quality data throughout the water column just west of PacWave South (Site ID 30223) in water having a depth of approximately 60 m.

Sediment samples were also taken from sites outside Yaquina Bay in various years from 1984 to 2000, mostly in summer and fall (USACE and EPA 2011). The 18 sample locations are in the open waters offshore of Yaquina Bay, an area that, like PacWave South and most of the cable route, has a uniform sand bottom. Metals concentrations detected in all samples were far below the screening levels outlined in USACE et al. (2009). All detected concentrations of organic compounds were either below the USACE et al. (2009) screening levels or below laboratory reporting limits.

Given the baseline description above, marine habitat in the action area supports the ESA-listed salmonids, green sturgeon, and eulachon that are the subject of this opinion. Warming ocean waters associated with climate change will likely have profound effects on the marine ecosystem. Warm ocean waters are generally associated with low fish productivity and abundance.

2.4.2 Estuarine Action Area

The estuarine analysis area includes Yaquina Bay in Newport, Oregon. Yaquina Bay supports ESA-listed Oregon Coast (OC) coho salmon and green sturgeon and is designated critical habitat for both species. Eulachon are thought to have occurred here, but are considered rare and infrequent with no documented observations of eulachon runs (Gustafson et al. 2010). Key management actions that have degraded OC coho salmon and green sturgeon habitat in Yaquina Bay include agriculture, forestry, grazing, roads, and urbanization. Probably the greatest impact to habitat in the bay has been estuarine development. The Yaquina Bay is a popular destination on the Oregon Coast for recreational fishing and crabbing and supports the largest commercial fishing fleet on the West Coast. Infrastructure associated with these includes large wharfs, piers, and docks supported by pilings that are often contaminated with creosote treatments to extend their service life. Thus, water and sediment quality are degraded because of this. Furthermore, Yaquina Bay experiences a high volume of vessel traffic and is dredged by the USACE to maintain the authorized Federal navigation channel. This continued disturbance has likely reduced the productivity of the bay to produce food resources for OC coho salmon and green sturgeon. Although critical habitat in Yaquina Bay is degraded from the activities described above, it supports OC coho salmon and green sturgeon for growth and development and migration.

2.4.3 Terrestrial Action Area

The terrestrial action area includes the beach, Driftwood Beach State Recreation Site, wetlands, uplands, and Friday and Buckley Creeks. The wetlands are associated with Friday and Buckley Creeks. Friday Creek is a tributary to Buckley Creek, which flows into the Pacific Ocean and supports anadromous coastal cutthroat trout (Appendix A, OSU 2019). There is no recent documentation of OC coho salmon in Buckley Creek or its tributaries. What we know of anadromous OC coho salmon is that they are present in several Pacific Ocean tributaries along the Oregon coast and that during pre-development times they were far more abundant than Chinook salmon in the majority of Oregon coastal watersheds (ODFW 2007, NMFS 2016). Buckley Creek tributaries include Friday, Twombly, and Thursday Creeks, of which Twombly Creek appears to be intermittent. No natural barriers exist between the portion of Buckley Creek affected by the proposed action and its confluence with the Pacific Ocean. Based on the previous discussion and the presence of anadromous cutthroat trout, we assume that over the 25-year license period that OC coho salmon would periodically be present in Buckley Creek and are reasonable certain to be exposed to the effects of the proposed action's activities in the terrestrial action area.

Aquatic and riparian habitat in Buckley and Friday Creeks and their associated wetlands have been degraded by development, construction of Highway 101, and likely stormwater contaminant discharges associated with Highway 101 and other areas. These activities have likely caused reduced water quality, function and value of surrounding wetlands, and reduced habitat complexity in Buckley and Friday Creeks in the action area.

2.5 Effects of the Action

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

Effects on ESA-listed Species

As described in the BA, effects on ESA-listed salmonids, green sturgeon, and eulachon would occur from habitat alteration, increased sound, increased electromagnetic fields, HDD, and upland construction including those at Driftwood Beach State Recreation Site and the UCMF. We reviewed the effects analysis and conclusions provided in the BA and compared it to the best available scientific literature on the potential effects that may occur. Based on our independent review, we fully agree with the assessment of most effect pathways and adopt the BA analysis for those. We do not agree with the severity of some as described by FERC, and have discussed those in detail below.

Our independent review found FERC's BA accurately described the following effects pathways; therefore, we adopt their analyses and summarize our conclusions below, while also considering them in the summaries at the end of this section:

- Habitat alteration from suspended sediment during installation and re-deployments;
- Habitat alteration from disturbance of the benthic community from project structures (anchors, cables, connectors, HDD conduits);
- Habitat alteration from effects of toxic substances introduced by the project on water quality;
- HDD associated with the HDD conduits and connection to upland facilities at Driftwood Beach State Recreation Site and the UCMF; and
- Ballast water intake.

To summarize, effects on water quality from suspended sediments, introduction of toxic substances, and frac-out from HDD associated with power cable installations, anchor and mooring systems installation and removal, and WEC operation would be short-term and localized and would rise to a level of magnitude for a long enough time to elicit an adverse response from individual ESA-listed fish. Effects from benthic habitat alteration from project structures would not change the way that ESA-listed fish use the action area or reduce their forage such that it would change the growth or survival of any individual ESA-listed fish. Effects from ballast water intake are unlikely because individual ESA-listed fish would be of size and capability to avoid entrainment during exposure to the intake of ballast water. Therefore, because the effects on ESA-listed fish are short-term, localized, or unlikely and would not change their use of the action area or reduce their growth or survival, the effect pathways identified above would not adversely affect individual ESA-listed salmonids, green sturgeon, or eulachon.

Our independent review found FERC's BA did not fully describe the effects on ESA listed OC coho salmon, green sturgeon, and eulachon from the pathways below. The scientific information provided in the BA suggests there is potential for adverse effects on individual ESA-listed fish from the proposed action and the effects pathways below. For those effects pathways identified below where we do not agree with the conclusions of the BA, there is limited scientific information that does not provide definitive or conclusive evidence relative to the magnitude, severity, or intensity of effects the proposed action would have on ESA-listed fish in the action area. Additionally, most field and modeling studies focused on wave and tidal energy devices involve characterization of a single device (Copping et al. 2016). Cumulative impacts of arrays need to be understood to aid in impact assessments for larger-scale development activities (Copping et al. 2016) relative to marine energy devices, such as the proposed action. Therefore, the best available scientific information is inconclusive regarding adverse effects of the proposed action on ESA listed fish. When the best available scientific information does not provide definitive or conclusive evidence relative to the adverse effects on ESA-listed species, for the sake of the ESA-listed species we conservatively assume that individuals would be exposed to the effect, which would elicit a reasonably certain direct or indirect response by individual fish because of said exposure over the 25-year license term. The BA did not include an analysis of effects from stormwater associated with the UCMF or Driftwood Beach State Recreation Site.

- Habitat alteration from changes to marine community composition and behavior;
- Underwater sound associated with WECs, vessel noise, and the cable laying vessel;
- Electromagnetic fields (EMF) associated with WECs and cable infrastructure; and
- Stormwater discharge associated with construction of the UCMF and re-paving of the parking lot at Driftwood Beach State Recreation Site.

ESA-listed fish presence and use information for the marine action area

The total footprint of the project structures is small and spread out over the PacWave South site. ESA-listed salmonids may occur in the action area at any time. Juvenile salmonids are pelagic and typically surface oriented, most often found in the upper 20 m of the water column. (Emmett et al. 2004, Walker et al. 2007), and their preferred prey types are also pelagic (e.g., copepods, euphausiids, and juveniles of northern anchovy, Pacific herring, sardines, rockfishes, and smelt; Brodeur et al. 2005, Brodeur et al. 2007, Daly et al. 2009, Santora et al. 2012). Adult salmonids, especially Chinook salmon, occur at greater depths than juveniles do, as evidenced by their capture as bycatch in midwater trawl fisheries (Lomeli and Wakefield 2014) and their prey is also predominately pelagic (e.g., euphausiids, northern anchovy, squid, Pacific herring, Pacific sandlance, and smelt; Hunt et al. 1999, PFMC 2000).

Green sturgeon concentrate and feed in coastal waters immediately offshore and up coast and down coast of estuaries, including Yaquina Bay (Erickson and Hightower 2007, Payne et al. 2015, Henkel 2017), thus they can concentrate in the general vicinity of the marine action area. Tagged green sturgeon also occur at PacWave South and PacWave North, based on lines of 8 acoustic receivers placed at PacWave North (1 line) and PacWave South (2 lines) between October 2015- January 2016, and April-October 2016 (Henkel 2017). Similar to Payne et al. (2015), most sturgeon moved through quickly (days) whereas others remained for longer periods (weeks or months) (Henkel 2017). Regardless, the likelihood of green sturgeon swimming past or near the cables and WECs during their migration and feeding is greater than for the other ESA-listed fishes because they could potentially occur in the action area for longer periods of time (i.e., days to months, Payne et al. 2015, Henkel 2017). Green sturgeon feed on demersal prey such as clams, crabs, shrimp, amphipods, isopods, and fish including sand lance and ling cod (Dumbauld et al. 2008, Miller 2004), and tend to remain near the bottom; however, they can make rapid vertical ascents to the surface likely following vertical migrations of prey (Erickson and Hightower 2007).

Juvenile eulachon are reported to rear in nearshore marine waters, and adults are regularly captured as bycatch in the ocean shrimp trawl fishery in nearshore marine waters of Oregon (Hannah et al. 2011, Al-Humaidhi et al. 2012, Wargo et al. 2014). They are typically caught in trawls during the day, near the ocean bottom in waters of 20-150 m depth, on the continental shelf and slope (Hay and McCarter 2000, Hannah et al. 2011, Al-Humaidhi et al. 2012, Wargo et al. 2014, Gustafson et al. 2017). Eulachon tend to orient toward the bottom and feed primarily on crustaceans, especially euphausiids, which tend to be distributed in large patches on the shelf, near the bottom but with diel vertical migrations (Ressler et al. 2005).

ESA-salmonids, green sturgeon, and eulachon would occur in the action area and while in the action area, they would likely be actively migrating and foraging. Therefore, we are reasonably certain that their exposure to the effects of the proposed action would occur. While the probability of ESA-listed fish being exposed to the effects of changes in marine community and behavior, underwater sound, and EMF is low because the size of the action area relative to the available habitat in the ocean, it is reasonable to expect that over the 25-year license period that a small number of each ESA-listed species would be exposed.

Habitat alteration – Changes to marine community and behavior

The BA (Appendix A, OSU 2019) analyzed the changes in the marine species community and behavior from the project structures (i.e., WECs, anchors, moorings, umbilicals, hubs, and subsea connections) and the effects of this on ESA-listed salmonids, green sturgeon, and eulachon. At full build-out, seafloor structure could include up to 100 anchors that would occupy a total footprint of up to 90,800 ft^2 (2 acres). Full build-out would also include water column and/or surface structure of up to 20 WECs (each separated by a distance of 50 to 200 m or more) and associated moorings and umbilicals (total area occupied within the water column is uncertain).

The BA (Appendix A, OSU 2019) presented scientific information that suggests that the project structures could attract marine species such as bio-fouling organisms (Boehlert et al. 2008), marine fish (Castro et al. 2002, Nelson 2003), birds, and pinnipeds (Appendix A, OSU 2019). Boehlert et al. (2008) reported that structures would likely become colonized ("biofouled") by algae and invertebrates, such as barnacles, mussels, bryozoans, corals, tunicates, and tube-dwelling worms and crustaceans and that changes in benthic habitat will occur due to litter fall from marine fouling communities that will form on the WECs, mooring lines, and anchors (Boehlert et al. 2008). Based on surveys at PacWave North, changes to the benthic habitat (particularly shell hash accumulation) may be expected to occur up to 250 meters away from an anchor installation (Appendix A, OSU 2019).

Some types of pelagic fishes are also known to associate with floating objects (Castro et al. 2002, Nelson 2003). So, project structures in the water column and at the surface (e.g., WECs, marker buoys and mooring lines) and associated biofouling might act as fish aggregating devices (FADs) and attract pelagic fishes through visual and/or olfactory cues (Dempster and Kingsford 2003). Salmonids and eulachon are not known to be associated with or be attracted to seafloor structures including natural or artificial reef habitats or dock pilings (Pearcy et al. 1989, Tissot et al. 2007, Tissot et al. 2008, Gallagher and Heppell 2010, Dauble 2010, Hannah and Rankin 2011, and Easton 2012 as compiled in Kramer et al. 2015). At existing wind and wave energy projects having both seafloor and vertical structure in cold-temperate waters of Europe, none reported a measurable "FAD effect", but all of them reported an artificial reef effect where demersal fish were attracted (e.g., Wilhelmsson et al. 2006, Langhamer et al. 2009, Leonhard et al. 2011, Bergstrom et al. 2013, Reubens et al. 2014, Krone et al. 2013). In temperate ocean waters of California, Oregon, and Washington, fish associations with midwater and surface structures were generally limited to pelagic juvenile rockfishes, which have been reported at various structures such as attached kelp (Matthews 1985, Bodkin 1986, Gallagher and Heppell 2010), floating kelp (Mitchell and Hunter 1970, Boehlert 1977), oil platforms (Love et al. 2010, 2012), and vertical structures of docks and pilings (Gallagher and Heppell 2010). The available information indicates that salmonids and eulachon would likely not be attracted to a single WEC. However, it is less certain whether an aggregation of WECs, such as proposed for this action, would have a FAD effect for salmonids, eulachon, and green sturgeon. Below, we take a precautionary approach and discuss the potential impacts on salmonids and eulachon if the proposed WECs were to have a FAD effect on these species.

In a study assessing the use of oil platforms by sea lions off the coast of California, sea lions were frequently observed hauled out on oil platforms and observed feeding on rockfish and spiny dogfish (BOEM 2016, Orr et al. 2017). Schools of fish within one kilometer of the platform were observed being attacked by several predators, including California sea lions, common dolphins, minke whales, gulls, brown pelicans, cormorants, and others (BOEM 2016, Orr et al. 2017). In addition, California and Stellar sea lions are regularly seen hauled out on offshore buoys off Oregon, suggesting that marine renewable energy platforms would be used by pinnipeds, when accessible.[4]Although, WECs and their associated infrastructure are typically designed to minimize haul-out by pinnipeds.

The BA (Appendix A, OSU 2019) suggested that cormorants and brown pelicans might roost on above-surface structures of WECs. This is supported by Grecian et al. (2010), who states that construction of new structures in the marine environment creates roosting sites that are quickly used by marine birds, as found around oil platforms (Wiese et al. 2001, as cited in Grecian et al. 2010). These birds are predators of salmonids and eulachon.

Based on information on ocean distribution, ESA-listed salmonids, green sturgeon, and eulachon will migrate through and feed in the action area during the 25-year license term. Thus, it is possible that they would be exposed to the effects of changes in the marine community composition and behavior associated with the proposed project structures. If exposed, salmon, eulachon, and green sturgeon would experience a slight increase in available forage items as they consume the types of organisms that would be attracted to the WECS. It is also possible that salmon and eulachon could be exposed to increased predation from animals attracted to the WECs including sea lions, birds and other fish. Green sturgeon could be preyed upon by sea lions but are generally too large to be consumed by birds or other demersal fish that would be attracted to the WECs. If these effects were to occur they would occur in a very limited area and thus would be expected to impact a very small number of fish in any given year.

As discussed previously, there is not clear and substantial information indicating salmonids, eulachon, and green sturgeon would be attracted to a single WEC. Since there is uncertainty about whether aggregations of WECs would attract these species, we considered the potential beneficial (increased forage) and negative effects (increased predation) and concluded these impacts would be very minor.

Returning to the question of whether aggregation of WECs might attract salmonids, green sturgeon, and eulachon, we did not find any information indicating this would occur. In fact, the available information indicates that even large structures in the marine environment, such as oil platforms, do not attract these three species. Given this, we do not consider the effects on salmonids, green sturgeon, and eulachon from alteration of habitat and community structure to be reasonably certain to occur.

Underwater sound associated with WECs, vessels, and cable laying

The primary sources of underwater sound would be from vessels at PacWave South and vessels transiting between Yaquina Bay and the site; cable laying; and from WECs and associated project structures. Sound from these sources would vary in intensity and duration based on the activity and the sea state, and all would be continuous (i.e., non-impulsive) sounds. As part of the adaptive management framework, OSU will implement a monitoring plan for acoustics

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[4] From State of Oregon Geographic Location Description – Analysis of reasonably foreseeable effects of Federal actions related to Marine renewable energy projects on resources and uses occurring within the federal waters of the Oregon Ocean Stewardship Area. Available at: https://www.oregon.gov/lcd/OCMP/Documents/OCMP_MarineRenewable_GLD_final.pdf. (Accessed December 13, 2019).

associated with the proposed action and PMEs for underwater noise to apply adaptive management and mitigation measures if needed. In the event of an exceedance of NMFS' published thresholds, per PME #7 OSU has 60 days to diagnose and make repairs or modifications to the WEC or mooring systems to return them to normal operation (not in exceedance).

The BA presented scientific information that suggests that presence and operation of WECs produce sound. The BA also presented information characterizing the magnitude of sound potentially produced during operation of the WECs and sound associated with vessel traffic, HDD, and vessel laying the subsea power cables. However, most field and modeling studies focused on wave (WECs) and tidal energy devices involve characterization of a single device (Copping et al. 2016) and are not focused on multiple devices or multiple arrays of devices as will be the case of the proposed action.

During WEC operation, sound may be generated by water flowing past the mooring lines, waves splashing against the WECs and other structures, failure of the moving components of the WECs, or by the moving components of the WECs and moorings. The maximum sound pressure level (SPL) for Columbia Power Technologies' 1/7-scale WEC was measured from 116 to 126 dB (re: 1 μPa) in the integrated bands from 60 Hz to 20 kHz at distances from 10 to 1,500 m from the SeaRay (Bassett et al. 2011). From this, the SPL was estimated at 145 dB (re: 1 μPa at 1m), and 126 dB (re: 1 μPa at 10m) (Thomson et al. 2012, as cited in NAVFAC 2014). In the environmental assessment prepared for the Hawaii Wave Energy Test Site, engineers conservatively assumed that a full-sized WEC would be 3-6 dB louder than the 1/7 scale version, and estimated that the maximum SPL for a WEC would be 148-151 dB (re: 1 μPa at 1m) (NAVFAC 2014). The maximum SPL generated by WECs off the west coast of Sweden was reported at 133 dB (re: 1 μPa at 20 m) with an average of 129 dB re 1μPa (Haikonen et al. 2013). This suggests a maximum source SPL of approximately 153 dB (re: 1μPa at 1m). Other analysis suggests that WECs would result in sound only in the range of 75 to 80 dB, with somewhat higher frequencies than light- to normal-density shipping sound (Sound & Sea Technology 2002 cited in Department of the Navy 2003). OSU will implement the acoustic monitoring study under the AMF to detect and, if needed, mitigate exceedances of WEC-related sound. Based on the limited information reporting on sound production of WECs and the above discussion, there appears to be high variability in the level of sound produced by WECs.

Vessels transmit sound through water predominantly through propeller cavitation, although other ancillary sounds may be produced, and the intensity of sound from service vessels is roughly related to ship size and speed (Hildebrand 2009). Large ships tend to be noisier and have lower frequencies than small ones, and ships underway with a full load (or towing or pushing a load) produce more sound than unladen vessels (Hildebrand 2009). For the proposed action, sound intensity generated by tugs, barges, and diesel-powered vessels (i.e., the types used for this project), would be no greater than 130 to 160 dB (re: 1 μPa) over a frequency range of 20 Hz to 10 kHz" (Richardson et al. 1995). At full build out, OSU estimated 69 vessel trips for deployment, operation and maintenance, and retrieval and 36 for monitoring (total 105 annual trips). OSU estimated that a WEC and mooring system turnover could affect two berths per year and at-sea activities would not take more than 9 days per WEC. Based on this we estimated that sound from vessel transit, WEC deployment activities, operation and maintenance, and monitoring would occur on 2,250 days (6.16 years), periodically, over the 25-year license period.

Sound associated with the vessel laying the subsea cables would be from 177 dB to 180 dB (re: 1 µPa at 1 m) (NMFS 2015b as cited in Appendix A, OSU 2019). For the cable-laying vessel, cable-laying operations will occur for 24 hours per day for approximately 30 days, assuming no weather delays. During subsea cable installation the vessel will move very slowly covering only 0.28 nm in 1 day (24 hours). The area surrounding the cable-laying vessel where sound would be reasonably certain to exceed 150 (dB re: 1 µPa) is approximately up to 328 feet laterally in all directions from the vessel.

Subsea cable installation would generate sound during HDD. HDD involves drilling below the seafloor, and sound may be generated in the marine environment as the drill head approaches the breakout point underwater. The information that exists about sound that may be generated in the marine environment as the HDD drill head approaches the breakout point underwater is qualitative, and indicates that the sound from the bore hole drilling would be much less than typical work vessels that would be expected to be used for the Project (Gaboury et al. 2008, Navy 2008 both cited in NAVFAC 2014).

While the sound produced by the WECs, vessel traffic and the cable-laying vessel appears to be below the thresholds for physical injury the best available information discussed above supports exceedances of the threshold for behavioral effects (150 dB [re: 1µPa]). Specifically, the vessels for WEC installation, retrieval, and monitoring and cable-laying operations are likely to exceed the threshold for behavioral effects. Regarding the WECs, the best available information is mainly focused at characterizing sound for single devices (Copping et al. 2016) and not a full-build out scenario or arrays of multiple devices such as the proposed in this action. It is also unclear what sound levels are produced by WECs when their components fail or are assembled incorrectly. Therefore, we conservatively assume that ESA-listed salmonids, green sturgeon, and eulachon would be exposed to WEC generated sound that would elicit a response from individual ESA-listed fish.

When exposed to sound levels above 150 dB, some individuals will likely move away, but some would remain in the exposure area. Behavioral effects on fish exposed to high enough sound levels include reduced foraging and lost foraging opportunities, reduced ability to detect prey, increased susceptibility to predation (Slabbekoom et al. 2010; Purser and Radford 2011; Voellmy et al. 2014; Simpson et al. 2015), which results in reduced growth, survival, and fitness of individuals. Thus, despite the uncertainties, on balance, the clear and substantial information about sound sources, the reported magnitude of sound produced by the sources, the presence of ESA-listed salmonids, green sturgeon, and eulachon in the action area, supports a conclusion that a small number of each species will be adversely affected by behavior modification caused by underwater sound.

Electromagnetic fields

Electromagnetic fields consists of both electric (E) and magnetic (B) field components with a second, weak induced electric (iE) component to the latter, created by the flow of seawater or movement of organisms. The strength of the two main fields (E and B) that would be generated by the proposed action depends on the magnitude and type of current flowing through the cable and the way the cable is constructed. Overall, strength of both the E and B fields in seawater, whether man made or naturally occurring, would diminish with distance from the source (Slater et al. 2010a).

Electromagnetic fields (EMF) originate from both natural and anthropogenic sources. Natural sources include the earth's magnetic field and various biochemical, physiological, and neurological processes within organisms. EMF generated by the proposed action would come from WECs, umbilical cables (connecting the WECs to the subsea connectors), the hubs and subsea connectors, and the subsea cables to the shore. The cables for the proposed action would be shielded by a common shield and mostly buried to 1 to 2 meters into the seafloor, except for 300 to 400-foot sections of the cables at the test site. The umbilical cables would be suspended in the water column by floats, the WECs moored at the surface and in the water column, and subsea connectors laid on the ocean floor, thus eliminating the possibility of reducing EMF through burial. The OSU proposed to implement an EMF monitoring plan that includes mitigation measures to reduce EMF in the event of an exceedance of 3 milliteslas at 10 m from WECs. In the event of an exceedance, per PME #1, within 60 days OSU would diagnose and make repairs or modifications to the source of the exceedance to return them to normal operation (not in exceedance). Measures to minimize EMF proposed by OSU include burial of the subsea power cable up to 2 m in the sea floor whenever possible.

Generally, the higher the power output from a WEC, the higher the electrical current transmitted through alternating current (AC) cables and hence the stronger the emitted magnetic field and iE-field (Gill 2016). The strength of the two main fields (E and B) that would be generated by the proposed action depends on the magnitude and type of current flowing through the cable and the way the cable is constructed. It is notable, however, that there is remarkable consistency among the measured attenuation of AC magnetic fields among 10 different cables (most of them associated with large offshore wind farms) (Normandeau et al. 2011, Gill 2016). These cables likely carried much larger currents than the proposed cables at full build out of PacWave South, all of them were unburied cables, and they all still showed an exponential decline that reached near ambient levels by around 2 m from the cable. Existing information (based on monitoring of EMF at 10 different cables) all showed similar and consistent exponential declines that reached ambient conditions by around 2 m from the cable (Normandeau et al. 2011, Kavet et al. 2016, Gill 2016).

Cable construction methods can shield and thus reduce or eliminate the E-field, but not B-field strength. Three-conductor cables can be individually shielded or have an outer shield encompassing all three conductors (Slater et al. 2010b). The three-conductor cable with a common shield has the lowest electric and magnetic field strengths compared to individually shielded three-conductor cables (Slater et al. 2010b); this is the type of cable planned for the proposed action. Modeling results indicate that EMF of the strength that could be detected by species is limited to a distance of much less than 10 m from the cable (Love et al. 2016, Normandeau et al. 2011); field measurements indicate robustness of model results (Slater et al. 2010b and c, Gill et al. 2014, 2016).

The BA presented scientific information that suggests that WECs, power cables, and subsea connectors would generate EMF. However, the existing scientific information has not focused on the EMF generated by multiple devices or arrays of multiple devices such as the proposed action. Additionally, there is poor understanding of the response of marine animals to EMF associated with marine renewable energy devices (Copping et al. 2016) and what the adverse effects on them from EMF are.

Potential effects of EMF on salmonids, green sturgeon, and eulachon include altered migration behavior and reduced ability to detect prey, mates, and predators. Salmonids are known to respond to magnetic fields in the 10-12 μT range (Normandeau et al. 2011, Gill et al. 2014). Putnam et al. 2014 reported that juvenile salmon changed their orientation when subjected to magnetic field intensity and inclination angles similar to those found in the latitudinal extremes of their ocean distribution. When subjected to unnatural pairings of magnetic field intensity and inclination, juvenile salmon orientation became more random (Putnam et al. 2014). Kavet et al. (2016) reported potential attraction to and misdirection during migration of Chinook salmon smolts after cable activation during migration through San Francisco Bay. However, cable activity did not appear to affect Chinook salmon smolts from successfully exiting the system (Kavet et al. 2016). ESA-listed salmonids are reasonably certain to be exposed to EMF generated by within up to 2 m of WECs and umbilical power cables in the water column with less frequent exposure to EMF generated by subsea power cables and connectors due to their, primarily, pelagic use of the action area.

Green sturgeon have specialized electroreceptors, which may be used to detect bioelectric fields emitted by prey, detect mates, and detect predators, as well as for short- and long-term movements or migration (Normandeau et al. 2011, Gill et al. 2014). Kavet et al. (2016) reported significantly increased travel times for green sturgeon during their outbound migration and decreased travel times during their inbound migration through San Francisco Bay during cable activation. Although, cable activation did not appear to have a strong impact on successful inbound or outbound migrations (Kavet et al. 2016). Hutchison et al. (2018) studied the effects of EMF on little skates (*Leucoraja erinacea*), which, like green sturgeon, are an electro-sensitive species and are typically associated with ocean bottom habitats. When exposed to EMF, significant differences in behavior of little skates were observed including increased activity defined by greater distance traveled at slower speeds, higher number of large turns, and being closer to the seabed in the treatment enclosure as opposed to the control enclosure (Hutchison et al. 2018). This suggests the EMF may have been perceived as a cue for the presence of food and that if the skates associated the EMF with prey items, it could result in higher expenditure of net energy than when not encountering EMF. Green sturgeon will be exposed to EMF primarily within 2 m of subsea and umbilical power cables with less frequent exposure to WEC generated EMF.

Although no research is available on the potential effect of EMF on eulachon or their response, Normandeau et al. (2011) notes that it is possible that EMF may affect eulachon similarly to salmonids as they are thought to use magnetic fields to navigate during migration. Their exposure to EMF will be primarily to within 2 m of WECs and umbilical power cables with less frequent exposure to subsea power cables and subsea connectors.

While the literature presented above shows that EMF can modify normal behaviors (migration and feeding) of fish, it is unclear how behavior modification caused by EMF affects fish physically and physiologically and at what magnitude and exposure durations to EMF these effects would occur. It is also unclear what the consequences of behavior modification caused by EMF would be to ESA-listed salmonids, green sturgeon, and eulachon, which could include but is not limited to increased risk of predation, increase energy expenditure, and sub-lethal injury resulting from physiological changes resulting in reduced growth, survival, and fitness. Furthermore, the existing scientific information does not evaluate the EMF produced at a full-build out scenario or arrays of multiple devices such as the proposed action. Nor does it provide definitive conclusions as to what the adverse effects on ESA-listed salmonids, green sturgeon, or eulachon are from EMF. Therefore, we conservatively assume that ESA-listed salmonids, green sturgeon, and eulachon would be exposed to EMF within 2 m of the project structures that would elicit a reasonably certain direct or indirect response from individual ESA-listed fish over the 25-year license term.

Responses of ESA-listed salmonids, green sturgeon, and eulachon would include behavior modification, which are reasonably certain to cause reduced feeding, and increased energy expenditure leading to reduced growth, survival, and fitness. Indirect responses of individuals from exposure to EMF associated with the proposed action would include sub-lethal physiological effects. The volume of EMF exposure would be limited to within 2 m of the power cables and WECs, which is less than 1 percent of the total volume of habitat in the action area. Considering the discussion and assumptions above, the presence and use of ESA-listed salmonids, green sturgeon, and eulachon in the action area, and the small area affected relative to the occupied marine habitat, a small number of each species would be adversely affected by EMF over the 25-year license term.

Stormwater from UCMF and Driftwood Beach State Recreation Site

The proposed action included construction of the UCMF and re-paving of the parking lot at Driftwood Beach State Recreation Site. The total area of new impervious surfaces at the UCMF would be 1.2 acres and the impervious area at the recreation site would be approximately 0.7 acre. The OSU will prepare a stormwater management plan in preparation for construction of the UCMF and paving of the recreation site that would include a design that incorporates best management practices and low impact development treatment facilities for stormwater. Thus, detailed designs or a stormwater management plan has not been provided for analysis of stormwater effects on ESA-listed species. Our analysis will be based on this point and we will assume no stormwater treatment would occur prior to discharge.

The UCMF and recreation site are located in the upland with the potential to discharge to nearby streams or wetlands. The UCMF site is located approximately 0.3 mile south of the recreation site and on the east side of Highway 101. Buckley Creek runs parallel to Highway 101, but is setback an average of 400 feet to the west. Because we do not have a completed stormwater management plan from OSU, we do not know the exact discharge points of stormwater associated with the UCMF or the recreation site. Therefore, we assume that stormwater will flow from the UCMF to Highway 101 and then discharge to Buckley Creek or its associated wetlands in the action area, ultimately discharging to the Pacific Ocean. Stormwater from the recreation site will likely flow to nearby wetlands and/or directly to the Pacific Ocean.

There is no recent documentation of OC coho salmon in Buckley Creek. No natural barriers exist between the portion of Buckley Creek affected by the proposed action and its confluence with the Pacific Ocean. Based on the previous discussion above and in Section 2.4.3 (*Environmental Baseline, Terrestrial Action Area*) and the presence of anadromous cutthroat trout, we assume that over the 25-year license period that OC coho salmon would be periodically present in Buckley Creek and are reasonably certain to be exposed to stormwater discharge associated with the proposed action.

Stormwater runoff from impervious surfaces delivers a wide variety of pollutants to aquatic ecosystems, such as metals (e.g., copper and zinc), petroleum-related compounds (e.g., polynuclear aromatic hydrocarbons), and sediment washed off the road surface (Driscoll et al. 1990; Buckler and Granato 1999; Colman et al. 2001; Kayhanian et al. 2003). These pollutants also accumulate in the prey and tissues of juvenile salmon where, depending on the level of exposure, they cause a variety of lethal and sublethal effects including disrupted behavior, reduced olfactory function, immune suppression, reduced growth, disrupted smoltification, hormone disruption, disrupted reproduction, cellular damage, and physical and developmental abnormalities (Fresh et al. 2005; Hecht et al. 2007; LCREP 2007). Aquatic contaminants often travel long distances in solution or attached to suspended sediments, or gather in sediments until they are mobilized and transported by the next high flow (Anderson et al. 1996; Alpers et al. 2000a, 2000b).

Metals tend to accumulate within the body of the fish by binding to phosphate and sulfide groups of various proteins. When the sulfhydryl groups of enzymes are bound, the enzyme activity can be inhibited, potentially causing major disruption of physiological functions and a general decline in fish health (Leland and Kuwabara 1985; Kime 1998). At high enough concentrations, osmoregulatory and hormonal systems can cease to function (LaLiberte and Ewing 2006). Some metals also interfere with olfaction in salmonids (Klaprat et al. 1992). Salmon use olfaction as the major sensory input describing the environment around them. Olfaction has been shown to play important roles in predator avoidance (Brown and Smith 1997; Hiroven et al. 2000; Scholz et al. 2000), recognition of kin (Quinn and Busack 1985; Olsen 1992), homing of adults to natal streams (Wisby and Hasler 1954; Hasler and Scholz 1983; Stabell 1992), and spawning rituals of adults (Sorensen 1992; Olsen and Liley 1993; Moore and Waring 1996).

Heavy metals also interfere with the workings of the immune system in salmonids (Anderson 1989) but the mechanism of interference is not clear (Kime 1998). Metals may affect the immune system directly or the response could result from a stress reaction that elevates cortisol, which subsequently results in immunosuppression (Schreck 1996). Suppression of the immune system increases susceptibility of salmonids to infection by bacteria, fungi, viruses, and parasites. Such infections decrease the vitality of the fish and increase the chances of mortalities due to osmotic imbalance, inability to feed, or predation (LaLiberte and Ewing 2006).

Two of the most studied metals are copper and zinc. Baldwin et al. (2003) exposed juvenile coho salmon to various concentrations of dissolved copper and found reduced olfactory sensory responsiveness. More recent research found reductions in the survival of individuals (Hecht et al. 2007, McIntyre et al. 2012). McIntyre et al. (2012) also determined that relatively brief (3 hours) exposures to dissolved copper eliminated the behavioral alarm response in coho salmon, leading to reduced evasion and reduced survival during predation trials. A review of dissolved zinc toxicity studies reveals effects including reduced growth, behavioral alteration (avoidance), reproduction impairment, increased respiration, decreased swimming ability, increased jaw and bronchial abnormalities, hyperactivity, and hyperglycemia. Juvenile fish are more sensitive. Avoidance of dissolved zinc in juvenile rainbow trout, brown trout, and cutthroat trout has been documented (Sprague 1968 and Birge et al. 1980 as cited in EPA 1987c, Woodward et al. 1995). Lethal and sublethal endpoint of dissolved zinc toxicity have been tested on juvenile rainbow trout (Hansen et al. 2002; EPA 2007).

Although OC coho have not been recently documented in Buckley Creek, they will likely be present and use Buckley Creek periodically during the 25-year license period. A small number of OC coho salmon will be exposed to stormwater contaminants described above and will experience the adverse effects described above that range from sub-lethal to lethal. Thus, a small number of OC coho salmon will be injured or killed by exposure to stormwater discharges.

Summary of effects on ESA-listed salmonids

The proposed action is reasonably certain to result in adverse effects on ESA-listed salmon over the 25-year license period. Adverse effects would occur from predation from changes to marine community composition and behavior; underwater sound associated with WECs, vessel noise, and cable laying; electromagnetic fields (EMF) associated with WECs and cable infrastructure; and stormwater discharge associated with construction of the UCMF and re-paving of the parking lot at Driftwood Beach State Recreation Site. The number of ESA-listed salmonids adversely affected by the proposed action would be small because the effects will be localized within the action area, the presence of ESA-listed salmonids would be short-term (up to a few days), and the action area represents such a small portion of the occupied marine habitat available to ESA-listed salmonids. Effects that are unlikely to adversely affect ESA-listed salmonids include habitat alteration from the anchors, installation of subsea power cables, increased suspended sediments, introductions of toxic substances, and ballast water intake.

For salmonids, the ESU with the most individuals reasonably certain to be adversely affected is the OC coho salmon ESU because its populations are the closest in location to the action area, specifically the Yaquina River population. The number of fish of each remaining ESU adversely affected by the proposed action would vary due to their location relative to the test site but would be small and fewer than the number of OC coho salmon affected. Because the action area represents such a small portion the marine habitat occupied by the 12 salmonid ESUs addressed in this opinion and their distribution is spread out over thousands of square miles of the occupied marine habitatit is unlikely that the proposed action will have a meaningful effect on any populations of LCR, UCR spring-run, UWR spring-run, SR spring-run, SR fall run, CC spring-run, Sacramento River winter-run, or CV spring-run Chinook salmon or LCR, OC, SONCC, or CCC coho salmon.

Summary of effects on green sturgeon

The proposed action is reasonably certain to adversely affect green sturgeon from exposure to underwater sound produced by WECs, vessel traffic, and cable laying operations and EMF associated with project structures. The number of green sturgeon adversely affected would be small because the effects will be localized within the action area, green sturgeon are highly migratory and would only be present in the action area for up to a few days, and the action area represents such a small portion of the occupied marine habitat available to green sturgeon. Because the number of green sturgeon individuals adversely affected by the proposed action is small, the proposed action would not have a meaningful effect on southern DPS green sturgeon.

Summary of effects on eulachon

The proposed action is reasonably certain to adversely affect eulachon from exposure to predation resulting from changes in marine community composition and behavior, underwater sound produced by WECs, vessel traffic, and cable laying operations, and EMF associated with project structures. The number of eulachon adversely affected would be small because the effects will be localized within the action area, eulachon are migratory in the action area and would only be present in the action area for up to a few days, and the action area represents such a small portion of the occupied marine habitat available to eulachon. Because the number of eulachon individuals adversely affected by the proposed action is small, the proposed action would not have a meaningful effect on southern DPS eulachon.

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).

In the action area, some state, tribal, and local government actions contribute to negative cumulative effects. Ongoing activities that occur in the action area include recreational and commercial fishing, derelict fishing gear, oceanographic monitoring and research, and commercial and recreational vessel traffic. These activities introduce stressors to the natural marine environment that result in changes to benthic habitats, changes in species assemblages, water quality contaminants, and noise pollution. Although these factors are ongoing and likely to continue in the future, past occurrence is not a guarantee that these activities will continue at the same level. Whether ongoing adverse effects continue and contribute to cumulative effects will depend on whether there are economic, administrative, and legal impediments (or in the case of contaminants, safeguards). For purposes of this analysis, it is reasonable to assume that cumulative effects of these activities will be commensurate to those of similar past activities, as analyzed in the baseline and will continue to affect marine habitat in the action area.

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.

The status of ESA-listed salmonids, green sturgeon, and eulachon considered in this opinion varies considerably from high risk to moderate risk. Similarly, the individual populations within the ESUs and DPSs affected by the proposed action vary considerably in their biological status. The species addressed in this opinion have declined due to numerous factors. One factor for decline of all species addressed in this opinion is degradation of their habitat. Human development has caused significant negative changes to riverine and estuary habitat quality. Species in the marine analysis areas share factors related to vessel traffic, primarily acoustic noise.

Commercial and recreational fishing, oceanographic research and monitoring, and commercial and recreational vessel traffic have negatively affected the environmental baseline of the marine action area. Development, road construction, and stormwater discharge have negatively affected the terrestrial action area environmental baseline. The long-term decline of ESA-listed salmonids, green sturgeon and eulachon inhabiting the action area reflects these degraded habitat conditions. Climate change will likely exacerbate these degraded conditions in the action area; in particular, increased ocean temperatures, ocean acidification, and sea level rise in the marine action area and increased water temperatures and reduced stream flows in the terrestrial action area.

As presented in the effects analysis above, the proposed action would cause adverse effects on ESA-listed salmon, green sturgeon, and eulachon over the 25-year license period. Adverse effects would occur from underwater sound associated with WECs, vessel noise, and cable laying; electromagnetic fields (EMF) associated with WECs and cable infrastructure; and stormwater discharge associated with construction of the UCMF and re-paving of the parking lot at Driftwood Beach State Recreation Site. However, the overall risk to species is low and the number of fish adversely affects is small for each species over the 25-year license period.

Cumulative effects from future state and private activities in the action area are likely to have a slightly negative effect over time on the species considered in this opinion. Ongoing activities in the action area including development, road construction, and shipping and vessel traffic will continue to negatively affect marine and aquatic habitat and, consequently, ESA-listed species in the action area.

At the ESU or DPS scale, the status of individual populations determines the ability of the species to sustain itself or persist well into the future, thus impacts to individual populations are important to the survival and recovery of the species. Because the adverse effects caused by the proposed action are small in scale and in numbers of fish affected, when we add them to the current population status, environmental baseline, and consider cumulative effects and climate change, we find the proposed action will not appreciably reduce the likelihood of the survival or recovery of any species at the population scale for any of the affected populations. Given our conclusion that the populations will not be impeded in recovery because of the proposed action, it will also not appreciably reduce the likelihood of the survival or recovery of any species at the ESU/DPS level addressed in this opinion.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, 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 LCR, UCR spring-run, UWR spring-run, SR spring-run, SR fall run, CC spring-run, Sacramento River winter-run, or CV spring-run Chinook salmon; LCR, OC, SONCC, or CCC coho salmon; green sturgeon; or eulachon.

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 C.F.R. § 402.16(a), if exceeded.

2.9.1 Amount or Extent of Take

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

- Behavior modification of ESA-listed fish associated with sound from WECs, vessel traffic, and cable laying;
- Behavior modification of ESA-listed fish associated with EMF generated by WECs, power cables, and subsea connectors; and

Accurately quantifying the small number of fish of each species taken by these pathways is not possible. Much of the action area is too deep and velocities are too great to allow observation of injured or killed fish. Furthermore, there are no methods available to monitor this death and injury because it will occur throughout the year over a large area. In such cases, we use a take surrogate or take indicator that rationally reflects the incidental take caused by the proposed action.

The best available indicator for the extent of incidental take associated with acoustic noise is the decibel measurements from WEC devices deployed in the test site. The OSU will implement the AMF, which consists of the acoustic monitoring plan and PMEs #5 and #7. Under PME #7(2) and (3), OSU will implement mitigation measures if: (1) persistent sound associated with one or more WECs is monitored to exceed 120 dB (re: 1µPa) at 100 m (equivalent to 151 dB [re: 1µPa at 1 m]) for 4 or more consecutive days that are not during high sea states;[5] and (2) temporary exceedance of 120 db (re: 1µPa) at 117 m (see Appendix I, OSU 2019) during two separate, but consecutive high sea state conditions. The NMFS uses a conservative exposure threshold for behavior modification of 150 dB (re: 1µPa). The indicator is the exceedance of 150 dB (re: 1µPa at 1 m) at either of the persistent or temporary conditions described above. This indicator is connected causally to the amount of take that will occur from increased sound because the exceedance of behavior threshold translates into an adverse behavior modification of listed species individuals. This metric can also be easily monitored during the proposed acoustic monitoring (Appendix H, OSU 2019) If acoustic monitoring exceeds 150 dB (re: 1µPa) at 1 m under the conditions described above, reinitiation of this consultation may be required.

The best available indicator for the extent of take associated with EMF is the measurement of EMF produced by the WECs, power cables, or subsea connectors. The EMF monitoring plan (Appendix H, OSU 2019) indicated that biologically relevant level of EMF is 3 milliteslas at 10 m from the source for up to 60 days. This will serve as the indicator and is causally linked to the amount of take that will occur because this level of EMF would translate to an adverse modification in behavior of listed species individuals. This metric can also be easily monitored during the proposed EMF monitoring (Appendix H, OSU 2019), allowing the indicator to serve

[5] 'High sea states' are define as conditions that meet the National Oceanic and Atmospheric Administration's small craft advisory definition.

as a clear reinitiation trigger. If EMF monitoring indicates that EMF exceeds 3 milliteslas at 10 m from the source for more than 60 days, then reinitiation of this consultation may be required.

For stormwater, OSU has yet to prepare a stormwater plan for stormwater associated with UCMF and Driftwood Beach State Recreation Site. Because we had no specific stormwater treatment plan or designs, we conducted our stormwater analysis on the assumption that stormwater would discharge from the sites untreated. Thus, the indicator is the 2 acres of impervious surfaces associated with the construction and the re-paving of the Driftwood Beach State Recreation Site, which is causally linked to the take caused by stormwater discharge from the amount of stormwater and contaminants discharged to Buckley Creek and the Pacific Ocean. This indicator is also easily designed and measured, allowing it to serve as a clear reinitiation trigger. If the construction and re-paving of impervious surfaces exceeds 2 acres, reinitiation of this consultation may be required.

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 or destruction or adverse modification of critical habitat.

2.9.3 Reasonable and Prudent Measures

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

1. Minimize incidental take from behavior modification associated with underwater sound produced by the proposed action.
2. Minimize incidental take from behavioral modification associated with EMF generated by the proposed action.
3. Minimize incidental take from stormwater discharge associated with the UCMF and Driftwood Beach State Recreation Site.
4. Conduct monitoring sufficient to document the proposed action does not exceed the parameters analyzed in this opinion 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 FERC or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The FERC or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1) To implement reasonable and prudent measure #1, FERC shall ensure that OSU (licensee will implement the acoustic monitoring plan and PMEs #5 and #7 (mitigation for impacts of

sound from WECs and their mooring systems on marine resources) as part of the adaptive management framework.

2) To implement reasonable and prudent measure #2, FERC shall ensure that OSU (licensee) will implement the EMF monitoring plan and PME #1 (mitigation for potential impacts of EMF on marine resources) as part of the adaptive management framework.

3) To implement reasonable and prudent measure #3, FERC shall ensure that OSU:
    a) Works with NMFS to develop an acceptable stormwater management plan for the UCMF and re-paving of the Driftwood Beach State Recreation Site. The stormwater management plan will include:
        i) Explanation of how runoff from all contributing impervious area that is within or contiguous with the project area will be managed using site sketches, drawings, specifications, calculations, or other information commensurate with the scope of the action.
        ii) Identify the pollutants of concern.
        iii) Identify all contributing and non-contributing impervious areas that are within and contiguous with the project area.
        iv) Describe the BMPs that will be used to treat the identified pollutants of concern, and the proposed maintenance activities and schedule for the treatment facilities.
        v) Provide a justification for the capacity of the facilities provided based on the expected runoff volume, including, e.g., the design storm, BMP geometry, analyses of residence time, as appropriate.
        vi) Include the name, email address, and telephone number of the person responsible for designing the stormwater management facilities that NMFS may contact if additional information is necessary to complete the effects analysis.
        vii) A maintenance, repair, and component replacement plan that details what needs to be done, when, and by whom for each treatment facility.
        viii) Water quality treatment practices and facilities designed to accept and fully treat the volume of water equal to 50% of the cumulative rainfall from the 2-year, 24-hour storm. A continuous rainfall/runoff model may be used instead of runoff depths to calculate water quality treatment depth.
        ix) Water quantity treatment using retention or detention facilities that must limit discharge to match pre-developed discharge rates (i.e., the discharge rate of the site based on its natural groundcover and grade before any development occurred) using a continuous simulation for flows between 50% of the 2-year event and the 10-year flow event (annual series).
        x) Low impact development practices to infiltrate or evaporate runoff to the maximum extent feasible. For runoff that cannot be infiltrated or evaporated and therefore will discharge into surface or subsurface waters, apply one or more of the following specific primary treatment practices, supplemented with appropriate soil amendments:
            (1) Bioretention cell
            (2) Bioslope, also known as an “ecology embankment”
            (3) Bioswale
            (4) Constructed wetlands

(5) Infiltration pond
(6) Media filter devices with demonstrated effectiveness. Propriety devices should be on a list of “Approved Proprietary Stormwater Treatment Technologies” i.e., City of Portland (2008) Stormwater Management Manual. Bureau of Environmental Services.
(7) Porous pavement, with no soil amendments and appropriate maintenance
(8) All stormwater flow control treatment practices and facilities will be designed to maintain the frequency and duration of instream flows generated by storms within the following end-points:
    (a) Lower discharge endpoint, by U.S. Geological Survey (USGS) flood frequency zone: Western Region = 42% of 2-year event
    (b) Upper discharge endpoint
        (i) Entrenchment ratio <2.2 = 10-year event, 24-hour storm
        (ii) Entrenchment ratio >2.2 = band overtopping event

xi) When conveyance is necessary to discharge treated stormwater directly into surface water or a wetland, the following requirements apply:
(1) Maintain natural drainage patterns
(2) To the maximum extent feasible, ensure that water quality treatment for contributing impervious area runoff is completed before commingling with offsite runoff for conveyance.
(3) Prevent of the flow path from the project to the receiving water and, if necessary, provide a discharge facility made entirely of manufactured elements (e.g., pipes, ditches, discharge facility protection) that extends at least to the ordinary high water line.

xii) NMFS will review the proposed stormwater treatment plan.

4) To implement reasonable and prudent measure #4, FERC shall ensure that OSU conducts reporting that ensures the extent of incidental take described in the ITS of this opinion is not exceeded. Reporting shall include:
   a) Annual reporting to NMFS on the results of the benthic sediments, organism interactions, acoustics, and EMF monitoring plans. OSU will contact NMFS within 48 hours of an exceedance of the following:
      i) More than 20 WECs installed at the site at any one time throughout the 25-year license period
      ii) Acoustic monitoring detects sound levels associated with WEC operation or mooring systems greater than 150 dB (re: 1μPA)
      iii) EMF monitoring detects or models EMF levels associated with WECs, subsea connectors, or power cables above 3 milliteslas equal to or greater than 10 m away from the source and the duration that this occurred
   b) Annual reporting on the WEC installation and removal activities including:
      i) The number and type of WECs installed at the test site
      ii) The number and type of WECs removed from the test site
      iii) The number and type of anchors associated with WECs installed or removed including the anchors re-used for WEC installation.
   c) A project completion report that consists of the following:
      i) Project name

ii) Contact name, address, and phone number
iii) Description of implementation of terrestrial HDD for power cable installation that includes:
    (1) Start and stopping dates
    (2) Any instances of frac-out affecting wetlands or streams in the action area
    (3) Explanation of the environmental impacts associated with frac-out, specifically pertaining to ESA-listed OC coho salmon
    (4) Measures taken to avoid or minimize effects of frac-out on ESA-listed salmon
iv) Description of subsea cable laying activities including:
    (1) Start and stopping dates and total number of days of cable laying activities
    (2) Explanation of any work stoppages associate with cable laying activities
    (3) Explanation of the effectiveness of meeting the measures outlined in PME #6 (appendix I, OSU 2019)
    (4) Explanation of any instances where any one of the subsea power cables was unable to be buried in the sea floor including the unburied distance and location and any minimization measures to attenuate EMF associated with the subsea power cables

d) Submit reports to:

ARA, Oregon-Washington Coastal Area Office
NOAA Fisheries, West Coast Region
Attn: WCRO-2019-03469
1201 Lloyd Blvd, Suite 1100
Portland, Oregon 97232-1274

2.10 Conservation Recommendations

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

1. The FERC and OSU should work with NMFS, BOEM and other applicable agencies or entities to direct research related to the effects of acoustics, EMF, and changes in the marine community and behavior associated with WECs or their infrastructure on ESA-listed species and their habitats.

2.11 Reinitiation of Consultation

This concludes formal consultation for the PacWave South Wave Energy Test Site.

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

This determination for ESA-listed species in Table 5 and proposed southern resident killer whale critical habitat, green sturgeon critical habitat, and leatherback sea turtle critical habitat was prepared by us pursuant to section 7(a)(2) of the ESA, implementing regulations at 50 CFR 402 and agency guidance for preparation of letters of concurrence.

Table 5. Listing status, status of critical habitat designations and protective regulations, and relevant Federal Register (FR) decision notices for ESA-listed species considered in this section. 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**
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
Sockeye salmon (*O. nerka*)			
Snake River	E 8/15/11; 70 FR 37160	12/28/93; 58 FR 68543	ESA section 9 applies
Steelhead (*O. mykiss*)			
Lower Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Middle Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	2/1/06; 71 FR 5178
Snake River Basin	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Northern California	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Central California Coastal	T 4/14/14; 79 FR 20802	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
California Central Valley	T 4/14/14; 79 FR 20802	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
South-Central California Coast	T 4/14/14; 79 FR 20802	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Killer whale (*Orcinus orca*)			
Southern Resident DPS	E 11/18/05; 70 FR 69903	11/29/06; 71 FR 69054	ESA section 9 applies
Humpback Whale			
Mexico DPS	T 9/8/16; 81 FR 62259	Not applicable	ESA section 9 applies
Central America DPS	E 9/8/16; 81 FR 62259	Not applicable	ESA section 9 applies
Blue Whale (*Balaenoptera musculus*)	E 12/02/70; 35 FR 18319	Not applicable	ESA section 9 applies
Sei Whale (*Balaenoptera borealis*)	E 12/02/70; 35 FR 18319	Not Applicable	ESA section 9 applies
Sperm whale (*Physeter catodon*)	E 12/02/70	Not Applicable	ESA section 9 applies
Leatherback turtle (*Dermochelys coriacea*)	E 6/02/70 ; 39 FR 19320	1/26/12; 77 FR 4170	ESA section 9 applies
Green turtle (*Chelonia mydas*)	ET 7/28/78 43 FR 32800	9/02/98; 63 FR 46693	ESA section 9 applies
Olive ridley turtle (*Lepidochelys olivacea*)	ET 7/28/78 43 FR 32800	Not Applicable	ESA section 9 applies
Northern DPS Loggerhead turtle (*Caretta caretta*)	T 7/28/78 43 FR 32800	Not Applicable	7/28/78; 43 FR 32800

The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Discountable effects are those extremely unlikely to occur. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs or where alteration of any PBFs of critical habitat reduces those features' ability to support listed species' conservation needs in the action area. Beneficial effects are contemporaneous positive effects without any adverse effect on the listed species or critical habitat. In terms of critical habitat, completely beneficial effects are positive only: an action cannot be deemed wholly beneficial if it has any adverse effect on critical habitat.

The proposed action and the action area for this consultation are described in the Introduction to this document (Sections 1.3 and 1.4).

2.12.1 ESA-Listed Salmonids

Table 5 shows the 11 ESUs of ESA-listed steelhead and sockeye and chum salmon analyzed in this analysis. Individuals from these species could occasionally be found in the action area, but their occurrence is likely to be rare. The far southern extent of the species range for chum and sockeye salmon is documented to occur on the central Oregon Coast (45° N) for chum salmon (Salo 1991, NPAFC 2012) and southward to 44°29'N for sockeye salmon (NPAFC 2012), all of which are north of the action area. Juvenile steelhead have been shown to move quickly from freshwater to areas beyond the continental shelf, often to the far western Pacific Ocean and along mid-ocean and northern areas of the Pacific, far from the action area (Burgner et al 1992, Myers et al 2007). Based on this information the likelihood of occurrence of these species in the nearshore Oregon coast is very unlikely and occurrence within the small area of the test site (3.4 km^2) is even more unlikely. Because of this, it is reasonably unlikely that exposure of ESA-listed steelhead, sockeye, and chum salmon to the effects of the proposed action will occur. Thus, the effects of the proposed action on individuals of the 11 ESA-listed steelhead, sockeye, and chum salmon ESUs listed in Table 5 are discountable.

2.12.2 ESA-Listed Marine Mammals

Marine mammals potentially affected by the proposed action include Southern Resident (SR) killer whales, humpback whales (Mexican and Central American DPSs), blue whales, sei whales, and sperm whales. The FERC did not request consultation for Western North Pacific gray whales, but given their potential to be in the action area, we included them in our analysis.

Species	Occurrence action area
Southern Resident killer whales	The SR killer whales are primarily found in the inland and coastal waters of Washington from April to October. In the winter and early spring, SR killer whales move into coastal waters and have occurred in Oregon waters with observations extending as far south as Monterey Bay in California and as far north as southeast Alaska (NMFS 2008). While these are seasonal patterns, SR killer whales have the potential to occur in the project vicinity throughout the year.

Species	Occurrence action area
Humpback whales (Mexican and Central American DPSs)	Humpback whales off the coast of California/Oregon/Washington are primarily from the non-listed Hawaii distinct population segment (DPS) and the threatened Mexico DPS, with a very small proportion from the endangered Central America DPS (Wade et al. 2016). The California/Oregon/Washington Stock is defined to include humpback whales that feed off the west coast of the United States. Two feeding groups are identified, California/Oregon and Washington/southern British Columbia.
Blue whales	Occasionally observed off Oregon, blue whale distribution and abundance of the eastern North Pacific (ENP) stock appears to be greater from central to Southern California and primarily distributed offshore out to the exclusive economic zone (EEZ) (Carretta et al. 2014). Although there is potential for blue whales to occur along the Oregon Coast, available data indicate that occurrence is likely to be rare in the action area.
Sei whales	Sei whales have a global distribution and occur in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere (NMFS 2011c). The species is cosmopolitan, but with a generally anti-tropical distribution centered in the temperate zones. Sei whales are distributed far out to sea in temperate regions of the world and do not appear to be associated with coastal features (Caretta et al. 2013).
Western North Pacific (WNP) gray whales	Western North Pacific gray whales are found from Russian foraging areas along the Aleutian Island, through the Gulf of Alaska, and south to the Washington and Oregon coasts (Mate et al. 2011), and to the southern tip of Baja California and back to Sakhalin Island (IWC 2012). The most recent abundance estimate for the Western North Pacific gray whale stock is 290 individuals. 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 2010, Mate et al. 2011, Weller et al. 2012, Urban et al. 2013). Although there is potential for Western North Pacific gray whales to occur along the Oregon coast, available data indicate that occurrence is likely to be rare in the action area.
Sperm whales	Sperm whales. Sperm whales of the California/Oregon/Washington stock were occasionally observed in Oregon waters with most observations occurring well offshore (Carretta et al. 2013). Sperm whales are seen off Washington and Oregon in every season except winter (Green et al. 1992).
Fin whales	Observations of the California/Oregon/Washington stock of fin whales off of Oregon were common with aggregations of fin whales observed off of Oregon in the summer (Carretta et al. 2014). Additionally, acoustic signals from fin whales are detected year around in northern California, Oregon, and Washington, with a concentration of vocal activity between September and February. They are well distributed across the EEZ (Carretta et al. 2014). Although there is potential for fin whales to occur along the Oregon Coast, available data indicate that occurrence is likely to be rare in the action area.

During standard-line transect surveys in the action area Henkel et al. (2019) observed or detected 20 humpback whales, four killer whales, and one fin whale. Henkel et al (2019) did not detect any blue whales, but there were four sightings near the Oregon coast during shipboard surveys between 1991 and 2008 (Carretta et al. 2015). Based on shipboard surveys off Oregon in 1991-2008, sei and sperm whales occur in deeper waters further offshore than the action area (Carretta et al. 2015), and would not be expected to occur within the action area due to their offshore distribution.

Blue, sei, fin, WNP gray whales, and sperm whales are not generally distributed nearshore, and their presence in the action area is unlikely. Humpback whales and Southern Resident killer whales are more likely to occur nearer to the shore, but their presence in the action area will be likely infrequent and transitory. The effects of the proposed action include changes in marine community composition and behavior; changes to water quality associated with suspended sediment and contaminants; increased sound associated with vessel traffic, cable laying, and WECs; collisions with vessels; and entanglements associated with mooring and anchoring systems. While there is potential for individuals of these whale species to be exposed to the effects of the proposed action, the rare, infrequent, and transitory nature of their exposure results in a low probability of exposure. The most likely exposure of individuals of these whale species to effects of the proposed action would occur from sound or interactions with WEC mooring and anchoring systems (entanglement).

Sound exposure may occur from WEC operation, vessel traffic, or cable laying. The opinion describes the sound levels associated with each potential exposure pathway which indicates there is potential for sound to exceed the 120 dB RMS (re: 1µPa) behavioral modification threshold for marine mammals. Individual whales may perceive noise from these project activities and may respond briefly, but they would likely avoid the source resulting in short-term and minor response that is unlikely to adversely modify their behavior. Therefore, effects from sound are insignificant and not likely to adversely affect individual ESA-listed whales.

Entanglement may occur from individual whales' interactions with mooring and anchoring cables and umbilical cables. The likelihood of entanglement is low due to the rare, infrequent, and transitory occurrence of ESA-listed whales in the action area. Additionally, the mooring lines and umbilical cables would be more substantial then fishing or crab pot lines, which are more likely to represent an entanglement risk for whales. The potential for entanglement would be reduced by the substantial tension on the mooring lines and umbilical cables, which would likely act more like a structure in the water column. There is potential for fishing or crab pot lines to become entangled in the mooring and umbilical cables, but the OSU will annually inspect these lines for fishing gear and remove it if it is found. Based on this discussion, the probability of entanglement is low enough that entanglement of ESA-listed whale individuals is extremely unlikely and is therefore, discountable.

Vessel traffic from the proposed action is mostly associated with small vessels for monitoring and operation and maintenance activities. Larger vessels for installation and removal of the WEC and mooring and anchoring systems would also travel to the site on an annual basis. Vessel traffic is presented in the BA (appendix A, OSU 2019) and in Section 2.4.1 of this opinion.

For 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 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. The annual level of human-caused mortality for this stock from 2007 to 2011 is zero animals per year (Carretta et al. 20139).

Although the range of southern resident killer whale overlaps with the action area, few sightings of them occur of the coast of Oregon. From 1982-2016, of the 49 confirmed sightings of southern resident killer whales in coastal waters off the western U.S., only eight occurred off Oregon (NMFS 2019). No documented southern resident killer whale deaths or strandings have occurred near the action area. The OSU would also use NOAA's "Be Whale Wise" guidelines to minimize vessel interactions with whales. The relatively small action area, low presence of killer whale in the action area, use of the "Be Whale Wise" guidelines, 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.

For Blue, sei, fin, humpback, WNP gray whales, and sperm whales the probability of vessel interactions is unlikely because their occurrence off the Oregon Coast and in the action area is rare. Additionally, the vessels are slow moving or stationary during monitoring, follow a predictable course, and thus should be easily detected and avoided by marine mammals. The OSU would also use NOAA's "Be Whale Wise" guidelines to minimize vessel interactions with whales. Based on this discussion, the probability of vessel interactions combined with the probability of whale occurrence in the action area are low enough that vessel strikes are discountable.

2.12.3 ESA-Listed Marine 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 1998a). Stranding reports indicate that the green sea turtle appears to be a resident in waters off San Diego Bay, California (NMFS and USFWS 1998a) 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.

Loggerhead sea turtles inhabit continental shelves, bays, estuaries, and lagoons in the Atlantic, Pacific, and Indian Oceans (NMFS and USFWS 1998b). 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.

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 1998c). In the eastern Pacific, nesting largely occurs off southern Mexico and northern Costa Rica (NMFS and USFWS 1998c). Although there is potential for olive ridley sea turtles to occur along the Oregon coast, available data indicate that occurrence is likely to be rare in the action area.

We do not have reliable abundance estimates for the foraging population of leatherback sea turtles in Oregon and Washington waters. Greatest densities are found off central California and in waters off the Columbia River (Benson et al. 2011). These areas have oceanographic retention areas or upwelling shadows that create favorable habitat for leatherback sea turtle prey, mainly cnidarians (medusae, siphonophores) and tunicates (salps, pyrosomas) (NMFS and USFWS 1998d). The critical habitat analytical review team (CHART) identified the Columbia River plume (46th parallel) and the Heceta Bank (44th parallel) as two important foraging areas off the Oregon Coast (NMFS 2012b). Suchman and Brodeur (2005) indicated favorable habitat for leatherbacks at Heceta Bank and Cape Blanco (). These areas are productive due to conditions conducive to growth of gelatinous prey (Benson et al. 2011). Aerial surveys conducted by NMFS and results of experimental driftnet fishery interactions off Oregon and Washington between 2003 and 2011 resulted in very few sightings of leatherback sea turtles. All but one sighting were close to or above the 45th parallel (NMFS unpublished data). The action area likely acts as a transitory area where leatherback turtles migrate between forage areas, thus their presence in the action may occur, but they will not spend a significant amount of time there.

Based on the information above there is low probability that marine turtles would be exposed to the effects action because of their rare occurrence and transitory use of the action area. In the event an individual were in the action area they will not spend a significant amount of time in the action area that would elicit an adverse individual response. Therefore, the proposed action is not likely to adversely affect marine turtles in the action area.

2.12.4 Critical Habitat

The action area is designated critical habitat for green sturgeon and leather back sea turtles. Recently, designated critical habitat was proposed for SR killer whales and humpback whales that includes the action area. The FERC did not address OC coho salmon designated critical habitat in their BA, for which Yaquina Bay is designated. Therefore, we include designated critical habitat in our analyses here.

OC coho salmon Critical Habitat

The Yaquina Bay estuary portion of the action area is designated critical habitat for OC coho salmon. The PBFs of critical habitat in the estuarine action area that support growth and development of OC coho salmon include forage, natural cover, water quality, water quantity, salinity, and passage free of obstruction. The marine action area where PacWave South is located is not designated critical habitat for OC coho salmon. The PBF that is reasonably certain to be affected would be water quality associated with habitat alteration from toxic substances introduced by the proposed action. After our independent review of the BA, we found that the BA accurately described this pathway. Therefore, we adopt the BA's analysis of this pathway. To summarize, release of toxic substances would not result in high enough concentrations for a long enough time to adversely affect the water quality PBF in the estuarine action area. Thus, the proposed action would not reduce the quality and function of water quality in the action area.

Green sturgeon critical habitat

The marine action area is designated critical habitat for green sturgeon within the 60-fathom line. The PBFs that are essential for the conservation of green sturgeon include migratory food resources, migratory corridors, and water quality. The proposed action would affect food resources, migratory corridors, and water quality.

Food resources. Green sturgeon food resources would be affected by anchors on the seabed, unburied cables, and jet plowing in the subsea cables. The effects on green sturgeon food resources will reduce abundance of green sturgeon prey organisms in the action area. The effects on prey organisms will be localized to 48 acres from disturbance associated with the anchors (full build-out), 2.8 acres associated with the subsea cable trenches, and 0.1 acre associated with the unburied power cables, which is 3.5 percent of the action area. The disturbance will spread out over the action area resulting in a patchy distribution of effected areas. Additionally, the effect on the abundance or food resources is short-term because prey organisms would quickly recolonize the affected areas. Because the effects are localized in the action area and short-term, and therefore insignificant, the proposed action will not reduce the quality and function of this PBF.

Water quality. The BA also discussed potential pathways for reducing water quality including increased suspended sediment, anti-fouling substances on the WECs and accidental spills of toxic fluids from WECs. Suspended sediment levels would temporarily increase over background when sand and some fine sediment were disturbed during installation and removal of anchors and subsea power cables. Suspended sediments would increase for a short time, with the highest concentrations occurring in the immediate vicinity of each anchor, and then rapidly disperse with local ocean currents. Copper leachate from antifouling coatings is not expected to result in copper concentrations, which would exceed thresholds for aquatic species in the action area. OSU proposed minimization measures including implement either an approved Spill Prevention, Control, and Countermeasure plans or a Spill Contingency and Emergency Response plan, a process designed to significantly reduce the likelihood of a spill and chemical contamination in the action area. The plans would include actions to ensure that any spills that do occur are quickly contained. Therefore, due to the short duration of exposure to suspended sediment levels, the reduced risk of chemical contamination, and the pre-planning for rapid detection and cleanup of any spills that do occur, the proposed action is not likely to reduce the function and quality of this PBF.

Migratory corridor. EMF may affect safe passage in the migratory corridor by delaying or impeding passage through the action area. Studies have shown that migratory behavior can be modified when EMF is present in the migratory corridor (Kavet et al. 2016), but EMF is unlikely to impact the migratory corridor such that it would result in unsuccessful inbound or outbound migration of green sturgeon. Additionally, the proposed project footprint which would generate and propagate EMF is small compared to the size of the action area and coastal marine area of green sturgeon critical habitat, EMF would be minimized by burial of the subsea power cables, and EMF would be dispersed throughout the action area and unlikely to affect but a small portion of the water column. Based on the above considerations, the quality and function of safe passage in designated critical habitat is not likely to be adversely affected by the proposed action.

Leatherback turtles

The proposed action may affect critical habitat for leatherback sea turtles. Based on the natural history of the species and their habitat needs, NMFS designated critical habitat based on occurrence of prey species (jellyfish) of sufficient condition, distribution, diversity, and abundance and density necessary to support individual as well as population growth, reproduction, and development (NMFS 2011c). Hypothetically, sound, EMF, structural habitat alterations, and/or chemical contamination in the action area could result in intermittent, localized changes to the aquatic species community, directly or indirectly affecting jellyfish prey (e.g., if other species that prey on jellyfish are attracted to or deterred from the site). However, these sea turtles are not anticipated to forage or spend extended amounts of time in the action area. Thus, any effects to jellyfish (their preferred prey) in the action area are unlikely to affect the quality and function of this PBF. Therefore, the proposed action is not likely to adversely affect critical habitat for leatherback turtles.

Proposed critical habitat for SR killer whales

The proposed action may affect forage for SR killer whales by reducing availability of their primary prey, Chinook salmon. The proposed activities are not expected 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 than zero by multiple decimal places (based on NMFS previous analyses of the effects of salmon harvest on Southern Resident killer whales. 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.

Proposed critical habitat for humpback whales

The marine action area is proposed critical habitat for humpback whales. The only PBF designated for critical habitat is prey. As described above the proposed action would leach chemicals from antifouling paint and potential accidental spills, which could affect prey resources of humpback whales. However, the effects of the proposed action on abundance of prey resources are reasonably unlikely to be meaningful because the action area consists of such a small portion of rangewide critical habitat designation for humpback whales. Therefore, the proposed action will not reduce the quality and function of the prey PBF for humpback whales.

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 FERC and descriptions of EFH for Pacific Coast groundfish (PFMC 2005), coastal pelagic species (CPS) (PFMC 1998), Pacific Coast salmon (PFMC 2014); and highly migratory species (HMS) (PFMC (2007) 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 PFMC described and identified EFH for Pacific coast groundfish (PFMC 2005), Pacific salmon (PFMC 2014), coastal pelagic species (PFMC 1998), and HMS (PFMC 2007). The proposed action and action area for this consultation are described in the Introduction to this document (section 1). The action area includes areas designated as EFH for various life-history stages of Pacific coast groundfish, Pacific salmon, coastal pelagic species, and HMS (Table 6). In addition, the following habitat area of particular concern is present in the action area: estuarine.

Table 6. Species with designated EFH found in waters of Oregon and Washington.

Groundfish Species	
Leopard shark (*Triakis semifasciata*) Soupfin shark (*Galeorhinus zyopterus*) Spiny dogfish (*Squalus acanthias*) Big skate (*Raja binoculata*) California skate (*R. inornata*) Longnose skate (*R. rhina*) Ratfish (*Hydrolagus colliei*) Pacific rattail (*Coryphaenoides acrolepsis*) Lingcod (*Ophiodon elongatus*) Cabezon (*Scorpaenichthys marmoratus*) Kelp greenling (*Hexagrammos decagrammus*) Pacific cod (*Gadus macrocephalus*) Pacific whiting (Hake) (*Merluccius productus*) Sablefish (*Anoplopoma fimbria*) Aurora rockfish (*Sebastes aurora*) Bank Rockfish (*S. rufus*) Black rockfish (*S. melanops*) Blackgill rockfish (*S. melanostomus*) Greenspotted rockfish (*S. chlorostictus*) Greenstriped rockfish (*S. elongatus*) Longspine thornyhead (*Sebastolobus altivelis*) Shortspine thornyhead (*Sebastolobus alascanus*) Pacific Ocean perch (*S. alutus*) Quillback rockfish (*S. maliger*) Redbanded rockfish (*S. babcocki*) Redstripe rockfish (*S. proriger*) Rosethorn rockfish (*S . helvomaculatus*) Rosy rockfish (*S. rosaceus*) Blue rockfish (*S. mystinus*) Bocaccio (*S. paucispinis*) Brown rockfish (*S. auriculatus*) Canary rockfish (*S. pinniger*)	Chilipepper (*S. goodei*) China rockfish (*S. nebulosus*) Copper rockfish (*S. caurinus*) Darkblotched rockfish (*S. crameri*) Grass rockfish (*S. rastrelliger*) Rougheye rockfish (*S. aleutianus*) Sharpchin rockfish (*S. zacentrus*) Shortbelly rockfish (*S. jordani*) Shortraker rockfish (*S. borealis*) Silvergray rockfish (*S. brevispinus*) Speckled rockfish (*S. ovalis*) Splitnose rockfish (*S. diploproa*) Stripetail rockfish (*S. saxicola*) Tiger rockfish (*S. nigrocinctus*) Vermillion rockfish (*S. miniatus*) Widow Rockfish (*S. entomelas*) Yelloweye rockfish (*S. ruberrimus*) Yellowmouth rockfish (*S. reedi*) Yellowtail rockfish (*S. flavidus*) Arrowtooth flounder (*Atheresthes stomias*) Butter sole (*Isopsetta isolepsis*) Curlfin sole (*Pleuronichthys decurrens*) Dover sole (*Microstomus pacificus*) English sole (*Parophrys vetulus*) Flathead sole (*Hippoglossoides elassodon*) Pacific sanddab (*Citharichthys sordidus*) Petrale sole (*Eopsetta jordani*) Rex sole (*Glyptocephalus zachirus*) Rock sole (*Lepidopsetta bilineata*) Sand sole (*Psettichthys melanostictus*) Starry flounder (*Platyichthys stellatus*)
Coastal Pelagic Species	
Northern anchovy (*Engraulis mordax*) Pacific sardine (*Sardinops sagax*) Pacific mackerel (*Scomber japonicus*)	Jack mackerel (*Trachurus symmetricus*) Market squid (*Loligo opalescens*)
Pacific Salmon	
Coho salmon (*O. kisutch*)	Chinook salmon (*O. tshawytscha*)
Highly Migratory Species	
Striped marlin (*Kajikia audax*) Swordfish (*Xiphias gladius*) Common thresher shark (*alopias vulpinus*) Shortfin mako shark (*isurus oxyrinchus*) Blue shark (*Prionace glauca*) North Pacific albacore (*Thunnus alalunga*)	Yellowfin tuna (*Thunnus albacores*) Bigeye tuna (*Thunnus obesus*) Skipjack tuna (*Katsuwonus pelamis*) Pacific Bluefin tuna (*Thunnis orientalis*) Dorado (*Coryphaena hippurus*)

3.2 Adverse Effects on Essential Fish Habitat

The ESA portion of this document describes the adverse effects of this proposed action on coho 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 that the proposed action will adversely affect designated EFH due to construction and operation of the proposed action. Where our ESA analysis does not agree with the effects on EFH is the changes to benthic habitat and marine community composition and behavior associated with the WECs and their anchor and mooring systems.

Potential adverse effects to Pacific salmon, groundfish, coastal pelagics, and highly migratory species include:

- Increased suspended suspended sediments from seafloor disturbance associated with installing and removing anchoring systems and jet plowing for power cable trenching;
- Introduction of contaminants from antifouling paint and petroleum products associated with WECs and vessel trips and introduction of stormwater contaminants associated with the UCMF and Driftwood Beach State Recreation Site;
- Increased underwater sound associated with vessel traffic, cable laying, and WEC operation;
- Introduction of EMF associated with power cables, WECs, and anchoring and mooring systems; and
- Changes to benthic habitat and marine community composition and behavior associated with the WECs and their anchor and mooring systems.

The EFH assessment in the BA (Appendix A, OSU 2019) analyzed the changes in the marine species community and behavior from the project structures (i.e., WECs, anchors, moorings, umbilicals, hubs, and subsea connections) and the effects of this on EFH. At full build-out, seafloor structure could include up to 100 anchors that would occupy a total footprint of up to 90,800 ft2 (2.1 acres). The placement of anchors on the seafloor could result in localized areas of scour or deposition. Scour depths may be up to 1 m and sedimentary changes may extend as far from the anchors as 20 m (Henkel et al. 2014). If an additional 20-m radius was included around each anchor to consider scour development and sediment re-deposition, the total direct and indirect disturbance surface area is anticipated to be approximately 21,124 ft2 per anchor (which assumes a 164-foot diameter of direct and indirect disturbance). For the full build-out scenario with 100 anchors, this could result in approximately 48 acres, or 3 percent of the total marine action area being potentially affected. Full build-out would also include water column and/or surface structure of up to 20 WECs (each separated by a distance of 50 to 200 m or more) and associated moorings and umbilicals (total area occupied within the water column is uncertain).

Food resources and benthic habitat would be lost within the footprint of the anchors and subsea connectors (up to about 2 acres of direct disturbance) because these structures would cover the substrate and any substrate dwelling organisms would be buried, causing a slight decrease in forage abundance and the amount of available habitat for groundfish, coastal pelagic species, and highly migratory species.

The BA (Appendix A, OSU 2019) presented scientific information that suggests that the project structures could attract marine species such as bio-fouling organisms (Boehlert et al. 2008), marine fish (Castro et al. 2002, Nelson 2003), birds, and pinnipeds (Appendix A, OSU 2019).

Boehlert et al. (2008) reported that structures would likely become colonized ("biofouled") by algae and invertebrates, such as barnacles, mussels, bryozoans, corals, tunicates, and tube-dwelling worms and crustaceans and that changes in benthic habitat will occur due to litter fall from marine fouling communities that will form on the WECs, mooring lines, and anchors (Boehlert et al. 2008). Based on surveys at PacWave North, changes to the benthic habitat (particularly shell hash accumulation) may be expected to occur up to 250 meters away from an anchor installation (Appendix A, OSU 2019).

Some types of pelagic fishes are also known to associate with floating objects (Castro et al. 2002, Nelson 2003). So, project structures in the water column and at the surface (e.g., WECs, marker buoys and mooring lines) and associated biofouling might act as fish aggregating devices (FADs) and attract pelagic fishes through visual and/or olfactory cues (Dempster and Kingsford 2003). Project structures at or near the seafloor may also act as artificial reefs and provide habitat for structure-oriented fishes, such as rockfish (Danner et al. 1994, Love and Yoklavich 2006, Kramer et al. 2015), potentially affecting groundfish EFH. At existing wind and wave energy projects having both seafloor and vertical structure in cold-temperate waters of Europe, none reported a measurable "FAD effect", but all of them reported an artificial reef effect where demersal fish were attracted (e.g., Wilhelmsson et al. 2006, Langhamer et al. 2009, Leonhard et al. 2011, Bergstrom et al. 2013, Reubens et al. 2014, Krone et al. 2013). In temperate ocean waters of California, Oregon, and Washington, fish associations with midwater and surface structures were generally limited to pelagic juvenile rockfishes, which have been reported at various structures such as attached kelp (Matthews 1985, Bodkin 1986, Gallagher and Heppell 2010), floating kelp (Mitchell and Hunter 1970, Boehlert 1977), oil platforms (Love et al. 2010, 2012), and vertical structures of docks and pilings (Gallagher and Heppell 2010). Attraction to project structures could alter the fish species composition in and around the action area, and may affect predator/prey interactions (Wilhelmsson and Langhamer 2014).

In a study assessing the use of oil platforms by sea lions off the coast of California, sea lions were frequently observed hauled out on oil platforms and observed feeding on rockfish and spiny dogfish (BOEM 2016, Orr et al. 2017). Schools of fish within one kilometer of the platform were observed being attacked by several predators, including California sea lions, common dolphins, minke whales, gulls, brown pelicans, cormorants, and others (BOEM 2016, Orr et al. 2017). In addition, California and Stellar sea lions are regularly seen hauled out on offshore buoys off Oregon, suggesting that marine renewable energy platforms would be used by pinnipeds, when accessible.

The BA (Appendix A, OSU 2019) suggested that cormorants and brown pelicans might roost on above-surface structures of WECs. However, use by marine birds is not limited to only cormorants and brown pelicans. This is supported by Grecian et al. (2010), who states that construction of new structures in the marine environment creates roosting sites that are quickly used by marine birds, as found around oil platforms (Wiese et al. 2001, as cited in Grecian et al. 2010).

The attraction of demersal fish and biofouling organisms project structures would likely increase foraging opportunities for some species and life stages of groundfish, coastal pelagic species, and highly migratory species while predator/prey interactions between pinnipeds, birds, and larger marine fish on adult and younger life stages of groundfish, coastal pelagic species, and highly migratory species would likely increase.

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 EFH. All of these conservation recommendations are a subset of the ESA terms and conditions.

1. Minimize adverse effects to EFH from changes to benthic habitat and marine community composition by implementing the monitoring plans for benthic sediments and organism interactions; and implement PME #2 (mitigation for benthic habitats from anchors, WECs, and other equipment during operation, maintenance, and monitoring activities), PME #4 (mitigation for organism interaction), and #8 (mitigation for pinniped haul out on WECs and marine project structures) as part of the adaptive management framework.
2. Minimize adverse effects to EFH from underwater noise, as stated in term and condition #1 of the accompanying opinion.
3. Minimize adverse effects to EFH from EMF, as stated in term and condition #2 of the accompanying opinion.
4. Minimize adverse effects to EFH from stormwater discharges, as stated in term and condition #3 of the accompanying opinion.
5. Ensure completion of a monitoring and reporting program to confirm the proposed action is meeting the objectives of limiting adverse effects on EFH, as stated in term and condition #4.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, approximately 1,695 acres of designated EFH for*:* Pacific Coast salmon, Pacific Coast groundfish, coastal pelagic species, and highly migratory species.

3.4 Statutory Response Requirement

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

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

3.5 Supplemental Consultation

The FERC 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.

5.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are FERC. Other interested users could include OSU. Individual copies of this opinion were provided to the BOEM. 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.

5.2 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.

5.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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