ENVIRONMENTAL ASSESSMENT
FOR HYDROPOWER LICENSE

PacWave South Project
FERC Project No. 14616-001
Oregon

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
888 First Street, NE
Washington, DC 20426

In Cooperation with
the Bureau of Ocean Energy Management
and the Department of Energy

April 2020

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

AC	Alternating current
AIS	Automatic Identification System
ALP	Alternative Licensing Process
APE	Area of potential effect
APEA	Applicant-prepared Environmental Assessment
BA	Biological Assessment
BIA	Biologically Important Areas
BPA	Bonneville Power Administration
BOEM	Bureau of Ocean Energy Management
BMPs	Best Management Practices
CLPUD	Central Lincoln People's Utility District
CEQ	Council on Environmental Quality
CWA	Clean Water Act
CWG	Collaborative Workgroup
CZMA	Coastal Zone Management Act
dB	Decibels
DLA	Draft License Application
DLCD	Department of Land Conservation and Development
DPS	Distinct population segment
DPV	Dynamic Positioning Vessels
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DSL	Department of State Lands
EA	Environmental Assessment
EFH	Essential Fish Habitat
EMEC	European Marine Energy Centre
EMF	Electromagnetic field
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
ESA	Endangered Species Act
ESU	Evolutionarily significant unit
FAD	Fish aggregation device
FERC	Federal Energy Regulatory Commission
FINE	Fishermen Involved in Natural Energy
FLA	Final License Application
FMP	Fishery Management Plan
FPA	Federal Power Act
FR	Federal Register
ft	Feet
FWS	U.S. Fish and Wildlife Service
G	Gauss

HAPC	Habitat Area of Particular Concern
HDD	Horizontal directional drilling
IHA	Incidental Harassment Authorization
km	Kilometer
kW	Kilowatts
kW/m	Kilowatts per meter
LASAR	Laboratory Analytical Storage and Retrieval
m	Meter
MARS	Monterey Accelerated Research System
MBTA	Migratory Bird Treaty Act
MLLW	Mean lower low water
MMPA	Marine Mammal Protection Act
MOU	Memorandum of Understanding
MW	Megawatt
NAVFAC	Naval Facilities Engineering Command
NDBC	National Data Buoy Center
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
OAR	Oregon Administrative Rules
O&M	Operations and Maintenance
OCS	Outer Continental Shelf
Oregon DEQ	Oregon Department of Environmental Quality
Oregon DFW	Oregon Department of Fish and Wildlife
Oregon DOE	Oregon Department of Energy
Oregon DOT	Oregon Department of Transportation
OOI	Ocean Observatories Initiative
Oregon PRD	Oregon Parks and Recreation Department
OPT	Ocean Power Technologies
OSU	Oregon State University
OWC	Oscillating water columns
OWET	Oregon Wave Energy Trust
PAD	Pre-Application Document
Park Service	U.S. Department of the Interior, National Park Service
PBF	physical and biological features
PMEC-NETS	Pacific Marine Energy Center North Energy Test Site
PMEC-SETS	Pacific Marine Energy Center South Energy Test Site
PM&E	Protection, Mitigation and Enhancement
PCE	Primary constituent element
PDEA	Preliminary Draft Environmental Assessment
PFMC	Pacific Fishery Management Council

PSU	Practical salinity units
RMS	Root mean square
ROV	Remotely operated vehicle
SCADA	Supervisory control and data acquisition
SEL	Sound exposure level
SHPO	State Historic Preservation Office
SPCC	Spill Prevention, Control and Countermeasure
SPL	Sound pressure level
T	Tesla
TSP	Territorial Sea Plan
TTS	Temporary threshold shift
UCMF	Utility Connection and Monitoring Facility
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
WEC	Wave energy converter
μPa	micro Pascal
$\mu Pa^2 s$	micro Pascal squared second

EXECUTIVE SUMMARY

Proposed Action

On May 31, 2019, Oregon State University (OSU) filed an application with the Federal Energy Regulatory Commission (FERC or Commission) for a license to construct and operate a wave energy test facility for the proposed up to 20-megawatt (MW) PacWave South Hydrokinetic Project (PacWave South Project or project). The project would consist of both marine (offshore) and terrestrial (onshore) components. Project facilities would be located on the Outer Continental Shelf (OCS) in the Pacific Ocean, approximately 6 nautical miles off the coast of Newport, Oregon, and in Oregon territorial waters. The project would occupy an area of approximately 2.65 square miles (1,695 acres) on the OCS, administered through a lease (Figure 1-1) by the Bureau of Ocean Energy Management (BOEM) within the U.S. Department of the Interior. The project, funded in part by the Department of Energy (DOE), would generate an average of about 70,000 to 175,000 megawatt-hours of energy annually.[1]

Project Description and Proposed Facilities

The proposed project would consist of: (1) four offshore test berths containing a maximum of 20 wave energy conversion (WEC) devices with a maximum total installed capacity of 20 MW; (2) various anchoring systems including gravity-based anchors, suction anchors, plate anchors, and drag embedment anchors, constructed with steel, concrete, or a mixture of steel and concrete; (3) single- or three-point mooring systems consisting of chain, steel cables, or synthetic materials; (4) mooring infrastructure including surface buoys, subsurface floats, and chain, wire or rope, as catenary, tendon or bridle lines; (5) subsea connectors; (6) five 8.3-nautical-mile-long buried subsea transmission cables[2] converging in five nearshore conduits; (7) five 10-foot by 10-foot by 10-foot onshore cable landing vaults and beach manholes at Driftwood Beach State Recreation Site (Driftwood); (8) five or fifteen 0.4-miles-long buried terrestrial transmission lines[3] (carried in 1-3 conduits) connecting to a Utility Conditioning and

---

[1] Energy generated by the project would vary over the license term as the number of wave energy converters deployed increases gradually as the technology advances.

[2] One of the five subsea cables and one of the five terrestrial lines will serve as an auxiliary cable/line.

[3] As discussed below, if three-conductor terrestrial lines are used, then one terrestrial line would be needed for each subsea cable, plus an auxiliary (i.e., five terrestrial lines total). If single-conductor terrestrial lines are used, three terrestrial lines would be needed for each subsea cable (i.e., 15 terrestrial lines total).

Monitoring Facility (UCMF); (9) five or fifteen 0.1-mile-long buried terrestrial transmission lines (carried in one to three conduits) to grid-interconnection at the Central Lincoln Peoples Utility District (CLPUD) substation; and (10) appurtenant facilities.

Project Operation

Onshore monitoring of project facilities is anticipated to be conducted on a continuous basis via a supervisory control and data acquisition (SCADA) system that would be part of the UCMF site. A system operator would be responsible for monitoring the sensor and alarm systems and identifying when a potential unexpected event or system failure has occurred. The system operator would be the first point of contact for notification by operations and maintenance personnel, regulatory agencies, and the general public of a potential incident. Emergency call-out arrangements and assistance would be in place to respond to major incidents. Routine work would be carried out during normal facility working hours, weather permitting and with consideration for safety and protection of personnel, the general public, and the environment.

Proposed Environmental Measures

OSU proposes the following environmental measures to protect or enhance environmental resources at the project:

General

Project Operation

- Implement the Adaptive Management Framework filed as part of the application (APEA, Appendix J), which would guide the evaluation of monitoring results, identification of unanticipated adverse effects, and implementation of and/or modification of response actions to include mitigation or revised monitoring (APEA, Appendix I) in consultation with resource agency stakeholders.

- Prepare and file a Five-Year Report, that includes the following information on past and future project operations, beginning 5.5 years after deployment of the first WEC at the project, and recurring every 5 years thereafter:
    - a review of all WEC deployments and associated project activities from the prior 5 years including a description of the types and number of WEC devices deployed, frequency and duration of WEC deployments, monitoring activities and results, and any adaptive management criteria or response actions that were applied or modified.
    - a description of WEC deployment activities that are planned or that are reasonably foreseeable in the next 5 years including the types and number

of WEC devices likely to be deployed, and the likely duration of such deployments.

- Develop a decommissioning plan to remove project facilities and restore the site in the future as the license term nears its end and implemented when the project is decommissioned.

Geologic and Soil Resources

Project Construction

- Use horizontal directional drilling (HDD) to install the subsea transmission cables under the nearshore and intertidal habitat (to approximately the 10-meter isobath) to minimize substrate disturbance.

- Use HDD to install a maximum of three conduits that carry the onshore transmission lines from the beach manholes at Driftwood to the UCMF site, and from the UCMF to the Highway 101 grid connection point, to minimize terrestrial habitat disturbance.

- Develop an erosion and sediment control plan to minimize potential effects of project construction, operation, and maintenance activities on sediment and soils.

- Follow best management practices during installation, operation, and removal activities to avoid or minimize potential effects to sediment, including:
    - Minimize the time that the seafloor is disturbed, sediment is dispersed, and the associated effects by completing cable laying and other construction activities within one construction season, to the extent practicable, during appropriate weather-related construction windows.

Project Operation

- Avoid grounding of project components on the bottom substrate during transport to protect nearshore and estuarine habitats.

- Minimize the frequency of anchor installation/removal cycles and reuse installed anchors.

Water Resources

Project Construction

- Develop a stormwater management plan[4] for onshore construction activities with spill prevention, response actions, and control protocols, and provisions to maintain existing drainage patterns and prevent contamination of streams with hazardous materials runoff.

- Develop an HDD contingency plan to minimize the potential adverse effects of any inadvertent return[5] of drilling fluids, with provisions for timely detection to include monitoring, containment, response and notification procedures for protection of water quality.

Project Operation

- Follow industry best practices and guidelines for antifouling applications (e.g., free of the biocide tributyltin (TBT)) on project structures such as marker buoys, subsurface floats, and WECs.

- Minimize storage and staging of WECs outside of existing dock, port, or other marine industrial facilities to protect water quality from toxic materials.

- Implement the Emergency Response and Recovery Plan (APEA, Appendix G) with spill prevention, response actions, and control protocols for offshore activities, including provisions for recording types and amounts of hazardous fluids contained in WECs and other project components; require all vessel operators to comply with the plan during installation and maintenance of offshore project components.

---

[4] OSU is proposing a stormwater containment plan, but we refer to this plan as the stormwater management plan in the EA to be consistent with the name given to the plan by NMFS term and condition 3.

[5] An inadvertent return or frac-out is an unanticipated discharge of drilling fluids to the ground surface or surface waters, including wetlands, associated with HDD or other trenchless construction methodologies.

Aquatic Resources and Threatened and Endangered Species

General

Project Construction

- Bury subsea cables at a depth of 1-2 meters, to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor. Protect portions of the cable on the seafloor in areas where it cannot be buried or persistently becomes unburied with split pipe, concrete mattresses, or other cable protection systems.

- Utilize shielding on subsea cables, umbilicals, and other electrical infrastructure, to the maximum extent practicable, to minimize electromagnetic field (EMF) emissions.

- Require all project-chartered or -contracted vessels to comply with current federal and state laws and regulations regarding aquatic invasive species prevention and control (measure to also be implemented during project operation).

- Notify agencies with regulatory authority as soon as possible in the event of an emergency in which fish or wildlife are being killed, harmed, or endangered by project facilities or operations in a manner that was not anticipated, and take action to promptly minimize the impacts of the emergency, based on guidance from those agencies they notify (measure to also be implemented during project operation).

Project Operation

- Implement the EMF Monitoring Plan (APEA, Appendix H) to measure project-related EMF emissions and implement measures based on the monitoring results to mitigate unanticipated adverse effects on marine aquatic resources (APEA, Appendix I).

Fish and Invertebrates

Project Construction

- Avoid crossing areas with rocky reef and hard substrate when installing the subsea cable, to the maximum extent practicable, to protect sensitive habitat features.

- Develop a vessel anchoring plan that establishes protocols to avoid anchoring in known rocky reef or hard substrate habitats, to the maximum extent practicable, and minimize the use of anchors within the project area wherever practicable by combining onsite activities to avoid or minimize adverse effects to hard substrate habitat (measure to also be implemented during project operation).

Project Operation

- Implement the Organism Interactions Monitoring Plan (APEA, Appendix H) to detect behavioral changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to or affected by the installed project components due to the potential for reduced fishing pressure, or biofouling on the anchors/WECs.

<u>Marine Mammals, Sea Turtles, and Seabirds</u>

Project Construction

- Require vessels in transit to/from the project site to avoid close contact with marine mammals and sea turtles and adhere to the National Marine Fisheries Service's (NMFS) "Be Whale Wise" guidelines to minimize potential vessel impacts to marine mammals (measure to also be implemented during project operation).

- Provide marine mammal observers for certain project-related vessel-based activity (e.g., sub-bottom profiling) (measure to also be implemented during project operation).

- Minimize construction activities during key Phase B gray whale migration periods (April 1-June 15) (measure to also be implemented during project operation).

- When using Dynamic Positioning Vessels (DPV)[6] to install project facilities or other equipment that may exceed NMFS's published threshold for injury to marine mammals (measures to also be implemented during project operation):
    - Avoid use of these vessels to the maximum extent practicable during Phase B of the gray whale migration (April 1-June 15). If construction activities are proposed during this migration period, consult with Oregon Department of Fish and Wildlife (Oregon DFW) regarding the timing of such activities including cable-laying in state waters.
    - With technical assistance from NMFS, establish and carry out the following actions and protocols necessary to maintain an appropriate acoustic zone of

[6] DPVs are computer-controlled to automatically maintain the vessel's position and heading through use of propellers and thrusters.

influence in accordance with NMFS's published harassment threshold (120 decibels (dB)) during DPV operations to minimize behavioral disturbance and protect marine resources:

    - Post qualified marine mammal observers on vessels during daylight hours.
    - Conduct dynamic positioning (DP) activities during daylight hours when feasible to ensure observations may be carried out.
    - Implement DP start up for cable laying during daylight hours.
    - Ramp up DP thrusters upon initial operation and, except during cable laying, reduce power to the extent practicable if a mammal approaches the acoustic zone of influence and increase power once the zone is clear of marine mammals, as may be modified by agreement of the licensee and NMFS.

Project Operation

- To minimize potential stranding, entanglements, impingements, injuries, or mortalities of marine mammals and seabirds associated with entangled fishing gear:
    - Once per quarter each year for the term of the license, conduct opportunistic (i.e., non-systematically collected) visual observations, including review of any underwater visual monitoring, at the project site to detect and remove any entangled fishing gear and other debris that has the potential to increase the risk of marine species entanglement.
    - Conduct annual surface surveys of active WEC berths for entangled fishing gear and other debris during the spring season (mid-March through mid-June) following the peak storm season and period of maximum activity for the Dungeness crab fishery.
    - Conduct annual subsurface surveys of moorings and anchor systems using ROV or other appropriate techniques with approval by NMFS concurrent with spring (mid-March through mid-June) monitoring under the Organism Interactions Monitoring Plan (APEA, Appendix H).
    - If entangled fishing gear or marine mammal (or sea turtle) stranding, entanglements, impingements, injuries or mortalities are detected, notify FWS, NMFS, and Oregon DFW and remove fishing gear as appropriate and make every effort to return the fishing gear to the owners (APEA, Appendix I).

- Ensure that WECs are maintained in good working order to minimize sounds that might injure marine mammals or alter their behavior due to faulty or poorly maintained equipment.

- Make opportunistic visual observations of pinnipeds when conducting operations, maintenance, or environmental monitoring work at the WEC test site. If pinnipeds are observed to be hauled out on project structures, follow the reporting and haulout protocols specified in APEA, Appendix I.

- Ensure that WEC cables and moorings are designed and maintained in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement, to the maximum extent practicable, and follow the reporting and haulout protocols specified in APEA, Appendix I.

- Implement the Bird and Bat Conservation Strategy (BBCS) Plan (APEA, Appendix B) that includes the following measures to minimize impacts to seabirds:
    - Once per quarter for the term of the license, conduct opportunistic visual observations at the project site to determine if seabird perching and nesting results in equipment fouling or interference with project operations and, if necessary, develop a plan in consultation with the U.S. Fish and Wildlife Service (FWS) to discourage perching and nesting with minimal impacts to seabirds.
    - Use low-intensity flashing lights and bird-friendly wavelengths on project structures to minimize seabird attraction based on specifications for project lighting developed in consultation with the FWS and U.S. Coast Guard (USCG).
    - Minimize lighting used at night by service and support vessels at the WEC test site and at the UCMF (e.g., use low intensity, bird-friendly wavelengths, shielded lighting not providing upward-pointing light or light directed at the sea surface) to reduce the potential for seabird attraction.
    - Require vessel operators to follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout.[7]
    - Require vessel operators to remain 500 feet away from seabird colonies during the nesting season to minimize disturbance to nesting seabirds.

[7] Fallout can occur when seabirds, that normally use natural light (e.g., moonlight) to navigate out to sea, become disoriented by artificial lighting causing them to repetitively circle lights and collide with structures which results in exhausted and injured seabirds “falling out” of the sky making them potentially vulnerable to other threats.

Terrestrial Resources and Endangered Species

Project Construction

- Minimize or avoid terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species) during project construction.

- Minimize ground disturbance and maintain protective buffers around wetlands to avoid adverse environmental effects.

- Develop a revegetation plan for using native species to the extent practicable to revegetate areas disturbed during construction to minimize impacts to local plant communities and wildlife populations.

- Avoid disturbance of snags and wildlife or legacy trees, including live or dead trees that provide benefit to wildlife, to the maximum extent practicable. If unavoidable, conduct additional species-specific surveys prior to construction activities to minimize effects.

- Avoid disturbance of forested wetlands, to the extent practicable.

- Avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Restore natural hydrology after construction is complete and develop a restoration plan that includes a provision for monitoring, as necessary, until successful restoration can be determined.

- Minimize disturbance of streams that support fish or are connected to fish-bearing streams. Unavoidable work within or adjacent to fish-bearing streams may be subject to in-water work windows based on consultation with Oregon DFW, FWS, and NMFS. Consult with NMFS if terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the Endangered Species Act (ESA), to identify measures to avoid and minimize any potential effects.

- Avoid, to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood. Where unavoidable, conduct species-specific surveys on properties outside of Driftwood but within the construction footprint to determine the extent of occupied habitat and associated mitigation.

- Develop measures that would limit the introduction or spread of invasive species, to be included in the proposed revegetation and restoration plan.

- Implement the BBCS Plan (APEA, Appendix B) that includes the following measures to minimize effects to bats and landbirds, including the federally listed western snowy plover:
    - HDD construction equipment or construction activities would not occur on Driftwood beach within suitable snowy plover nesting, roosting, or foraging habitat, and would be limited to the Driftwood parking lot, at least 164 feet (50 meters) from any potentially suitable habitat.
    - HDD operations in the parking lot would occur during daylight hours, but if lighting is required at night, it would be appropriately shielded and directed to minimize artificial light reaching western snowy plover nesting habitat. Animal-proof litter receptacles and related signage and coordination would be provided to minimize potential attraction of nest predators.
    - If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), conduct surveys of suitable nesting habitat prior to operation of the HDD. If nests are detected, implement measures specified in the BBCS Plan, including noise monitoring and implementation of engineering controls, if appropriate (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers).
    - Conduct surveys for nesting birds prior to any vegetation clearing that occurs within the nesting season and implement the following measures for active nests found during the surveys:
        - Remove nest-starts for any birds other than raptors or listed species when observed if found within the project footprint and within 100 feet of a construction zone, and where feasible.
        - If an active nest is found, determine the extent of a construction-free buffer zone to be established around the nest (typically 300 feet for raptors and 100 feet for other species), to ensure that no nests of species protected by the Migratory Bird Treaty Act would be disturbed during project construction.
        - If necessary, the no-disturbance nesting buffers may be adjusted to reflect existing conditions including ambient noise, topography, and disturbance with approval of Oregon DFW.
        - If nesting bald or golden eagles are identified, restrict activities near nest sites according to guidelines outlined in the National Bald Eagle Management Guidelines (FWS 2007b).
    - If construction activities would not be initiated until after the start of the nesting season, remove all potential nesting substrates (e.g., bushes, trees, snags, grasses, and other vegetation) in late winter, prior to the start of the nesting season.

- Conduct preconstruction surveys for roosting bats to identify sites to minimize construction impacts from high frequency sound disturbance, night lighting, and air quality degradation near roosts by implementing bat roost buffers, or excluding bats within bat roost buffers, or developing species and equipment specific buffers, use noise controls, and monitor bat roost activity before, during and after construction.

Recreation, Ocean Use, and Land Use

Ocean Use and Recreation

- Mark project structures with appropriate navigation aids, as required by the USCG.

- Conduct outreach to inform mariners of project structures or activities to be avoided in the area (e.g., Notice to Mariners, flyers posted at marinas and docks).

- Install subsurface floats at sufficient depth to avoid potential vessel strike.

- Work cooperatively with commercial, charter, and recreational fishing entities and interests to avoid and minimize potential space-use conflicts with commercial and recreational interests during construction and operation.

Terrestrial Use and Recreation

- If acceptable to Oregon Parks and Recreation Department (Oregon PRD), develop a plan to install an interpretive display describing PacWave South in the Driftwood.

- Use construction fencing to isolate work areas from park lands to provide safe access for visitors to the beach and to recreational facilities unaffected by construction activities within Driftwood.

- Maintain pedestrian public beach access at Driftwood during construction activities, if practicable, and coordinate with the Oregon PRD to mitigate impacts to public access and use of the site.

- Conduct ground-disturbing construction activities and staging within previously disturbed areas, as practicable.

Cultural Resources

- Should historic properties be identified in the future, modify the project to exclude the historic property from the project's area of potential effect (i.e., avoid any potential project effects to the historic property) or develop a historic properties management plan (HPMP) to consider and manage historic properties throughout the term of the license.

Public Involvement

On April 15, 2014, OSU filed with the Commission a Pre-Application Document, a Notice of Intent, and a request to use the Alternative Licensing Process (ALP) to license the project. The Commission issued a public notice of the filing and approved the use of the ALP on May 27, 2014. The intent of the Commission's pre-filing process is to initiate public involvement early in the project planning process and to encourage citizens, governmental entities, tribes, and other interested parties to identify and resolve issues prior to formal filing of the application with the Commission.

As part of the National Environmental Policy Act scoping process, OSU distributed a scoping document on June 5, 2014. Two scoping meetings were held on July 9, 2014, in Newport, Oregon. Based on comments made during the scoping meetings and written comments filed with the Commission, OSU distributed a revised scoping document on September 16, 2014. On May 31, 2019, OSU filed its final license application. OSU amended its license application on August 27, 2019. On August 29, 2019, we issued a notice that OSU's application for an original license for the PacWave South Project was ready for environmental analysis, and requesting comments, terms and conditions, recommendations, and prescriptions.

Alternatives Considered

This environmental assessment analyzes the effects of the proposed project's construction and operation and recommends conditions for any license that may be issued for the project. In addition to OSU's proposal, we consider two alternatives: (1) no-action, whereby the project would not be licensed and constructed; and (2) OSU's proposal with staff modifications (staff alternative).

Staff Alternative

Under the staff alternative, the project would include all of OSU's proposed measures. The staff alternative also includes the following recommended modifications to OSU's proposal and some additional measures.

Project Construction

- Develop an HDD plan that is based on criteria outlined in the Commission's HDD Plan Guidance (FERC 2019. *Guidance for Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plans*) and on Commission criteria for HDD crossings beneath wetlands (FERC 2013. *Wetland and Waterbody Construction and Mitigation Procedures*) to reduce risks of construction complications and inadvertent return, and to minimize adverse environmental effects of HDD for protection of natural resources.

- Notify Oregon Department of Transportation (Oregon DOT) at least 3 months in advance of construction-related closures of the Driftwood site that would be 90-days in duration, or longer, and coordinate with Oregon DOT to ensure adequate signage is posted to inform motorists in advance of any closure.

- Modify the proposed revegetation plan to include: (1) a description of specific measures to ensure long-term success of revegetation efforts and control the spread of invasive plant species; and (2) a description of the survey requirements and methods, and mitigation methods to be implemented to ensure that habitat for the elfin butterfly is maintained in the long term.

- Modify the BBCS Plan to include: (1) modified measures for marbled murrelet and western snowy plover provided in the revised biological assessment filed by OSU on August 27, 2019; (2) consultation with FWS, Oregon DFW, and Oregon PRD, to define what constitutes suitable nesting habitat for the western snowy plover in the project area to ensure nesting habitat is properly identified for implementing any relevant measures to minimize effects to nesting plovers and their habitat; (3) consult with Oregon PRD on the placement of any necessary structures (e.g., sound barriers) and signage to protect western snowy plover; (4) observations of western snowy plover nests occurring near the proposed project location from surveys conducted in 2017, 2018, 2019; and (5) results from bat maternity roost surveys conducted in July 2019.

No-action Alternative

Under the no-action alternative, the project would not be constructed.

Environmental Impacts and Measures of the Staff Alternative

The primary issues associated with constructing and operating the project are effects of project construction, operation, and maintenance on geology and soils, water quality, benthic and marine organism composition, biofouling species, aquatic species interaction, and predator-prey interactions, marine mammals, seabirds, upland and wetland habitat, wildlife, threatened and endangered species, essential fish habitat, recreation use, ocean use, aesthetics, and cultural resources. The environmental effects of the staff alternative are described in the following section.

Geology and Soils

Project construction, maintenance, operation, and removal would require land-disturbing activities associated with HDD installation methods for the transmission cables and lines, construction at Driftwood including excavation of the underground cable vaults and parking lot, and construction of the UCMF site buildings, which can result in soil erosion and sedimentation. Offshore project activities requiring disturbance of the seabed associated with HDD, jet plow subsea cable installation, and installation and removal of WECs and anchors would result in the temporary and long-term disturbance of the seafloor. OSU's proposed measures to install subsea cables and transmission lines with HDD, develop an erosion and sediment control plan, use best management construction practices, minimize the time that the seafloor is disturbed, and minimize frequency of anchor installation/removal cycles and reuse installed anchors would limit the adverse effects of erosion and seabed disturbance. In nearshore areas where subsea cables have the potential to not be buried, the rocky substrate would be covered by another artificial hard substrate to protect the cables, and result in minor, long-term effects on geology and result in localized scour and deposition of seabed sediments.

Water Resources

Potential adverse effects of project construction and operation on water quality include: (1) sediment suspension and increased levels of turbidity caused by anchor and subsea transmission cable installation; (2) HDD inadvertent return[8] of drilling fluids during installation of the subsea transmission cables and terrestrial transmission lines; and (3) toxins introduced from antifouling paint or coatings on project components, and accidental spills of fuel, lubricants, and hydraulic oil.

The following proposed measures would reduce project-related effects on water quality: (1) minimize the time that the seafloor is disturbed, and sediment is dispersed by attempting (weather contingent) to complete subsea cable installation within one construction season; (2) minimize the frequency of anchor installation/removal cycles and reuse installed anchors; (3) use HDD to install subsea transmission cables and

---

[8] An inadvertent return of HDD fluid or frac-out is a condition that can develop despite: (1) an appropriate subsurface investigation; (2) an engineering design and analysis of the drill path; (3) an evaluation of subsurface pressures; (4) use of appropriate drilling fluids; (5) following the drill path that was designed; and (6) monitoring and adjusting drilling fluid pressures throughout the drilling process.

terrestrial transmission lines to reduce seabed and ground disturbance; (4) fabricate and apply antifouling paint (to prevent marine life from colonizing these components) to WECs and other project components at properly equipped and properly located facilities; (5) store and stage project components at docks permitted for industrial use with existing dredged channels; and (6) avoid grounding of project components on the bottom substrate during transport.

The proposed storm water management plan with spill prevention, response actions, and control protocols, and provisions to maintain existing drainage patterns and prevent contamination of streams with hazardous materials would minimize effects of onshore construction activities on water quality. The proposed Emergency Response and Recovery Plan with spill prevention, response actions, and control protocols, including provisions for recording types and amounts of hazardous fluids contained in WECs and other project components, would help minimize the potential for spills of hydraulic fluids or fuels, as well as the extent of adverse effects of any spills that do occur during offshore project construction and operation activities.

The staff-recommended HDD plan, which would include contingency measures and be based upon criteria outlined in the Commission's HDD Plan Guidance[9] and Commission criteria for HDD crossings beneath wetlands,[10] would reduce the risks of construction complications and inadvertent return, and would minimize potential adverse environmental effects of HDD. Monitoring of the drilling process would aid in the detection of any seepage of drilling fluid and identification and implementation of any corrective measures (e.g., rerouting the drill route or stopping drilling to allow the fracture to seal). HDD contingency measures would minimize the effects of an inadvertent return of drilling fluid by providing monitoring and timely detection, containment procedures, and response and notification procedures to be implemented by the HDD contractor.

Aquatic Resources

The installation and placement of project structures (e.g. cables, anchors) beneath and on the seafloor would alter benthic habitat and likely cause some changes in the composition and abundance of the demersal fish and invertebrate community, reducing

[9] The Commission's guidance (FERC 2019. *Guidance for Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plans*) includes specific criteria for contingency planning.

[10] The Commission's guidance (FERC 2013. *Wetland and Waterbody Construction and Mitigation Procedures*) at section V.B.6.d requires a site-specific plan prior to beginning construction for all HDD crossings of wetlands and waterbodies.

the amount of habitat for species adapted for burrowing in the seabed and creating habitat for structure-oriented species. The presence of project structures (e.g. mooring lines, WECs) in the water column and at the surface would likely cause some changes in the composition and abundance of invertebrates and fish in the WEC test site area. Project structures could regularly attract marine life in substantial numbers, and attract larger fish predators, which could then prey on smaller fish and other attracted organisms. The proposed Organism Interactions Monitoring Plan and Benthic Sediments Monitoring Plan, under the Adaptive Management Framework, would help evaluate any unanticipated adverse effects on aquatic resources and identify any potential protective measures that may be needed. The proposed anchoring plan would minimize anchoring in known rocky reef or hard substrate habitats and minimize anchor use within the project area wherever practicable by combining onsite activities. OSU would minimize the risk of transporting invasive species from other areas by informing vessel owners and WEC clients about aquatic invasive species management and practices to reduce the spread of invasive species, such as detection monitoring, incidental observations, and reporting. Effects of EMF generated by the subsea cables are expected to be minor on fish that are sensitive to EMF because the cables would be shielded and/or buried. EMF emissions of WECs and subsea connectors at the project would be detected through actions taken under the EMF Monitoring Plan and, if needed, protective measures could be implemented under the EMF Monitoring Plan for any unanticipated adverse effects of EMF emissions on fish. Based on the low levels of EMF expected, and spatially limited exposure to fish, it is anticipated that relatively minor, short-term potential effects, if any, could occur.

Marine Mammals, Sea Turtles, and Sea Birds

Use of DPVs to install the subsea cables are not expected to expose gray whales to harmful noise levels given the short timeframe for cable installation, the ability of gray whales to avoid the area, and limited numbers of gray whales expected to occur in vicinity of the DPVs. Other cetaceans and pinnipeds are highly mobile and would likely avoid the effective range of cable laying operations and exposure to sound generated by DPVs. The sounds associated with various periodic WEC tests and vessel traffic would likely not adversely affect whales, or pinnipeds. The proposed Acoustics Monitoring Plan, under the Adaptive Management Framework, would help evaluate any unanticipated adverse effects on marine mammals and identify any potential protective measures that may be needed. The potential for whale entanglement on project structures and in any derelict fishing gear entangled on the project structures (e.g. mooring lines) would be reduced by the removal of any entangled gear that is found during surface monitoring by marine mammal observers on vessels or periodic underwater inspections. OSU would direct WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement. Vessel strike risk on marine mammals would be minimized by a requirement that project-related vessels avoid close contact with marine mammals and adhere to NMFS's "Be Whale Wise" guidelines, while in transit. OSU would comply with current regulations that require marine mammal observers for certain vessel-based activity (e.g., sub-bottom profiling and DP vessel activities). Because Oregon's nearshore waters are a migration corridor for a variety of seabirds, there is some potential for birds to be injured or killed if they collide with above-water portions of the WECs. Given the proposed WEC and berth spatial configuration, and the features that would be built into the navigation lighting system to minimize bird attraction, the potential for bird collision is low. The proposed measures to document pinniped and seabird use of project facilities and develop any necessary protective measures to discourage future use of project facilities would minimize potential impacts to pinnipeds and seabirds including seabird nests.

Terrestrial Resources

The staff-recommended modification to the proposed revegetation plan would replace or transplant any loss of kinnikinnick (a larval host plant species for the seaside hoary elfin butterfly), offset the loss of shore pine forest habitat, and limit the spread of invasive plant species as a result of construction at Driftwood and the UCMF site, OSU would further minimize long-term effects to the elfin butterfly by surveying Driftwood and the UCMF construction sites for kinnikinnick, and avoid its removal where possible. The proposed HDD to install the terrestrial transmission lines would avoid disturbance of wetlands, and developing the staff recommended HDD plan would minimize the potential for an inadvertent return of fluids released into the wetlands. OSU also proposes to maintain buffers around wetlands and develop a stormwater management plan for onshore construction of project facilities to maintain existing drainage patterns, protect project-adjacent habitat, and prevent contamination of streams. Implementing these measures would minimize the potential impacts to wetland habitats during project construction. The proposed BBCS Plan contains measures that would minimize impacts to birds and bats: (1) removal of vegetation in winter outside of the bird nesting period and pre-construction surveys to identify and protect active nests with protective, species-specific buffers; (2) limit disturbance to potential habitat used by bats (e.g., dead trees) and conduct construction activities outside of the bat maternity period; (3) provide animal-proof receptacles and guidance to construction workers to minimize attracting additional predators that could incidentally prey on bird eggs and young in the area; use shielded lighting during night-time construction to avoid attracting birds; (4) conduct preconstruction surveys to identify the location of bat roosts and include provisions for species- and impact-specific protective buffers (e.g. from high-frequency noise) from nearby construction activities and (5) restrict HDD construction equipment and construction activities from Driftwood beach, and limit noise producing HDD construction equipment and activities in Driftwood parking lot, to a 164-foot buffer from any potentially suitable plover habitat.

Threatened and Endangered Species and Essential Fish Habitat

NMFS biological opinion for the project includes the following terms and conditions that are consistent with OSU's proposed measures: (1) implement the Acoustic Monitoring Plan and associated mitigation measures for impacts of sound from WECs and their mooring systems on marine resources as part of the adaptive management framework; (2) implement the EMF Monitoring Plan and associated mitigation measures for potential impacts of EMF on marine resources as part of the adaptive management framework; (3) develop a stormwater management plan for the UCMF and re-paving of the Driftwood parking lot addresses multiple components such as runoff containment, treatment of pollutants, and implementing BMPs; (4) submit annual reports that document the extent of incidental take described in the Incidental Take Statement is not exceeded to include: (a) the results of the benthic sediments, organism interactions, acoustics, and EMF monitoring; (b) WEC installation and removal activities; and (c) one report on construction completion that describes HDD installation of the terrestrial transmission lines, and HDD and jet plow installation of the subsea transmission cables. Fully implementing the terms and conditions in any license issued for the project would not likely jeopardize the listed affected species and would not likely adversely affect listed critical habitat. Further, NMFS concluded that the project would not adversely affect proposed critical habitat. NMFS concluded that the proposed construction and operation of the project would adversely affect EFH for groundfish, coastal pelagic species, Pacific Coast salmon, and highly migratory fish species. NMFS provided five conservation measures 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 and are consistent with OSU's proposed measures. Fully implementing the recommendations would protect, or minimizing the adverse effects to, designated EFH fish species. FWS concurred that the project, as proposed with staff-recommended measures, would not likely adversely affect the marbled murrelet, western snowy plover, northern spotted owl, and short-tailed albatross.

Recreation and Ocean Use

Construction activities at Driftwood would have a short-term, but major effect on recreational resources. Construction would result in an approximately 6- to 8-month closure of Driftwood to vehicular traffic and beach access for Phase I, and an approximately 45- to 60-day closure to vehicular traffic and beach access for Phase II. OSU's proposed advanced notice to the public, by posting signs at Driftwood concerning construction activities and closure of the site to vehicle traffic, could help visitors make alternative plans to visit one of the six other Oregon PRD sites close-by. OSU proposes to coordinate with Oregon PRD to develop a plan to mitigate impacts to public access and use of Driftwood would minimize effects on the recreating public during project construction. OSU's proposal to mark project structures with navigational markers and lighting as required and approved by the USCG for warning nearby vessels would minimize the potential for collisions, and to install subsurface floats at sufficient depths to avoid potential vessel strikes. OSU would equip each WEC with Automatic Identification System (AIS) equipment and the WEC deployment area boundaries would be clearly marked on NOAA navigation charts. In the unlikely event that a WEC becomes separated from its mooring, it would be a navigational hazard, and quickly located with the AIS equipment. In such an event, OSU would implement its Emergency Response and Recovery Plan to coordinate with agencies and retrieve the WEC. The proposed measures to avoid, minimize, and mitigate impacts to navigation and commercial and recreational fishermen and crabbers substantially reduce the risk of vessel strikes on WECs and other project infrastructure.

Aesthetic Resources

The size of the WECs when viewed from shore would be less than 1.6 millimeters at arm's length. At night, the WECs would be lit for navigational safety. Under clear conditions, these lights would appear as pinpoints on the horizon, creating a minor visual change to relatively unbroken nighttime ocean views off the Oregon Coast. Because most operational activity would take place 6 miles offshore, the work vessels that would be present would not be visually obtrusive when viewed from shore. Offshore aesthetic effects would be minor. All land-based project components in Driftwood, including the terrestrial transmission lines and beach manholes, would be located underground and would not affect the aesthetics of the area. The UCMF site would include three, one-story buildings and a parking/laydown area located within an approximately 4.5-acre private parcel. The buildings would be set back from Highway 101 resulting in minor aesthetic effects.

Cultural Resources

No historic properties were identified within proposed project's APE, and as a result, the proposed project would not affect historic properties. Nevertheless, there is always a possibility that unknown archaeological resources may be discovered in the future as a result of the project's construction, operation, or project-related activities. Staff's recommended consultation with the Oregon SHPO and involved Indian tribes, in the event that a significant cultural resource is inadvertently discovered during project construction, operation, or maintenance activities, would ensure that any adverse effects to historic properties can be avoided, reduced, or mitigated.

Socioeconomics

EcoNorthwest estimated that this type of project would create total construction employment for 45 workers, and that operation of the facility would create 40 direct jobs and another 51 jobs associated with facility and employee spending for goods and services (FERC 2010). The proposed environmental measures for the project would mitigate any adverse effects on the crabbing and fishing industry.

No-action Alternative

Under the no-action alternative, the project would not be constructed.

Conclusions

Based on the analysis, we recommend licensing the project as proposed by OSU with some staff modifications and additional measures.

In section 4.2 of the environmental assessment, we estimate the likely cost of alternative power for each of the two alternatives identified above. The analysis shows that, during the first year of operation under the proposed action alternative, project power would cost $7,685,000, or $350.92 per MWh more than the likely alternative cost of power. Under the staff alternative, project power would cost $7,699,000, or $351.53/MWh more than the likely alternative cost of power.

We chose the staff alternative as the preferred alternative because: (1) the project would provide a source of electrical energy for the region (21,900 MWh annually); (2) the 20 MW of electric capacity comes from a renewable resource that does not contribute to atmospheric pollution, including greenhouse gases; (3) the recommended environmental measures proposed by OSU, as modified by staff, would adequately protect and enhance environmental resources affected by the project; and (4) the project would provide, through proposed monitoring, an improved understanding of the environmental effects of wave energy projects, which could be used in assessing the potential effects of future projects of this type and identifying measures to minimize adverse environmental effects. The overall benefits of the staff alternative would be worth the cost of the proposed and recommended environmental measures.

1.0 INTRODUCTION

1.1 APPLICATION

On May 31, 2019, Oregon State University (OSU) filed an application with the Federal Energy Regulatory Commission (FERC or Commission) for a license to construct and operate the proposed up to 20-megawatt (MW) PacWave South Hydrokinetic Project (PacWave South Project or project). The proposed wave energy test facility would consist of both marine (offshore) and terrestrial (onshore) components. Project facilities would be located on the Outer Continental Shelf (OCS) in the Pacific Ocean, approximately 6 nautical miles off the coast of Newport, Oregon, and in Oregon territorial waters. The project would occupy an area of approximately 2.65 square miles (1,695 acres) on the OCS, administered through a lease (Figure 1-1) by the Bureau of Ocean Energy Management (BOEM) within the U.S. Department of the Interior, and approximately 8.2 square miles (5,232 acres) of state territorial waters. The onshore components would occupy portions of state, county, and privately-owned lands (Figure 1-2). The project, funded in part by the Department of Energy (DOE), would generate an average of about 70,000 to 175,000 megawatt-hours of energy annually.[11]

1.2 PURPOSE OF ACTION AND NEED FOR POWER

1.2.1 Purpose of Action

The purposes of the proposed PacWave South Project include: (1) to test the operation of grid-connected wave energy conversion (WEC) devices; (2) to refine the deployment, recovery, operations, and maintenance procedures for WEC devices; (3) to collect interconnection and grid synchronization data; (4) to gather information about environmental, economic, and socioeconomic effects; and (5) to provide a source of hydroelectric power. Therefore, under the provisions of the Federal Power Act (FPA), the Commission must decide whether to issue an original license to OSU for the PacWave South Project and what conditions should be placed on any license issued. In deciding whether to issue a license for a hydroelectric project, the Commission must determine that the project would be best adapted to a comprehensive plan for improving or developing a waterway. In addition to the power and developmental purposes for which licenses are issued (such as flood control, irrigation, and water supply), the Commission must give equal consideration to the purposes of: (1) energy conservation; (2) the protection of, mitigation of damage to, and enhancement of fish and wildlife resources; (3) the protection of recreational opportunities; and (4) the preservation of other aspects of environmental quality.

---

[11] Energy generated by the project would vary over the license term as the number of wave energy converters deployed increases gradually as the technology advances.

The Commission issuing a license, BOEM issuing a research lease, and DOE providing funding for the PacWave South Project would allow OSU to test WECs and generate electricity at the project for the term of the license, making electric power from a renewable resource available to Central Lincoln People's Utility District (CLPUD). OSU's proposed monitoring plans would also provide important information on any unanticipated environmental effects of such wave energy developments, which could assist with the evaluation of similar projects.

This EA has been prepared pursuant to the National Environmental Policy Act (NEPA) of 1969 to assess the effects associated with construction and operation of the proposed project and alternatives to the proposed project. In this EA, staff evaluates the effects of OSU's proposed action and recommends conditions for any license issued. In addition to OSU's proposed action, the EA considers: (1) OSU's proposal with additional Commission staff-recommended measures (staff alternative); and (2) a no-action alternative.

1.2.2 Need for Power

In addition to serving as a test center to evaluate the performance of commercial scale or near-commercial scale WECs, the project would provide hydroelectric generation to meet part of Oregon's power requirements, resource diversity, and capacity needs. The project would provide electricity to the Oregon coast region, and would have a maximum installed capacity of 20 MW. This capacity is based on the Oregon Wave Energy Trust (OWET) sponsored market analysis that forecasted future demand for berthing capacity at PacWave South (OWET 2014). The power generated at PacWave South would vary depending on the number and types of WECs installed and testing conditions; preliminary estimates range from 150 kilowatts (kW) to 2 MW per WEC. As a result, the energy capacity of the project would vary over the term of the license. The capacity and number of WECs at the project would be lower earlier in the license term and increase gradually as the industry advances.

The North American Electric Reliability Corporation (NERC) annually forecasts electrical supply and demand nationally and regionally for a 10-year period. The PacWave South Project is located within the jurisdiction of the Northwest Power Pool (NWPP), a sub-region of the Western Electricity Coordinating Council, a region of the NERC. According to NERC's 2019 forecast, average annual demand requirements for the NWPP sub-region are projected to grow at an average rate of 1.5 percent from 2019

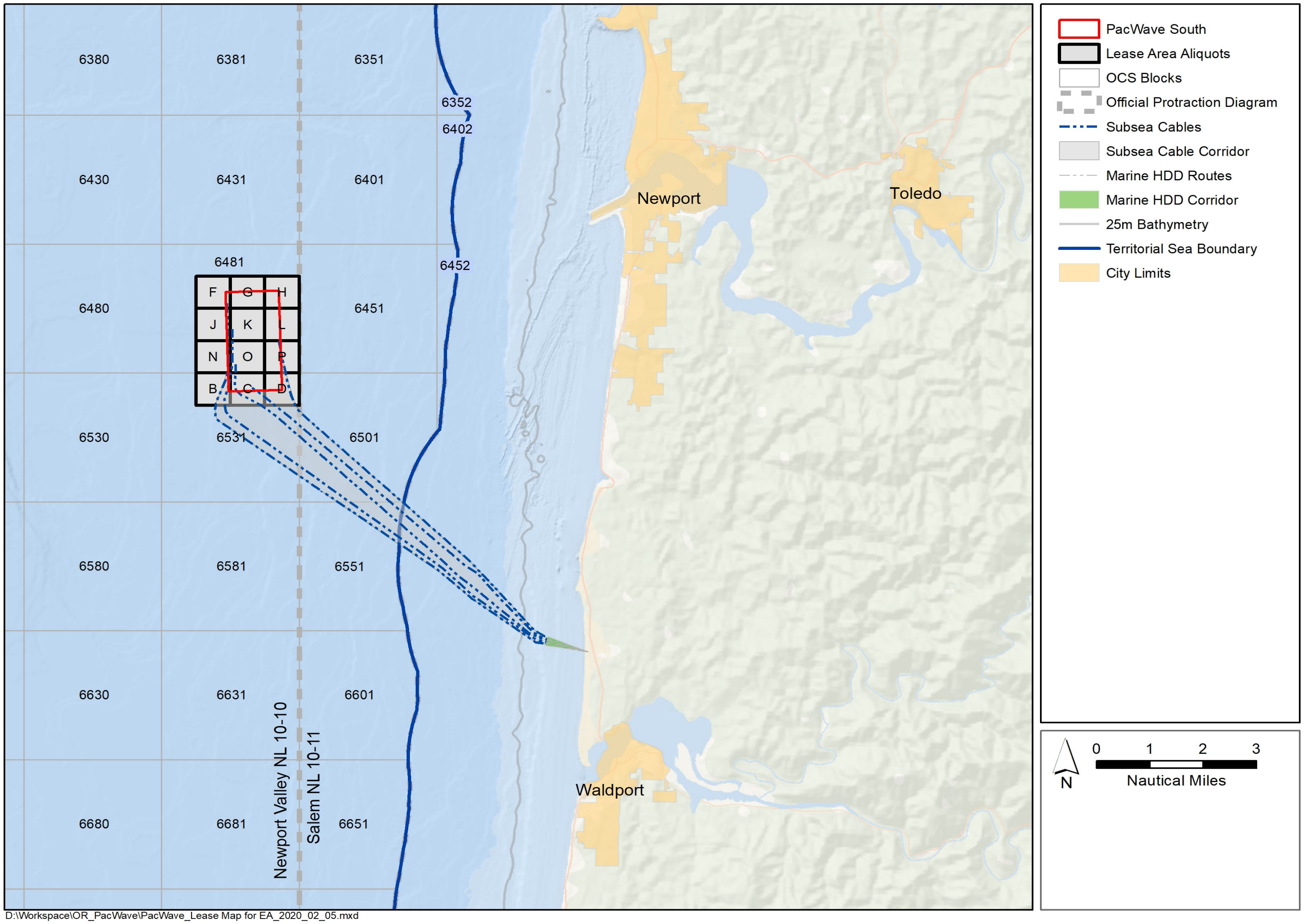

Figure 0-1. PacWave South Marine Project Area.

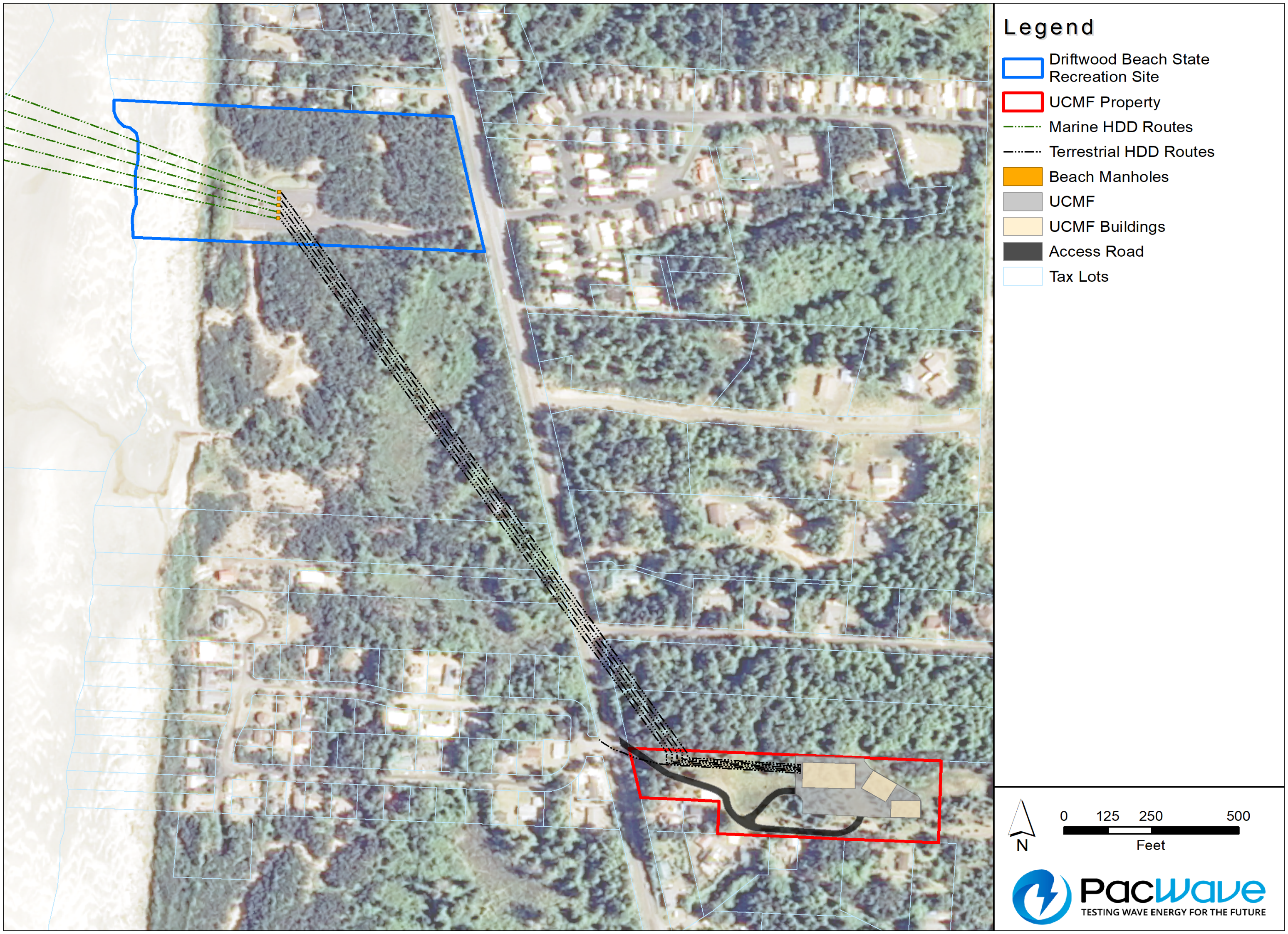

Figure 0-2. PacWave South Terrestrial Project Area.

through 2028. NERC projects that resource capacity margins (generating capacity in excess of demand) would range between 21.8 percent and 23.4 percent of firm peak demand during the 10-year forecast period, including estimated new capacity additions.

The project would connect to the CLPUD system, which serves over 38,000 customers including residential, commercial, and industrial users (CLPUD 2014). CLPUD is the fourth largest utility in Oregon (ODOE 2012) and receives all its required energy from the Bonneville Power Administration (BPA). The energy supplied by the project would offset only a minor part of the total demand. CLPUD serves less than 3 percent of Oregon's electrical load and is considered a "small utility" (ODOE 2012) under Oregon's Renewable Portfolio Standard (ORS 469A). As a small utility, CLPUD is required to provide 10 percent of its power with renewable resources by 2025 (ORS 469A.055). The project could generate up to 20 MW, which is small compared to regional demand, but would contribute renewable energy to CLPUD's future Renewable Portfolio Standard obligation.

Power generated by the project would also support Oregon's goal to develop wave energy as a source of future renewable energy. The State of Oregon Biennial Energy Plan 2015-2017 highlights that "Oregon is at the crossroads of a developing marine energy industry, with a powerful wave climate and an environment suited for testing wave energy conversion technologies. Oregon is becoming the place to develop WECs from concept to full-scale deployment and learn how well they work in the marine environment" (ODOE 2015). Regionally, the Northwest Power and Conservation Council (2016) predicts the electricity demand in the Pacific Northwest will increase 0.5 to 1.0 percent per year, between 2015 and 2035. The testing of wave energy technology at PacWave South could advance the commercialization of wave energy and add to the diversification of Oregon's energy sources.

1.3 COOPERATING AGENCY ROLES

BOEM, DOE, U.S. Army Corps of Engineers (USACE), U.S. Coast Guard (USCG), and National Park Service (Park Service) filed requests to be cooperating agencies in the Commission's preparation of this EA. Letters of understanding (LOU), signed individually by these agencies with the Commission, established their cooperating agency status.

Under the authority of the Outer Continental Shelf Lands Act (OCSLA) and the April 9, 2009 Memorandum of Understanding (MOU) between FERC and BOEM, BOEM must decide whether to issue a research lease to OSU for the PacWave South Project and what stipulations should be placed on any lease issued. The portion of the OCS where the project's WEC testing is proposed to be located (Figure 1-1) would be administered through a lease of Aliquots (1/16th portions of OCS Blocks), issued by BOEM. A proposed easement may be included in the lease for the subsea cables on the

OCS. Renewable marine hydrokinetic (MHK) energy leases issued by BOEM do not authorize construction of facilities, but rather provide an applicant the right to occupy the OCS for the purpose of conducting MHK activities, subject to obtaining a FERC license authorizing construction, operation, and decommissioning of the project on the leasehold. FERC is the action agency responsible for licensing activities on the BOEM MHK renewable energy lease. Issuance of a BOEM MHK lease is an administrative precondition to proceeding with construction and operation under a FERC license.

The purpose of DOE's proposed action (providing partial funding of the proposed project) is to support the development of the testing infrastructure necessary to test and validate MHK devices in an open ocean environment. DOE's proposed action would support its goal of supporting the development and deployment of innovative MHK systems that have the potential to be cost competitive with other forms of electricity generation. Through the Wave Energy Test Facility Funding Opportunity Announcement, DOE provides financial support for researching, testing, and developing innovative technologies capable of generating renewable, environmentally responsible, and cost-effective electricity from U.S. water resources, specifically MHK technologies that harness the energy from waves.

DOE is proposing to authorize the expenditure of federal funding by OSU to support the development, including design and construction of the PacWave South Project as described in this EA. Federal funding for construction would be contingent upon OSU implementing the Environmental Measures contained within sections 5.1.1 and 5.1.2 of this EA. The operation and maintenance of the facility is considered a connected action under 40 C.F.R. § 1508.25. The independent FERC, BOEM, and DOE actions—acting on the license application by potentially issuing a license, issuing a research lease, and providing funding, respectively—for the PacWave South Project form a larger action that triggered this EA. Commission staff intends that the EA will be used to make a licensing decision for the project, and BOEM and DOE will not proceed with their independent actions without the simultaneous review undertaken by this EA. DOE has authorized OSU to use federal funding for preliminary activities, which include EA preparation, information gathering, site analysis, design simulations, permitting, and environmental surveys. Such activities are associated with the proposed action and do not significantly impact the environment or represent an irreversible or irretrievable commitment by DOE in advance of completion of the EA and DOE's subsequent decision to issue a Finding of No Significant Impact (FONSI) or to recommend the preparation of an Environmental Impact Statement (EIS).

1.4 STATUTORY AND REGULATORY REQUIREMENTS

Any new license for the project would be subject to numerous requirements under the FPA and other applicable statutes. The major regulatory and statutory requirements are described below.

1.4.1 Federal Power Act

1.4.1.1 Section 18 Fishway Prescriptions

Section 18 of the FPA states that the Commission is to require construction, operation, and maintenance by a licensee of such fishways as may be prescribed by the Secretaries of the U.S. Department of Commerce (Commerce) or the U.S. Department of the Interior (Interior). Interior, on behalf of the U.S. Fish and Wildlife Service (FWS), by letter filed September 26, 2019, requests that a reservation of authority to prescribe fishways under section 18 be included in any license issued for the project.

1.4.1.2 Section 4(e) Conditions

Section 4(e) of the FPA provides that any license issued by the Commission for a project within a federal reservation shall be subject to and contain such conditions as the Secretary of the responsible federal land management agency deems necessary for the adequate protection and use of the reservation. For the PacWave South Project, Interior, which has mandatory conditioning authority under Section 4(e) for the project, has not filed any Section 4(e) conditions.

1.4.1.3 Section 10(j) Recommendations

Under section 10(j) of the FPA, each hydroelectric license issued by the Commission must include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by the project. The Commission is required to include these conditions, unless it determines that they are inconsistent with the purposes and requirements of the FPA or other applicable law. Before rejecting or modifying an agency recommendation, the Commission is required to attempt to resolve any such inconsistency with the agency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency.

Interior, on behalf of the FWS, and the Oregon Department of Fish and Wildlife (Oregon DFW) filed timely recommendations under section 10(j) on September 26 and September 30, 2019, respectively. These recommendations are summarized in Table 5-1, and discussed in section 5.3, *Fish and Wildlife Agency Recommendations*. In section 5.3, we also discuss how we address the agency recommendations and comply with section 10(j).

1.4.2 Clean Water Act

Under section 401(a)(1) of the Clean Water Act (CWA), 33 U.S.C. § 1341(a)(1), a license applicant must obtain either a water quality certification (certification) from the appropriate state pollution control agency verifying that any discharge from a project would comply with applicable provisions of the CWA, or a waiver of such certification. A waiver occurs if the state agency does not act on a request for certification within a reasonable period of time, not to exceed 1 year, after receipt of such request.

On April 17, 2020, OSU applied to the Oregon Department of Environmental Quality (Oregon DEQ) for section 401 certification for the PacWave South Project.[12] Oregon DEQ received this request on the same day. Oregon DEQ has not yet acted on the request.

Under section 404 of the Clean Water Act, the USACE reviews permits for projects proposing to deposit or discharge dredge or fill material into surface waters of the United States, including wetlands, and projects must receive authorization for any such activities. Applicable discharges include return water from dredged material disposed on upland property and generally any fill material, such as rock, sand, or dirt. OSU's proposed project would likely include construction of five underground concrete vaults at Driftwood, HDD installation of offshore and onshore transmission cables and lines and construction of four buildings at the UCMF site, sediment management activities associated with implementation of the soil and erosion control plan, the stormwater management plan, and the HDD plan.

1.4.3 Rivers and Harbors Act

Under section 10 of the Rivers and Harbors Act, the USACE reviews permits for projects proposing to dredge or dispose of dredged materials, excavation, filling, rechannelization, or any other modification of a navigable water of the United States. It further includes, without limitation, any wharf, dolphin, weir, boom breakwater, jetty, groin, bank protection (e.g. riprap, revetment, bulkhead), mooring structures such as pilings, aerial or subaqueous power transmission lines, intake or outfall pipes, permanently moored floating vessel, tunnel, artificial canal, boat ramp, aids to navigation,

[12] On September 24, 2019, USACE, on behalf of OSU, applied to Oregon DEQ for section 401 certification for the PacWave South Project. By letter filed on October 28, 2019, OSU informed the Commission that Oregon DEQ would issue one certification that would cover both the USACE's approval of a section 404 permit and the Commission's issuance of a license. On April 1, 2020, Oregon DEQ filed a letter stating that the USACE's application was only a request for certification for the USACE's section 404 permit approval.

and any other permanent, or semi-permanent obstacle or obstruction. OSU's proposed project would likely include installation of subsea transmission cables using HDD and jet plowing techniques, mooring structures such as WECs, mooring lines, and anchors, and aids to navigation. The USACE's section 10 requirements for non-Federal hydropower development are met through the Commission's licensing process.

1.4.4 Coastal Zone Management Act

Under section 307(c)(3)(A) of the Coastal Zone Management Act (CZMA), U.S.C. § 1456(3)(A), and pursuant to the 2009 Memorandum of Understanding (MOU) between FERC and the State of Oregon, FERC would not issue a license for a project within or affecting a state's coastal zone unless the state's CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days of its receipt of the applicant's certification.

The Oregon Coastal Zone Management Program is managed by the Oregon Department of Land Conservation and Development (Oregon DLCD). On February 23, 2020, OSU applied to the Oregon DLCD for a CZMA consistency determination for the PacWave South Project. Oregon DLCD has not yet provided its consistency determination.

1.4.5 Endangered Species Act

Section 7 of the Endangered Species Act (ESA), 16 U.S.C. § 1536, requires federal agencies 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.

In a notice dated May 27, 2014, FERC designated OSU as its non-federal representative for carrying out informal consultation pursuant to Section 7 of the ESA. OSU determined with input from the National Marine Fisheries Service (NMFS) and the FWS that 41 species listed under the ESA may occur in the project area (Table 3-16), including 7 species of whales, 4 species of sea turtles, 23 species of salmonids, 1 species of sturgeon, 1 species of smelt (eulachon), and four species of birds. Critical habitat has been designated within the project area for the Southern Distinct Population Segment (DPS) of the North American green sturgeon, Oregon Coast coho salmon, and the leatherback sea turtle, and proposed for southern resident killer whale and humpback whale. Our analysis of project impacts on listed species and designated critical habitat is presented in section 3.3.5.2, *Threatened and Endangered Species.*

Species and Critical Habitat under NMFS's Jurisdiction

We conclude that licensing the project, as proposed with staff-recommended measures, would be likely to adversely affect eight Chinook salmon Evolutionarily Significant Units (ESUs), four coho salmon ESUs, Southern DPS North American green sturgeon, and Southern DPS Pacific eulachon. We also conclude that the project would not likely adversely affect the following species or designated critical habitat: nine steelhead DPSs, Snake River sockeye salmon ESU, Columbia River chum salmon ESU, blue whale, fin whale, humpback whale, sei whale, southern resident killer whale, sperm whale, western North Pacific gray whale DPS, green sea turtle, olive Ridley sea turtle, loggerhead sea turtle, and leatherback sea turtle, and designated critical habitat for the green sturgeon, Oregon Coast coho salmon, and leatherback sea turtle.

We also conclude that the project would not destroy or adversely affect proposed critical habitat for the southern resident killer whale and humpback whale. Therefore, no conference with NMFS is necessary.

On September 17, 2019, Commission staff requested formal consultation with NMFS based on its likely to adversely affect findings described above and requested concurrence with our not likely to adversely affect findings.

On December 20, 2019, NMFS issued a biological opinion concluding that the proposed action is not likely to jeopardize the species on which we requested formal consultation. NMFS also concurred with our not likely to adversely affect findings. Further, NMFS concluded that the project would not adversely affect proposed critical habitat for the southern resident killer whale and humpback whale. Therefore, no further consultation under the ESA is required regarding these species or critical habitats.

Species under FWS's Jurisdiction

We conclude that the project, as proposed with staff-recommended measures, would not likely adversely affect the marbled murrelet, western snowy plover, northern spotted owl, and short-tailed albatross.

On September 17, 2019, Commission staff requested FWS concurrence with our findings. FWS concurred with these findings by letter filed October 16, 2019. Therefore, no further consultation under the ESA is required regarding these species.

1.4.6 Marine Mammal Protection Act

The 1972 Marine Mammal Protection Act (MMPA) prohibits, with certain exceptions, the "take" (defined under statute to include harassment) of marine mammals in U.S. waters and the high seas. In 1986, Congress amended both the MMPA, under the incidental take program, and the ESA, to authorize incidental takings of depleted, endangered, or threatened marine mammals, provided the "taking" (defined under the statute as actions which are or may be lethal, injurious, or harassing) was small in number and had a negligible impact on marine mammals.

On April 10, 2019, OSU requested a determination from NMFS that the project's construction and operation was not expected to result in "take" under the MMPA. NMFS issued a letter on May 30, 2019, concluding that neither construction nor operation of the project is expected to result in take of marine mammals and that no Incidental Harassment Authorization is therefore required.[13]

1.4.7 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) requires federal agencies to consult with NMFS on all actions that may adversely affect Essential Fish Habitat (EFH). In a notice dated May 27, 2014, FERC designated OSU as its non-federal representative for carrying out informal consultation, pursuant to Section 305(b) of the Magnuson-Stevens Act and implementing regulations at 50 C.F.R. Section 600.920.

OSU determined with input from NMFS that the proposed project area includes habitat that has been designated as EFH for groundfish, coastal pelagic species, Pacific salmon, and highly migratory fish species. OSU consulted with NMFS regarding potential project effects to EFH. Information on EFH that may occur in the vicinity of the project is presented in section 3.3.5.1, *Threatened and Endangered Species and Essential Fish Habitat*, as well as the Biological Assessment (BA) (FERC, 2019).

On September 17, 2019, Commission staff issued a letter to NMFS providing an EFH assessment and requesting that NMFS provide any EFH recommendations under section 305(b) of the Magnuson-Stevens Act. In the EFH assessment, staff concluded that licensing the project would not adversely affect EFH designated for groundfish, coastal pelagic species, Pacific salmon, and highly migratory fish species because the anticipated direct or indirect physical, chemical, or biological alterations of the waters or substrate within the project site would be insignificant due to its small spatial scale. In its December 20, 2019 response, NMFS concluded that the proposed construction and operation of the project would adversely affect EFH for groundfish, coastal pelagic species, Pacific Coast salmon, and highly migratory fish species. NMFS recommends that certain terms and conditions of the Biological Opinion be adopted as EFH conservation recommendations. NMFS concludes that fully implementing the

---

[13] See Appendix N of the Applicant-prepared Environmental Assessment (APEA) filed on May 31, 2019 by OSU as part of the Final License Application.

recommendations would protect, by avoiding or minimizing the adverse effects to, designated EFH for groundfish, coastal pelagic fish species, Pacific salmon, and highly migratory fish species.

1.4.8 National Historic Preservation Act

Section 106 of the NHPA requires that the Commission take into account the effects of its actions on historic properties and afford the Advisory Council on Historic Preservation (Advisory Council) a reasonable opportunity to comment on the undertaking.[14] Historic properties are those that are listed or eligible for listing on the National Register of Historic Places (National Register). In this document, we also use the term "cultural resources" for properties that have not been evaluated for eligibility for listing on the National Register. Cultural resources represent things, structures, places, or archaeological sites that can be either prehistoric or historic in origin. In most cases, cultural resources less than 50 years old are not considered historic. Section 106 also requires that the Commission seek concurrence with the state historic preservation office (SHPO) on any finding involving effects or no effects on historic properties and consult with interested Indian tribes or Native Hawaiian organizations that attach religious or cultural significance to historic properties that may be affected by an undertaking.

No historic properties are located within the project's area of potential effects (APE) and, as a result, the proposed project would have no effect on historic properties. The Oregon State Historic Preservation Office (Oregon SHPO) was consulted and determined that no historic properties would be affected by the proposed project.[15]

1.4.9 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) (16 U.S.C., § 703, Supp. I, 1989) prohibits killing, possessing, or trading in migratory birds except in accordance with regulations prescribed by the Secretary of the Interior.

---

[14] An undertaking means "a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including those carried out by or on behalf of a Federal agency; those carried out with Federal financial assistance; and those requiring a Federal permit, license, or approval." 36 C.F.R. § 800.16(y). Here, the undertaking is the potential issuance of an original license for the PacWave South Project.

[15] See Oregon SHPO letter, dated December 17, 2019, filed by OSU on January 23, 2020.

Under Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds," Federal agencies have been directed to take certain actions to further implement the MBTA. To this end, the FWS has entered into MOUs with over a dozen agencies, including FERC, DOE, and the Minerals Management Service (precursor to BOEM). The MOU with BOEM, signed in June 2009, obligated the two agencies to strengthen migratory bird conservation through enhanced collaboration and to work together to reduce negative impacts of resource development projects on migratory birds. Specifically, it obligates BOEM to integrate migratory bird conservation principles, as well as reasonable and feasible conservation measures and management practices into BOEM approvals, procedures, and practices consistent with the Council on Environmental Quality's (CEQ) regulations, and FWS and BOEM guidelines and procedures. While this MOU expired in 2014, FWS and BOEM are in the process of updating it and the 2009 MOU is indicative of the agencies' commitments to work collaboratively to conserve migratory birds. OSU has coordinated with FWS to develop a Bird and Bat Conservation Strategy (BBCS) Plan.

1.4.10 U.S. Coast Guard Approval for Navigation Aids

The USCG Thirteenth District is responsible for the permitting of all Private Aids to Navigation located in Idaho, Montana, Oregon, and Washington. USCG District 13 enforces federal laws on the high seas and navigable waters off Oregon and maintains aids to navigation, such as buoys. The project would require USCG approval for new Private Aids to Navigation (e.g., lighting and reflectors) to be affixed to the WECs and navigation marker buoys. A USCG Local Notice to Mariners would also be required for the deployment of in-water infrastructure and equipment associated with the project, and OSU would implement any navigational designations prescribed by the USCG.

1.4.11 Outer Continental Shelf Lands Act and Energy Policy Act

Subsection 8(p)(1)(C) of the OCS Lands Act (43 U.S.C. § 1337(p)(1)(3)), which was added by Section 388 of the Energy Policy Act of 2005, gave the Secretary of the Interior the authority to issue leases for MHK projects on the OCS. OSU submitted an Unsolicited Request for Renewable Energy Research Lease to BOEM on October 29, 2013; on June 19, 2014, BOEM determined that it is appropriate to issue a research lease for the project on a non-competitive basis.

1.5 PUBLIC REVIEW AND COMMENT

The Commission's regulations (18 C.F.R. § 4.38) require applicants to consult with appropriate resource agencies, tribes, and other entities before filing an application for a license. This consultation is the first step in complying with the Fish and Wildlife Coordination Act (16 U.S.C. §§ 661-667e), the ESA, the NHPA, and other federal statutes. Pre-filing consultation must be completed and documented according to the Commission's regulations.

Licensing of the project was formally initiated April 15, 2014, when OSU filed with the Commission a Pre-Application Document (PAD), a Notice of Intent, and a request to use the Alternative Licensing Process (ALP) to license the project. The Commission issued a public notice of the filing and approved the use of the ALP on May 27, 2014.

1.5.1 Scoping

Before preparing this EA, staff conducted scoping to determine what issues and alternatives should be addressed. Scoping Document 1 (SD1) was issued on June 5, 2014. Two scoping meetings were held on July 9, 2014, in Newport, Oregon, to obtain comments on the project. A court reporter recorded all comments and statements made at the scoping meetings, and these are part of the Commission's public record for the project. An environmental site review was held on July 10, 2014. In addition to the comments provided at the scoping meetings, the following entities filed written comments on SD1 and the PAD:

Commenting Entities	Date Filed
Oregon DLCD	July 31, 2014
FWS	August 1, 2014
NMFS	August 4, 2014
Oregon DFW	August 4, 2014
Oregon Parks and Recreation Department (Oregon PRD)	August 4, 2014
Oregon Department of Energy	August 4, 2014
Marine Mammal Commission	August 4, 2014
OWET	August 4, 2014

A revised scoping document 2, addressing these comments, was issued on September 16, 2014.

1.5.2 Interventions

On August 29, 2019, the Commission issued a notice accepting the application and setting September 30, 2019, as the deadline for filing protests and motions to intervene. The following entities filed motions to intervene:

Intervenors	Date Filed
Interior, on behalf of FWS	September 26, 2019
Oregon DFW	September 30, 2019

On November 18, 2019, NMFS filed a late motion to intervene, which was granted by Secretary's Notice issued on December 5, 2019.

1.5.3 Comments on Application

A notice requesting comments, recommendations, and preliminary terms and conditions was issued on August 29, 2019. The following entities responded:

Commenting Entity	Date Filed
Interior, on behalf of FWS	September 26, 2019
Oregon PRD	September 30, 2019
Oregon DFW	September 30, 2019

2.0 PROPOSED ACTIONS AND ALTERNATIVES

This EA assesses the environmental and economic effects of constructing, operating, and maintaining the project: (1) as proposed by OSU; and (2) as proposed by OSU with staff's recommended measures (staff alternative). It also considers the effects of the no-action alternative.

2.1 NO-ACTION ALTERNATIVE

The no-action alternative is license denial. Under the no-action alternative, the project would not be built and environmental resources in the project area would not be affected. This is the baseline against which the action alternatives are compared.

2.2 APPLICANT'S PROPOSAL

2.2.1 Project Facilities

The project facilities proposed in OSU's FLA include: (1) four offshore test berths containing a maximum of 20 WEC devices with a maximum total installed capacity of 20 MW; (2) various anchoring systems including gravity-based anchors, suction anchors, plate anchors, and drag embedment anchors, constructed with steel, concrete, or a mixture of steel and concrete; (3) single- or three-point mooring systems consisting of chain, steel cables, or synthetic materials; (4) mooring infrastructure including surface buoys, subsurface floats, and chain, wire or rope, as catenary, tendon or bridle lines; (5) subsea connectors; (6) 5 buried subsea transmission cables[16] converging in 5 nearshore conduits; (7) 5 onshore cable landing vaults and beach manholes at Driftwood Beach State Recreation Site (Driftwood); (8) 5 or 15 buried terrestrial transmission lines[17] (carried in 1-3 conduits) connecting to a Utility Conditioning and Monitoring Facility (UCMF); (9) 5 or 15 buried terrestrial transmission lines (carried in 1-3 conduits) to grid-interconnection at CLPUD substation; and (10) appurtenant facilities.

[16] One of the 5 subsea cables and one of the 5 terrestrial lines will serve as an auxiliary cable/line.

[17] As discussed below, if three-conductor terrestrial lines are used, then one terrestrial line would be needed for each subsea cable, plus an auxiliary (i.e., five terrestrial lines total). If single-conductor terrestrial lines are used, three terrestrial lines would be needed for each subsea cable (i.e., 15 terrestrial lines total).

2.2.1.1 Wave Energy Converters

WEC technology is expected to evolve over the term of any license issued for the project and various types of WECs would be tested. To accommodate near-term and long-term industry needs, OSU surveyed and interviewed WEC technology developers to ascertain what types of WECs could be reasonably expected to be deployed at PacWave South, based on the proposed location of the WEC test site (e.g., water depth and wave resources) and present state of technology. Based on this research, the following WEC types could be tested (singly or in arrays) at PacWave South (Figure 2-1):

- **Point absorbers:** floating or submerged structures with components at or near the ocean surface that capture energy from the motion of waves, and drive a generator. Point absorbers could be fully or partly submerged.
- **Attenuators:** structures that respond to the curvature of the waves rather than the wave height. These WECs could consist of a series of semi-submerged sections linked by hinged joints. As waves pass along the length of the WEC, the sections would move relative to one another. The wave-induced motion of the sections would be captured and used to drive a generator.
- **Oscillating water columns (OWC):** 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 air is forced in and out through a turbine, which usually can rotate regardless of the direction of the airflow (i.e., a bi-directional turbine).
- **Hybrids:** WEC types that 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 could 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.

To allow for the testing of arrays of WECs, the project could accommodate the deployment of up to 20 WECs (total) at one time. However, OSU expects that the number of WECs to be deployed would vary throughout the license term and that fewer WECs would likely be deployed in the initial years of operation (i.e., the first 5 years or so). To evaluate the true range of potential effects that the project might have over the term of any license issued, this EA evaluates both an initial development scenario and a full build-out scenario, as follows:

- *Initial Development Scenario* (Figure 2-2) – six WECs consisting of:
  - Berth 1 = 1 point absorber;

- Berth 2 = 1 OWC;
- Berth 3 = 1 attenuator; and
- Berth 4 = 3 point absorbers with shared anchors.

- *Full Build-Out Scenario* (Figure 2-3) – 20 WECs consisting of:
  - Berth 1 = array of 5 point absorbers;
  - Berth 2 = array of 5 OWCs;
  - Berth 3 = array of 5 point absorbers; and
  - Berth 4 = array of 5 attenuators.

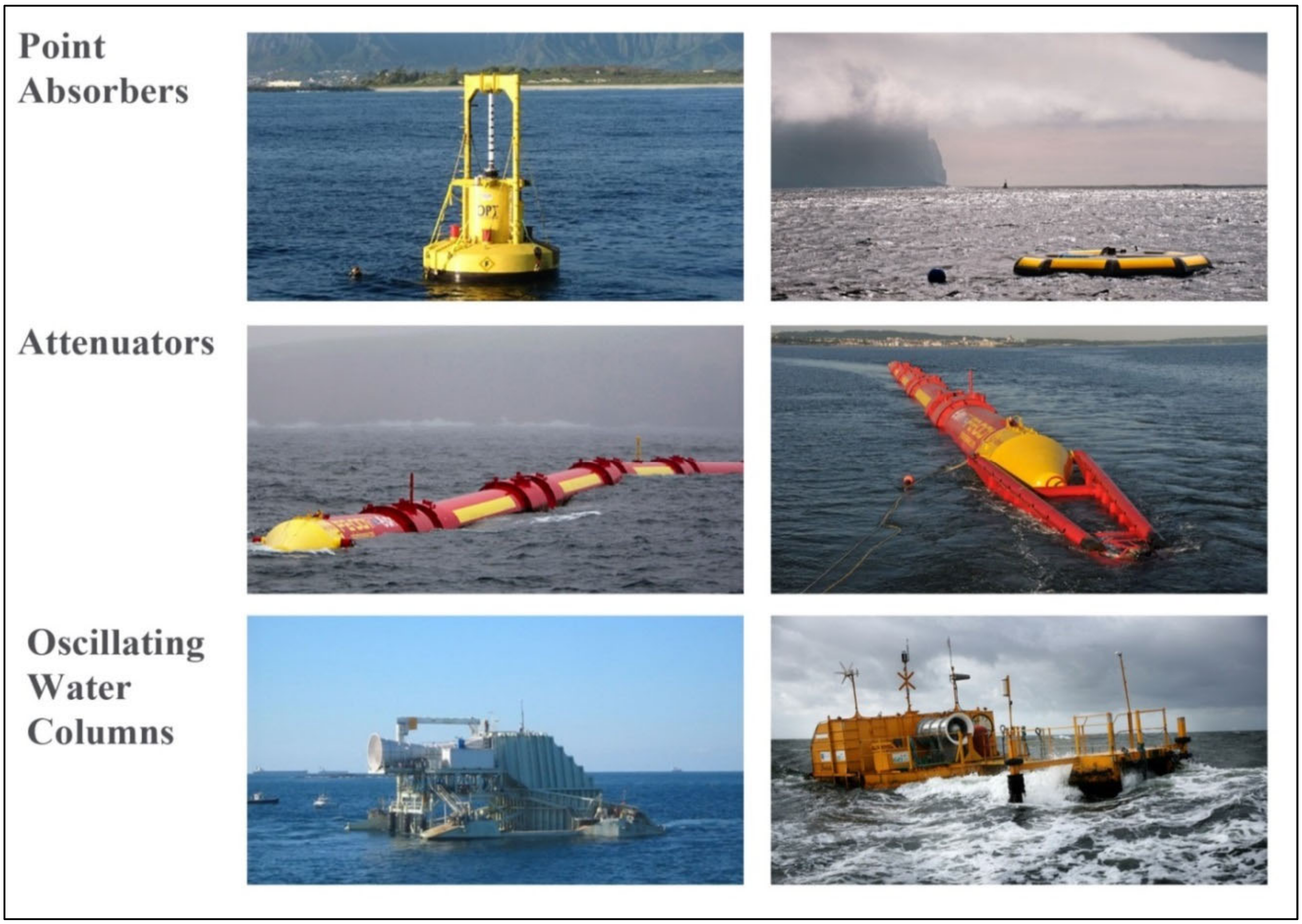

Figure 0-1. Examples of different types of WECs.

WECs would likely be deployed 50 to 200 meters or more apart from each other within a berth[18] (Figures 2-4 and 2-5). The rated capacity of individual WECs would vary, and preliminary estimates range from 150 kW to 2 MW per device. Based on these

[18] The referenced distance refers to the separation of the WECs; the moorings may be located closer to each other.

estimates and the number of deployed WECs mentioned above, the installed capacity for the initial development scenario is expected to range from 900 kW to 10 MW, and the full build-out will not exceed 20 WECs and 20 MWs. Because the rated capacity of WECs would vary depending on the units installed for testing at the site at any given time, the average power output from the project would also vary during the term of the license. Accordingly, the characterization of power and generation produced by the proposed project would similarly vary with time, including the average capacity factor, availability, and value of installed capacity.

Supporting buoys and instrumentation would also be used to gather data on site conditions and support testing operations. This equipment would likely be similar to those previously deployed at OSU's nearby PacWave North[19] (formerly known as Pacific Marine Energy Center North Energy Test Site [PMEC-NETS]).

---

[19] PacWave North is an existing wave energy test facility developed by OSU in 2012. The facility, which is north of the proposed PacWave South site, is not grid-connected and is not part of the PacWave South license application.

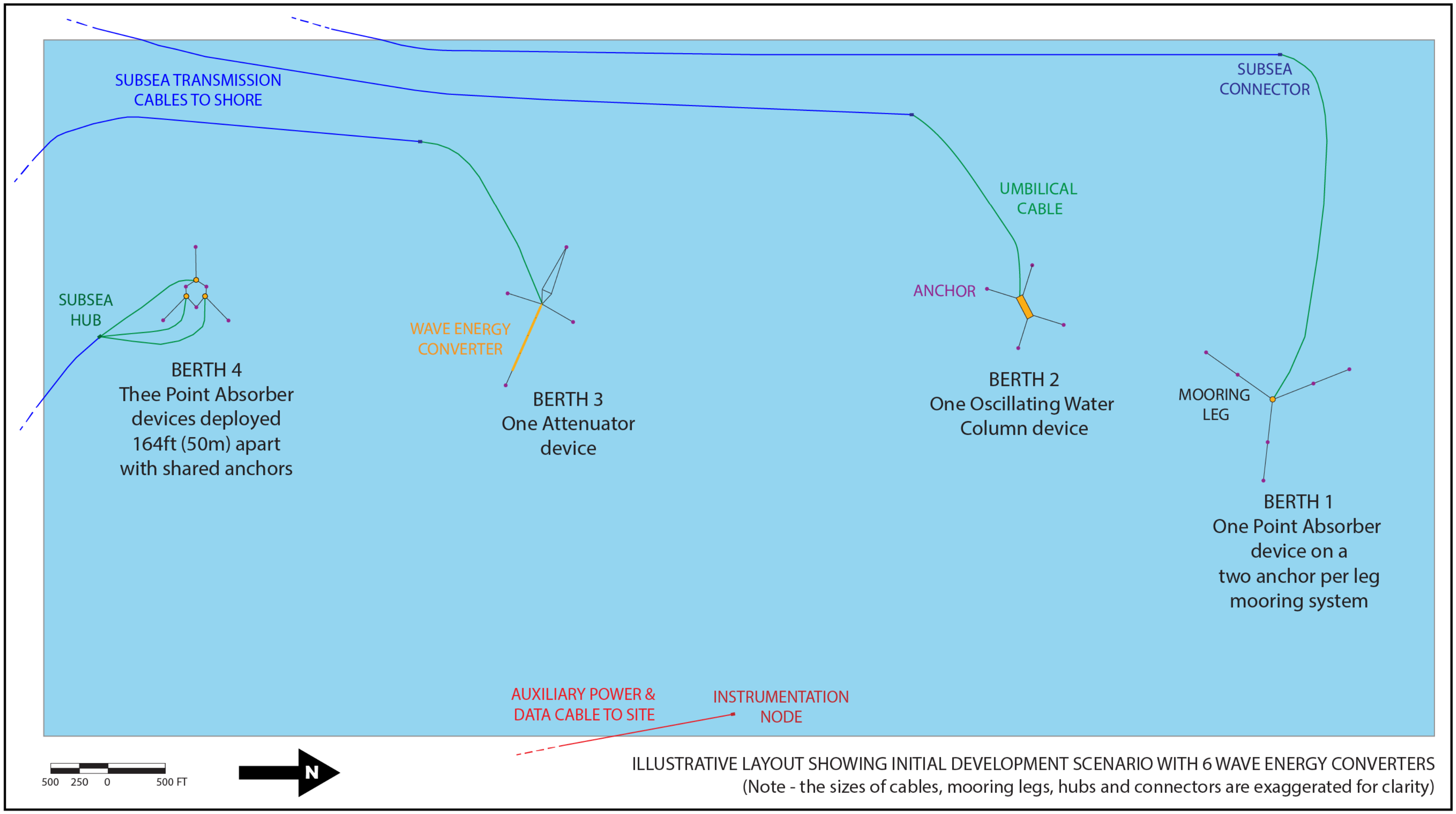

Figure 0-2. Illustrative test berth configuration for the initial development scenario. Note, actual deployment would vary.

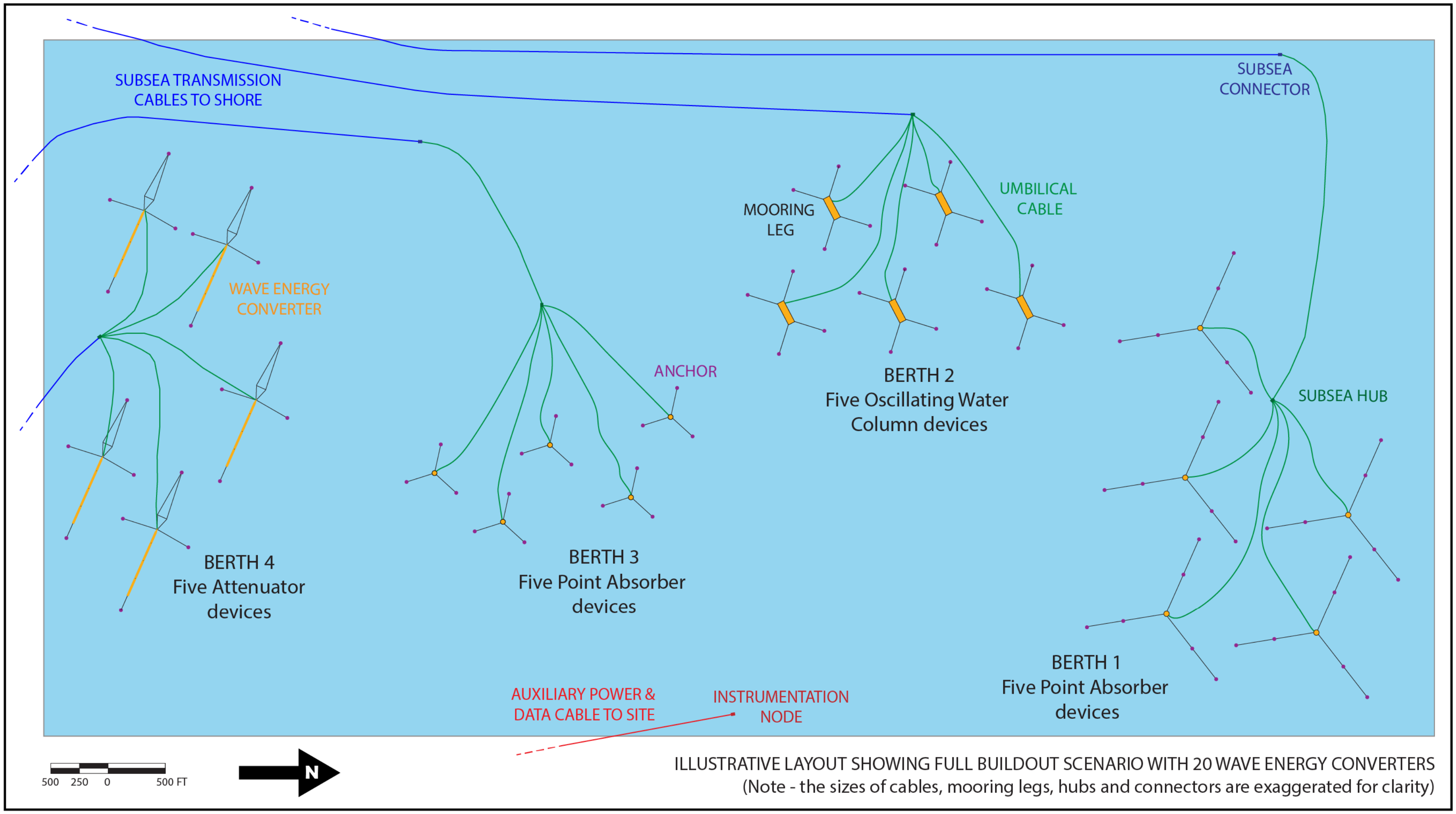

Figure 0-3. Illustrative test berth configuration for the full build-out scenario. Note, actual deployment would vary.

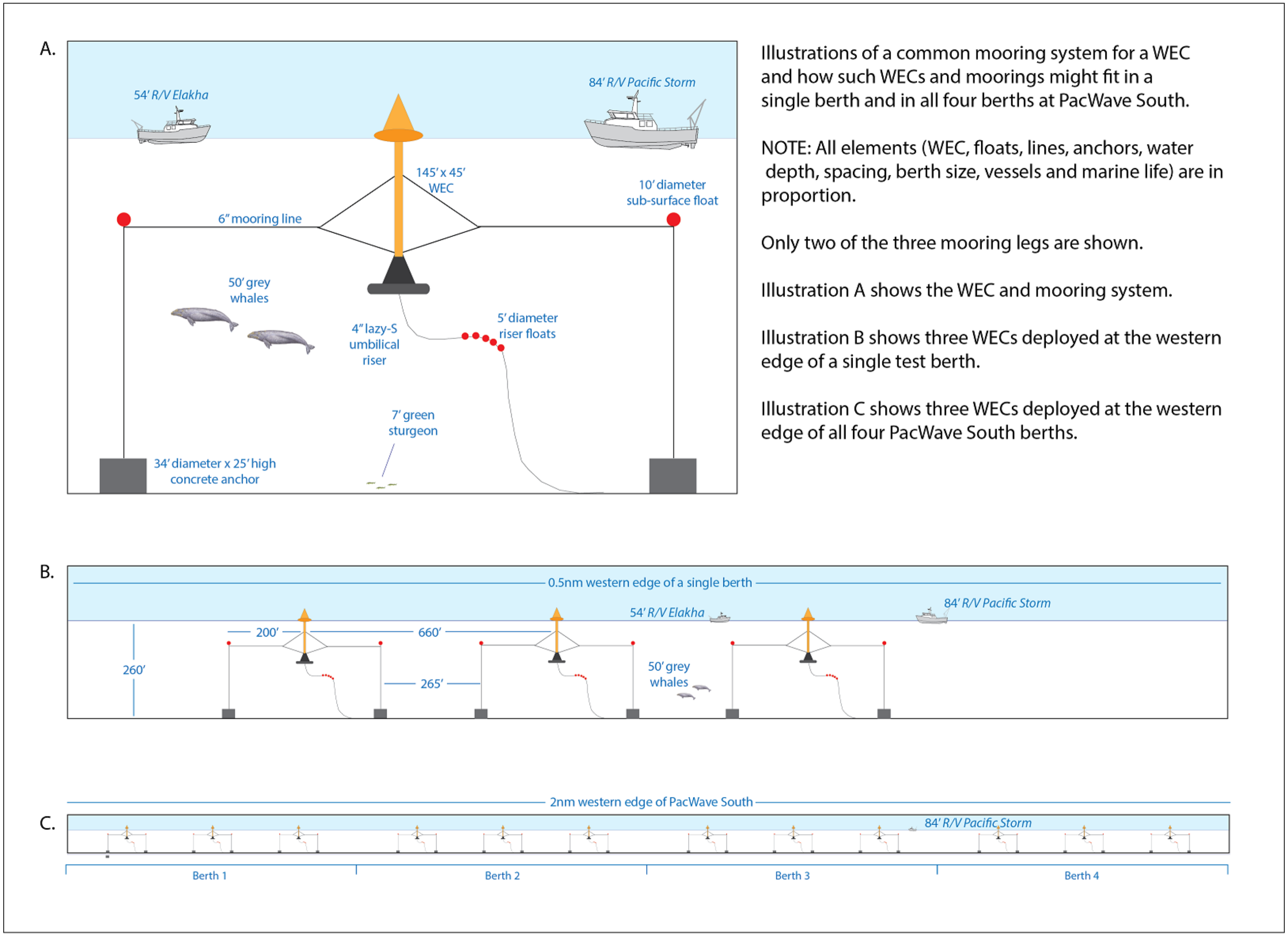

Figure 0-4. Scale drawing of WECs at 200-meter spacing (660 ft).

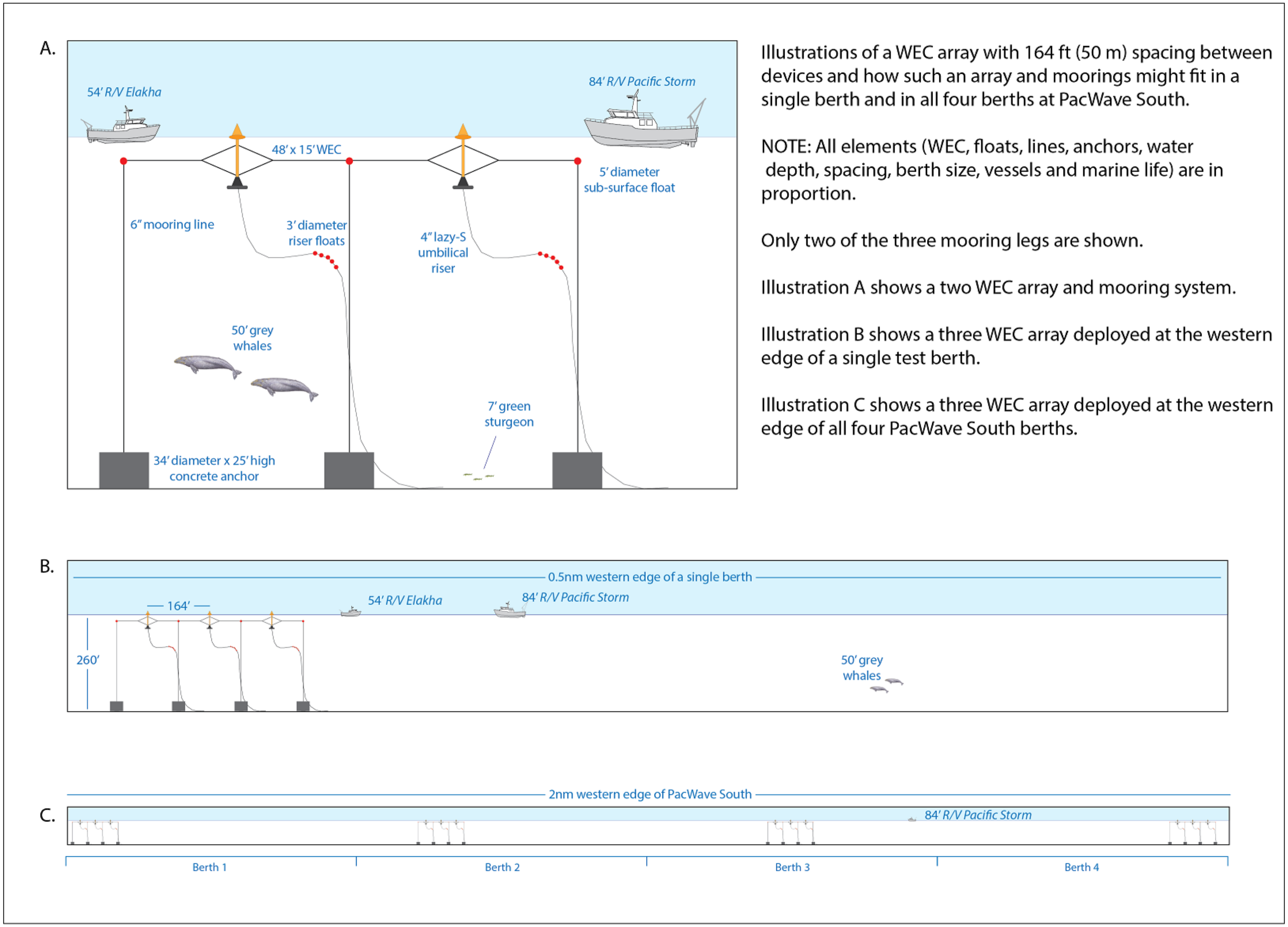

Figure 0-5. Scale drawing of WECs at 50-meter spacing (164 ft).

2.2.1.2 Anchors and Mooring Systems

The specific anchor types and mooring configurations at the project would vary based on the specific WECs being deployed. However, because the physical and environmental conditions within the test site are relatively uniform, the general types of anchoring and mooring systems would not vary substantially. Furthermore, the anchors and mooring systems used would be the same as, or similar to, those commonly used for other applications in the marine environment. An OWET-funded report, titled *Advanced Anchoring and Mooring Studies,* describes common types and features of mooring systems (Sound & Sea Technology 2009).

Results of the OSU survey of WEC technology developers indicate that anchoring systems used at the project would likely include gravity anchors, drag embedment anchors, suction anchors, and plate anchors (Figure 2-6). In some cases, a combination of anchor types might be used. The survey results also show that anchors would likely consist of steel, concrete, or a combination of the two.

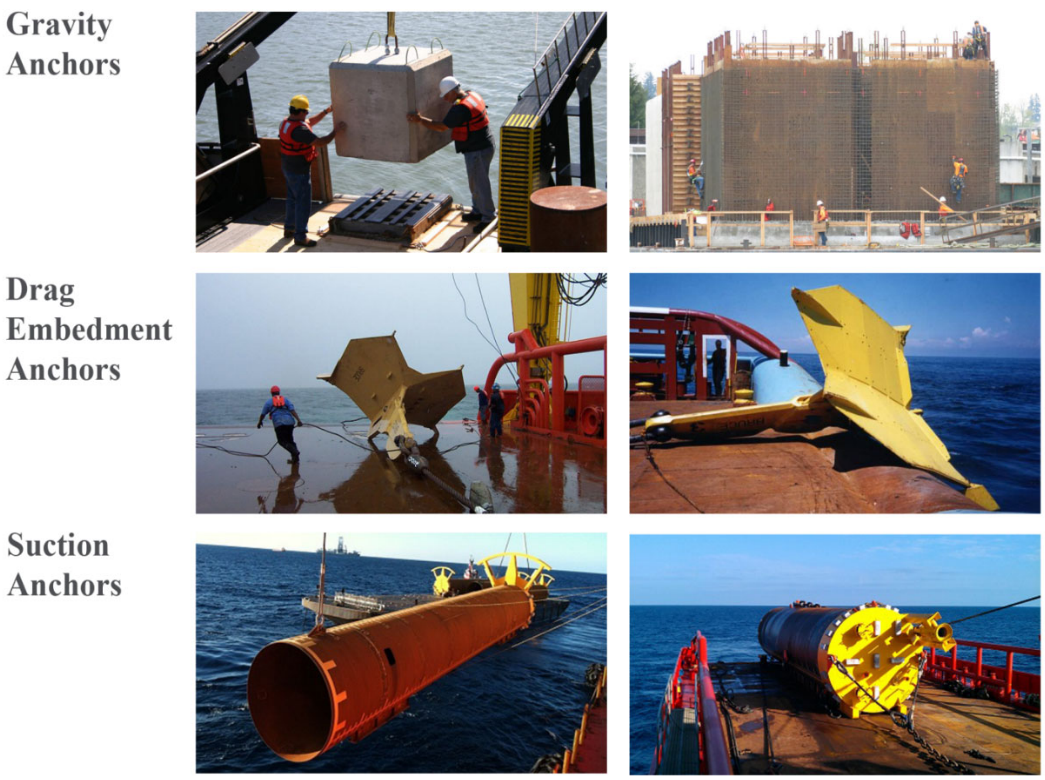

Figure 0-6. Examples of different anchor types.

The maximum estimated area covered by the anchors (i.e., the anchor footprint) under the initial and full build-out scenarios are provided in Table 2-1. The estimates are based on exclusive use of 34-foot diameter cylindrical gravity anchors as these represent the largest anchors that might be expected to be used at the project; however, other types of smaller anchors would likely be used for many of the WECs, and shared anchors may be used for some WECs when feasible. Therefore, the actual seafloor anchor footprint is expected to be considerably smaller than the estimates in Table 2-1.

Table 0-1. Estimated maximum anchor footprints for initial development and full build-out scenarios by berth.

Scenario	WEC Type	No. WECs	Total No. Anchors	Maximum Seafloor Anchor Footprint (ft^2)*
Initial Development				
Berth 1	Point absorber	1	6	5,448
Berth 2	OWC	1	4	3,632
Berth 3	Attenuator	1	4	3,632
Berth 4	Point absorber with shared anchors	3	7	6,356
			Maximum Total Anchor Footprint =	**19,068 ft^2 (0.4 acre)**
Full Build-Out				
Berth 1	Point absorber	5	30	27,240
Berth 2	OWC	5	20	18,160
Berth 3	Point absorber	5	30	27,240
Berth 4	Attenuator	5	20	18,160
			Maximum Total Anchor Footprint =	**90,800 ft^2 (2 acres)**

* Based on the total footprint of 34-ft-diameter gravity anchors (908 ft^2 per anchor), representing the largest possible footprint per anchor; other anchor types would have a considerably smaller footprint.

The OSU survey of WEC technology developers also asked developers about mooring systems, and analysis of the results shows that most WECs would use single- or three-point mooring systems (25 percent and 28 percent of responses, respectively). Mooring systems are generally classified by their configuration (e.g., single- or multi-leg) and components (i.e., anchors, buoys, and lines). As with anchor types, mooring lines would consist of types commonly used in the marine industry (e.g., chain, steel wire, or synthetic materials). Like the rest of the marine industry, WEC technologies use various combinations of these anchor types and mooring system components. Mooring infrastructure may also include buoys and/or subsurface floats. Although these components can be combined in various ways, there are only a few different component types (i.e., three common types of mooring line and four common types of anchor), as shown in Table 2-2.

Table 0-2. Standard mooring systems configurations and components.

CONFIGURATION	COMPONENTS		
A. Single Leg	**Anchors** (steel/concrete/both)	**Buoys**	**Lines**
B. Multi Leg	A. Gravity/deadweight	A. Steel	A. Chain
1. Three-point	B. Drag embedment	B. Composite	B. Wire rope
2. Four-point	C. Suction embedment	1. Surface	C. Synthetic
3. Five-point	D. Plate embedment	2. Subsurface	
4. Six-point			
i. Catenary			
ii. Taut			

Sample mooring and anchor specifications for different types of WECs are presented in Table 2-3.

Table 0-3. Illustrative WEC mooring and anchoring configurations.

	Point Absorber	**Point Absorber**	**Attenuator**	**Oscillating Water Column**
Mooring Configuration	Single leg	Multi-leg Catenary	Multi-leg Catenary	Multi-leg Taut
Approx. Water Depth (ft)	250	250	250	250
Line Length per Leg (ft)	~300	~600	~400	~350
Line Material	Chain & wire rope	Chain & synthetic rope	Chain & synthetic rope	Wire & synthetic rope
No. of Legs	1	3	4	4
No. of Anchors Per Leg	1	2	1	1
Anchor Type	Suction	Drag & gravity	Drag	Gravity
Anchor Sizes (ft)	DxH (Qty) 6x8 (1)	LxWxH (Qty) Drag: 12x13x8 (3) Gravity: 8x6x4 (3)	LxWxH (Qty) 16x18x11 (3) 22x24x15 (1)	DxH (Qty) 34x25 (4)
Anchor Material	Steel	Drag: Steel Gravity: Steel & concrete	Steel	Steel & concrete

*Note: D = Diameter; H = Height; L = Length; W = Width; (Qty) = number of anchors.

Anchor deployment and recovery would be infrequent. The OSU industry survey and OWET market analysis indicate that most developers plan to deploy WECs for multi-year test periods (e.g., 3-5 years), so anchors would likely also be deployed for multi-year periods. Furthermore, it is unlikely that anchor systems would be adjusted during a WEC test due to the high costs associated with installing and removing them. Therefore, disturbance due to anchor installation and removal operations within a berth should only occur occasionally (e.g., once a year, or perhaps only once every several years). Additionally, these activities rely on specific weather windows, so the timeframes within which anchor deployment and recovery operations could occur are limited. Finally, OSU proposes to reuse anchors wherever practicable. If an incoming WEC developer could use an anchor and/or mooring configuration that was already in place from a previous test, then the anchors could be left in place to limit seafloor disturbance.

2.2.1.3 Power Transmission and Grid Interconnection

Subsea Connectors

Power generated by WECs would be transferred via umbilical cables (also known as dynamic risers) to a subsea connector attached to the end of a subsea cable and located on the seafloor at each test berth; from there, electricity would be transmitted from the subsea connector via the subsea cable to shore. As the WECs would be on or near the surface, the umbilical cables would run from the WEC to the seafloor and would therefore be partially suspended in the water column. The common configuration for such umbilical cables is to attach subsurface floats to create a "lazy-S", which maintains tension but allows enough motion to prevent the umbilical from being damaged by WEC movements. There would be one umbilical cable per WEC. If a client were testing an array of WECs, or needed additional power conditioning or conversion support, the umbilicals would all connect to a client-supplied hub, which would then connect to the project subsea connector at that berth.

The final subsea connector choice would depend on several factors including the final cable specification. Subsea connectors are also an area of on-going research and development. However, one option is the GreenLink Inline Termination manufactured by MacArtney Underwater Technology (Figure 2-7). The connector has no external moving parts and can be dry, oil, gel or nitrogen filled as required. It is a "drymate" system, which requires the connector to be winched onto a vessel for a WEC to be connected or disconnected.

Using a system like this would allow test clients to easily connect their WECs to the subsea cables, monitor device performance, and export power to the grid via the onshore UCMF. Subsea connector systems such as this typically have built-in cathodic protection and are expected to operate for up to 25 years. The subsea connectors would be installed at the same time as the subsea cables to shore.

Figure 0-7. Example of subsea connector (MacArtney's GreenLink Inline Termination).

Subsea Cables

OSU plans to install four subsea transmission cables, one for each of the four test berths, and an auxiliary cable. The subsea transmission cables would transfer power back to shore and allow for the monitoring and control of WECs via fiber optic elements incorporated into the transmission cables themselves. The cable corridor dimension and routing are described in further detail below.

The auxiliary cable would increase the monitoring capabilities at PacWave South. An auxiliary cable would allow for extended deployments of instruments or equipment with high data bandwidths or power requirements. Cabling instruments could also greatly reduce maintenance costs associated with some instrumentation (e.g., acoustic landers require battery replacements every few months) and increase the feasibility of real-time data. Field-testing cutting-edge technology and having real-time data for environmental and WEC monitoring would greatly enhance the PacWave South testing capabilities and could potentially benefit other offshore projects and marine industries that require technological solutions.

OSU anticipates that the subsea transmission cables would be three-conductor, AC cables with a rated voltage of 35 kilovolts (kV), like the cable shown in Figure 2-8. At present, OSU is considering cables with either 70-square-millimeter (mm^2) or 50-mm^2 copper conductors, which are slightly less than 4 inches in diameter and weigh between 7 and 8 pounds per foot.

The exact specifications for the subsea cables would be developed during final design. All the cables would use standard industrial shielding and armoring (e.g., galvanized steel wires), as illustrated in Figure 2-8. Electric fields from energized AC cable conductors are shielded effectively by metallic sheathing and armoring.

Figure 0-8. Example of medium-voltage subsea cable.

Within the project site, the umbilical cables and a segment (approximately 300 meters) of the subsea cables would remain unburied to allow for access during WEC deployment and removal, and maintenance activities (Figure 2-9); however, the majority of the subsea cable segment would, to the extent practicable, be buried to a target depth of 1 to 2 meters from the offshore WEC test site back to the Horizontal Directional Drill (HDD) conduits. In areas where burial is not feasible (due to unsuitable seafloor conditions), the cables would be laid on the seafloor and protected by split pipe, concrete mattresses, or other cable protection systems. The subsea cables would enter HDD-installed conduits at approximately the 10-meter isobath and continue to shore, south of an area of rocky geology that extends along the coast to the north, passing under the beach and dune system and into the parking lot at Driftwood in the unincorporated coastal community of Seal Rock, Oregon (Figure 2-10). The industry best practice for minimum spacing between buried subsea cables is 1.5 times the water depth. The eastern edge of the WEC site is in approximately 65 meters of water, and the HDD-installed conduits carrying the transmission cables from onshore at Driftwood would surface from the seabed in approximately 10 meters of water, 0.6 mile offshore. Accordingly, the minimum spacing between each cable at the edge of the WEC test site would be at least 100 meters (i.e., 65 meters x 1.5 = 97.5 meters), and 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 WEC test site to a minimum of 60 meters at the nearshore HDD conduits. As the seafloor does not shelve evenly, the cable corridor would not widen at a constant rate between the HDD conduits and the WEC test site (see Figure 2-9).

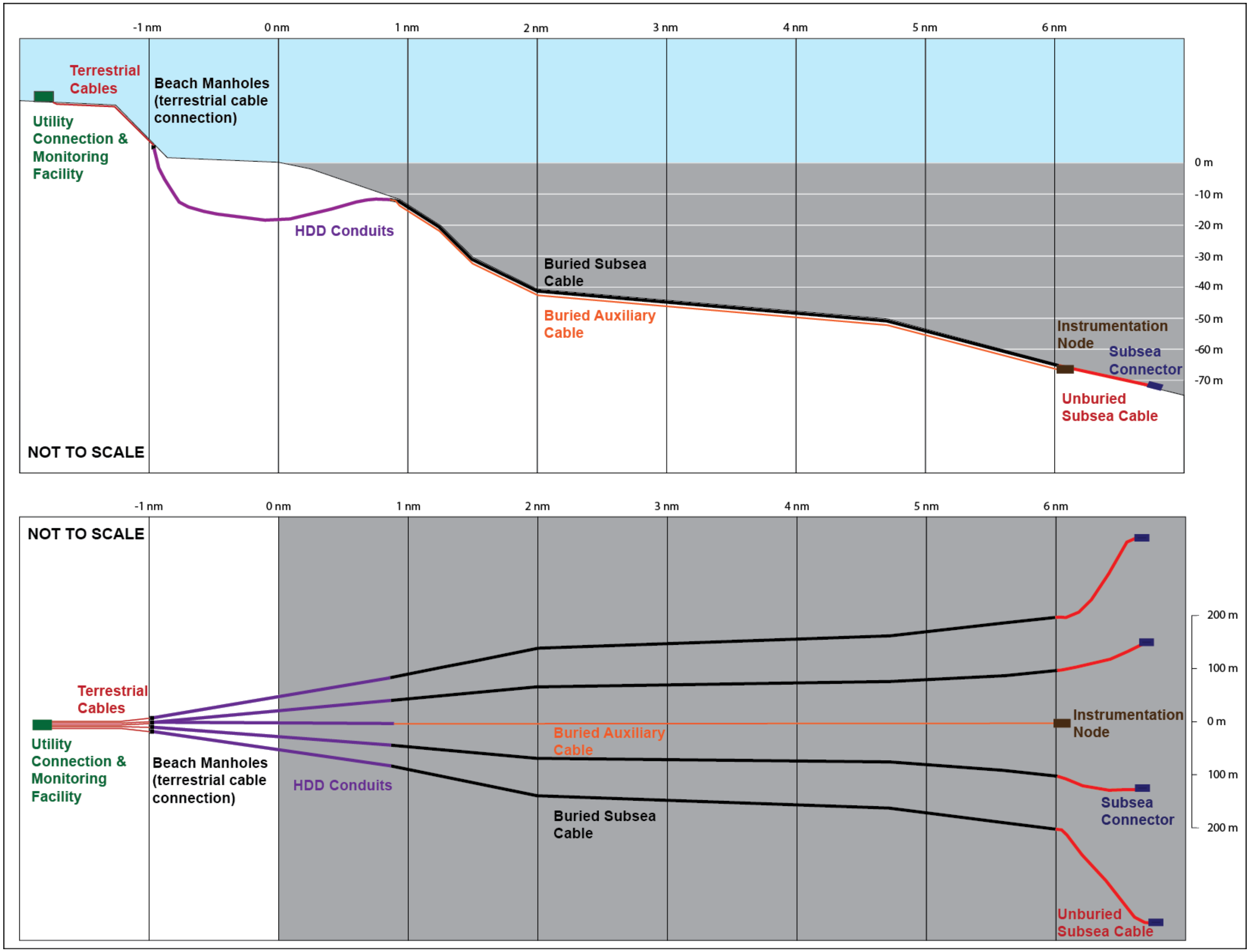

Figure 0-9. Subsea cables schematic. Note, these schematics are illustrative and are not to scale.

Figure 0-10. PacWave South landfall, Driftwood Beach State Recreation Site. Beach manholes are shown in red, the buried HDD conduits to the test site are shown in green, and the underground HDD conduits to the Utility Connection and Monitoring Facility are shown in yellow.

HDD would be used to install five separate conduits (for four subsea transmission cables and one auxiliary cable) from the Driftwood, about 50-100 feet beneath the beach and dune system and, out to the 10-meter isobath, a distance of 0.6 nautical miles (Figure 2-9). The four transmission cables and auxiliary cable would each run through separate HDD conduits to individual, onshore cable splice vaults, known as beach manholes, where the subsea cables would transition to terrestrial cables. It is anticipated that there would be five beach manholes, which would be made of precast concrete. The buried concrete vaults would measure approximately 10 feet by 10 feet by 10 feet. Access to each beach manhole would be via a standard manhole cover, like those used to access underground utilities (sewer, power, and telephone). The proposed project subsea transmission cable route would be about 8.3 nautical miles long, consisting of about 3.7 nautical miles located on the OCS, 4.0 nautical miles in the Territorial Sea and 0.6 nautical miles of HDD installed conduit beneath the nearshore zone, beach, and sand dunes.

Terrestrial Transmission Line

From the beach manholes at Driftwood, the transmission lines would be installed in up to three HDD bores[20] to the UCMF site. From the beach manholes, the transmission lines would run to the southeast, under the southern portion of the Driftwood. The HDD transmission line conduits would then run under small sections of six private properties located on either side of Highway 101, and then to the OSU-owned UCMF parcel east of the highway. From the UCMF, additional conduits would also be buried by HDD west to, and under, Highway 101 to the grid connection point with the CLPUD overhead distribution lines along the road; for this part of the construction, the HDD rig would be set up on the UCMF site. The total distance of the terrestrial transmission lines would be about 0.5 mile (Figure 1-2). The specifications of the terrestrial transmission lines are dependent on the final subsea cable design and coordination with CLPUD to ensure compatibility with existing infrastructure. At this stage, OSU anticipates that the terrestrial transmission lines would either be three-conductor cables, such as the Okonite cable (Figure 2-11), or single-conductor terrestrial cables such as the Kerite cable (Figure 2-12). If three-conductor terrestrial cables are used, then one terrestrial cable would be needed for each subsea cable, plus the auxiliary (i.e., five terrestrial cables total). If single-conductor terrestrial cables are used, three terrestrial cables would be needed for each subsea cable (i.e., 15 terrestrial cables total).

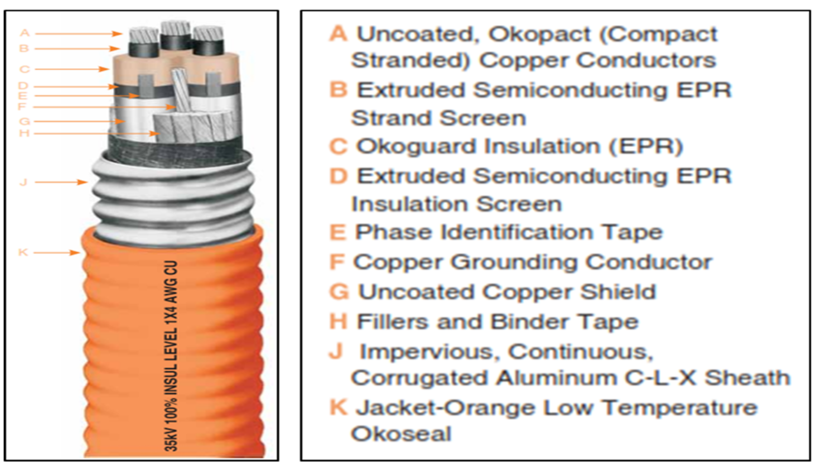

Figure 0-11. An example of an Okonite three-conductor terrestrial cable.

[20] In its reply comments to FWS and Oregon DFW's REA comments to limit the number of HDD bore holes, OSU proposes to use a maximum of three HDD bore holes to install conduits and the terrestrial transmission lines instead of the five bore holes proposed in the FLA.

Depending on insulation type, the three-conductor cables are typically between 3.2 and 3.7 inches in diameter and weigh between 4.7 and 5.7 pounds per foot. The single conductor cables are between 1.4 and 1.6 inches in diameter and weigh between 0.9 and 1.5 pounds per foot. Due to the number, size, and weight of the cables, using the existing above-ground utility poles would not be feasible, and it would be necessary to bury the cables.

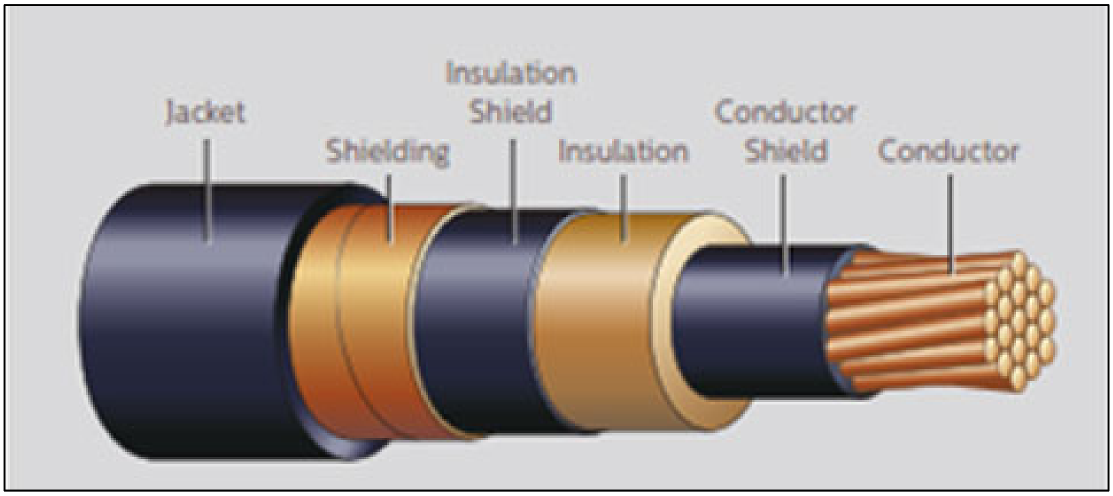

Figure 0-12. An example of a Kerite single-conductor terrestrial cable.

Utility Connection and Monitoring Facility

Power monitoring, conditioning, utility equipment and other electrical operations would be performed at the onshore UCMF site, located on the OSU-owned property 0.3 mile south of Driftwood. At the UCMF site, OSU plans to construct three, single-story buildings (Figure 1-2). One approximately 11,250-square-foot (ft^2) building would accommodate the conditioning and monitoring equipment for each of four potential test clients. A second, 4,800-ft^2 building would include the PacWave South switch gear, utility equipment, and general storage. A third approximately 4,250-ft^2 building would be the project's data, control, and communications center and would contain monitoring, communications, data storage, and supervisory control and data acquisition (SCADA) systems. The building would also contain operational support infrastructure such as restrooms and a maintenance/supply area. The existing gravel lane (NW Wenger Lane) would be paved to accommodate semi-truck access to the UCMF. The improved road would be approximately 20 feet wide and 800 feet long and would run from Highway 101 to the UCMF compound. The UCMF compound would include the three buildings and a parking/laydown area large enough to allow truck access (approximately 80 feet by 200 feet). The entire area of the UCMF compound would be approximately 1.2 acres and would be fenced and covered by security cameras and necessary lighting to meet building code standards.

The grid connection to CLPUD's distribution system would run from the UCMF to CLPUD's distribution lines on the west side of Highway 101. The proposed power line from the electrical meters at the UCMF to the grid connection on Highway 101 would be owned by OSU or owned and maintained by CLPUD, in which case OSU would negotiate the right to undertake any action required by FERC. All wire, conduit, transformers, meters, and other ancillary equipment needed to support the grid connection would be specified by CLPUD. OSU would be responsible for HDD installation of the conduits along the route, and CLPUD would then pull the wires through the conduits and complete the installation. It is expected that three 4-inch diameter conduits, and a bare copper ground wire would be required.

The CLPUD has existing telemetering capabilities at BPA's Toledo substation, which meet federal interconnection requirements. In addition, the CLPUD has experience installing and operating data and communications systems, including SCADA, ION metering, Distribution Automation, Smart Grid technologies, and other fiber optic communications. OSU believes that this expertise, along with the CLPUD's proven track record of operating a highly reliable system, would facilitate a successful test facility operation at PacWave South. OSU has worked with CLPUD to develop and submit an application for grid interconnection to BPA. The application submittal has placed PacWave South into the BPA project queue and OSU and BPA have completed a series of grid interconnection studies to help ensure that the proper design requirements are developed during the PacWave South design process. In addition to power transmission and grid-connection, OSU is also exploring power purchase options with the CLPUD. CLPUD has stated that there is sufficient grid capacity to accommodate the project, but OSU would continue to coordinate with both CLPUD and BPA to determine whether grid upgrades would be necessary to achieve the planned 20 MW of generating capacity as the facility approaches maximum capacity. If grid upgrades are determined to be necessary in the future to directly accommodate the generating capacity of the project, such upgrades would be subject to FERC approval and any required federal and state permits.

2.2.2 Project Boundary

The proposed project boundary encloses the facilities described above and identified in Figures 1-1 and 1-2. The project, which would consist of both marine and onshore components, would be located on the OCS in the Pacific Ocean, in Oregon territorial waters, and occupy portions of state, county, and privately-owned lands. The proposed project boundary encompasses approximately 8,205.7 acres of onshore and offshore areas.

The proposed BOEM research lease area would be 12 Aliquots (1/16th portions of OCS Blocks), lying within Official Protraction Diagram Newport Valley NL10-10, comprise 1,728 hectares (4,270 acres), more or less. OCS Lease Blocks and Aliquots for the project area include OCS Block 6481: Aliquots F, G, H, J, J, L, N, O, P; and OCS Block 6531: Aliquots B, C, D. The proposed project easements consist of an area of 100 feet to either side of the centerline of each of the five subsea cables. The 200-foot wide cable corridor lies within 16 Aliquots which are within Official Protraction Diagram Newport Valley NL 10-10 and Salem NL 10-11 and include OCS Blocks 6531, 6501, 6581, 6551.

The coordinates for the corners of the 2.65 square mile project site on the OCS are:

NW:	44° 35' 00.00"N	124° 14' 30.00"W
NE:	44° 35' 02.75"N	124° 13' 06.17"W
SE:	44° 33' 02.75"N	124° 12' 58.51"W
SW:	44° 33' 00.00"N	124° 14' 22.41"W

2.2.3 Project Safety

As part of the licensing process, the Commission will review the adequacy of the proposed project facilities. Special articles would be included in any license issued, as appropriate. Commission staff would inspect the licensed project both during and after construction. Inspection during construction would concentrate on adherence to Commission-approved plans and specifications, special license articles relating to construction, and accepted engineering practices and procedures. Operational inspections would focus on the continued safety of the structures, identification of unauthorized modifications, efficiency and safety of operations, compliance with the terms of the license, and proper maintenance. In addition, any license issued would require an inspection and evaluation every 5 years by an independent consultant and submittal of the consultant’s safety report for Commission review.

2.2.4 Cable Installation, Test Site Operation, and Maintenance

OSU proposes to oversee each stage of WEC testing: deployment; testing plans, protocols, and procedures; WEC performance monitoring; environmental monitoring; demobilization; and removal.

As noted, up to six WECs would likely be deployed during the initial development scenario and a maximum of 20 WECs would be deployed for the full build-out, with a maximum total capacity of 20 MW. OSU expects that fewer WECs would be deployed during initial operations and this number would increase gradually as the industry advances. However, the number of WECs would fluctuate based on clients’ needs.

Project components would be fabricated at land-based facilities prior to being installed at the test site. The primary staging areas for the project would likely center around the Port of Newport, Toledo, or other private facilities. The WECs, mooring and anchor systems, navigational buoys, and monitoring equipment, would be staged at mobilization sites for vessel transport to the project site for installation.

As a WEC test center, deployment and recovery of WECs, supporting infrastructure and instrumentation, and associated anchor and mooring systems would occur throughout the license term of the project.

2.2.4.1 Power Transmission and Grid Interconnection

The subsea transmission cables would be buried approximately 1 to 2 meters below the seafloor from near the 10-meter isobath about 0.6 nautical miles offshore to the WEC test site in the OCS using jet plowing or a similar technique. Jet plowing is a standard technique used for burying subsea cables. This technique 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 plow device, installers simultaneously lay and embed the subsea cables. Cable installation would take approximately 30 days for active installation of all five cables, assuming no weather delays, and 10 days for post-installation inspections. During cable installation a constant tension must be maintained to ensure the integrity of the cable. Each of the subsea cables would weigh between 175 to 275 tons therefore any significant stoppage or loss of position during jet plow activities has the potential to result in significant damage to the cable. As with all cable laying operations, these activities at PacWave South would need to occur 24 hours a day until installation is completed.

The HDD installation from the shore at Driftwood out to approximately the 10-meter isobath would likely be accomplished using a "drill and leave" technique where the drill pipe is left in place and becomes the cable conduit. This technique allows for installation of the conduits in a single pass and eliminates the need for successive reaming and conduit pullback. The HDD laydown area would be in the parking lot of Driftwood and each bore would be spaced about 20 feet apart at the shoreside end. Drilling fluids, generally a mixture of bentonite clay and water, would be circulated through the drilling tools to lubricate the drill bit and conduits, and to remove drill cuttings. Each HDD bore is expected to take up to 1 month to complete; the onshore cable landing installation would occur over a period of 6 to 8 months.

Each test berth at the project would include a subsea connector that would rest on the seafloor. A surface buoy would likely mark the location of the subsea connector. During WEC deployment, the subsea connector would be hoisted onto the deck of an operations vessel (which could employ dynamic positioning), where it would be mated to the WEC umbilical cable or hub; based on experience at European Marine Energy Centre

(EMEC), this may occur approximately once a year, but could occur as often as several times per year or as infrequently as once every three years or more (EMEC 2015). Once the connection is made, the mated umbilical cable and connector would be lowered to the seafloor. The Operations and Management Plan would include a comprehensive set of engineering and operational requirements that minimize risks to equipment and personnel, as well as provide equipment and vessel requirements for installation and maintenance of the subsea connectors and cables.

As noted above, OSU proposes to install the terrestrial transmission lines and conduits using up to three HDD bores from the Driftwood parking lot directly to the UCMF site on the east side of Highway 101. From the UCMF, conduits would be buried west out to and under Highway 101 to the grid connection point with the CLPUD overhead distribution line adjacent to the highway; HDD would also be used for this installation, with the HDD rig set up on the UCMF site.

2.2.4.2 Anchors and Mooring Systems

Installation of anchors and mooring systems would occur prior to WEC deployment. Anchors would be deployed and recovered by a vessel(s) with adequate assets and load-handling capabilities. For example, smaller anchors and mooring systems could be installed using a vessel such as OSU's 82-foot, 510-horsepower (hp) *R/V Pacific Storm*. Larger anchors or more complex mooring systems would likely require tug boats and multi-purpose, offshore work vessels. OSU previously chartered the 159-foot, 486-ton, *NRC Quest* for operations at PacWave North. The *Quest* was equipped with a 122- by 28-foot stern deck, a 22-ton deck crane, and two Manitowoc 390 double drum winches with 10,000 feet of 1.25-inch wire rope. Similar type vessels are stationed in Oregon and Washington ports, and these are expected to be available for project needs. While the number of vessels needed for anchor installation or removal would depend on the number and size of anchors being deployed, these activities typically require two to four vessels (specialized work vessels, tugs, barges, and smaller crafts).

Based on OSU's experience at the nearby PacWave North, it is anticipated that it could take up to 7 days to install the mooring system for a single WEC, and an additional 1 to 2 days to connect the WEC to the mooring. If an array was installed, which consisted of several WECs on individual mooring systems, this process would need to be repeated for each device. This time would not necessarily be continuous as weather could delay the start-to-finish completion however, actual at-sea activities would not be expected to take more than 9 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.

Once the anchors arrive at the WEC test site, the installation vessels would be positioned over preselected anchor locations. These locations would be selected based on the WEC mooring system design and engineering analysis of the sea floor characteristics. For drag embedment anchors, a second anchor handling vessel would likely be required to deploy and set the anchors.

A drag anchor resembles an "inverted kite". These are installed 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 (DOE 2011). Drag anchors are commonly used and are relatively easy to install. Large size and capacity anchors are available for both sandy seafloor conditions, as well as mud/soft clay (Sound & Sea Technology 2009).

Sound & Sea Technology (2009) noted that "[s]uction piles are a relatively new type of pile system; however, their use has been growing steadily in the offshore industry particularly for soft soil in deep water. They are also effective in normal sand seafloors but are not appropriate for hard bottom conditions." For deployment of suction anchors, a floating crane is used to lift and lower the caissons to the sea floor; suction equipment, a remotely operated vehicle (ROV), control cabin, and launch cradle are also frequently needed (DOE 2011). An important feature of suction piles is their ability to be extracted and recovered by reversing the pump to apply pressure inside the pile (Sound & Sea Technology 2009). An advantage of suction piles is that they are installed using a submerged pump, which produces low levels of sound (further described in Section 3.3.3.2) (Laurinollo et al. 2005).

Sound & Sea Technology (2009) further describes installation of suction piles:

> During installation, the suction caisson acts as an inverted bucket. Initial penetration of the suction caisson into the seabed occurs due to the self-weight; subsequent penetration is by the "suction" created by pumping water out from the inside of the caisson. The installation method involves applying a pressure differential.
>
> The rim of the inverted bucket seals with the seafloor, and then water is pumped out of the upper end of the enclosed volume. This produces a net downward pressure, or suction, forcing the bucket into the seabed. In clays, the pressure is sufficient to bring the suction caisson to a substantial depth. In sands, water inflow reduces the effective stresses in the sand near the bucket rim, allowing the bucket 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 caissons can easily be removed by reattaching the pumps and pumping water back into the bucket cavity, forcing it out of the seabed.

Gravity anchors are heavy objects placed on the seafloor that resist vertical and lateral loading. They are typically made of concrete and/or steel and are placed directly on the seafloor (Sound & Sea Technology 2009, DOE 2011).

Most anchors would likely be retrieved by winching the anchor up to the surface and onto a vessel (using the mooring system itself or a recovery line). Recovery lines may be installed at the time of deployment and activated by acoustic releases during retrieval, or lines may be attached to the anchor at the time of recovery using an ROV. Removal of embedment anchors is achieved by pulling the mooring line in a perpendicular direction to lift the anchor out of the sediment along the reverse of its initial traverse (DOE 2011). For removal of suction anchors, water would be pumped into the anchor chamber, creating positive pressure, and the mooring line pulled up raising the caisson from the sediment. Once the anchor is free of the seafloor, it would be raised to the deck of the vessel and brought to shore (DOE 2011). For removal of gravity anchors, the anchor would 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 contact the sea floor during transit. The anchor would then be recovered by shoreside crane or an inshore crane vessel (DOE 2011).

As noted previously, anchor deployment periods would align with WEC test durations, so they would likely be in place for 3-5 years at a time. Anchors could be in place up to 25 years if the anchors are to be used for multiple WEC tests throughout the project license term. Marker buoys may be installed between WEC deployments if anchors are not removed at the same time as the WECs. Although anchor deployment and recovery would occur periodically over the license term, OSU intends to limit the frequency of anchor deployment and recovery to the extent possible. These activities rely on specific weather windows, so the timeframes within which anchor installation or removal could occur are limited. Additionally, most clients would likely plan to deploy WECs for multi-year test periods, and it is unlikely that anchor systems would be adjusted or replaced during a WEC test due to the high costs associated with installing and removing them. Finally, OSU would reuse anchors wherever possible.

2.2.4.3 WECs

Once the anchors and mooring systems are in place, the WECs would be deployed singly or in arrays. Results of the OSU industry survey and the OWET market analysis show that average deployment timeframes are likely to range from one to five years; the market analysis also indicates that five-year deployment periods are most likely during the initial stage of project operations. OSU anticipates that most WECs would be transported by truck, barge, or marine tow transport to the Port of Newport for deployment.

In general, WECs would be towed or barged to the site, configured, and attached to the mooring system. In most cases, two or three vessels would be needed to deploy a WEC, although some are designed to be deployed using a single vessel. Examples of vessels that might be used for such operations are OSU's *R/V Pacific Storm* and tugboats such as the 38-foot, 465-hp *Thea Knutson,* operated by Wiggins Tow & Barge. Larger, 3,000 to 8,000-hp, ocean-going tugs are located in Coos Bay and Astoria. Once the WEC is attached to its mooring system, it is anticipated that an umbilical cable would be attached to the WEC to connect it to the subsea connector, possibly through a developer-supplied hub. Connecting to the subsea connector would likely require that the connector be winched 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 developer-supplied hub, and the hub would be connected to the subsea connector. Test-specific deployment procedures would be developed to address each WEC deployment and subsea connection. OSU anticipates that it would take 1 to 2 days to deploy a single WEC and up to 7 days to deploy a small array of WECs. Like anchor deployment, these operations would not necessarily be continuous because weather could delay the start-to-finish timeframe completion or postpone certain activities.

When a test is complete, the WEC would be de-energized and a suitable vessel would be used to disconnect the umbilical cable. With the umbilical cable detached, the WEC would be removed from the test site. If any materials are to be disposed of after the testing period, OSU would require test clients to dispose of these at permitted facilities in accordance with federal, state, and local environmental control regulations.

2.2.4.4 Estuarine Activities

Project components would be fabricated at land-based facilities prior to being installed at the WEC test site. The primary staging area for the project would likely be the Port of Newport.

The natural harbor of Yaquina Bay provides a protected haven for commercial fishing vessels, and the Port provides a number of support facilities for the local fleet and the locally-based distant water fleet (commercial fishing boats that spend much of the year in waters off the coast of Alaska), including moorage, space for suppliers and services, fuel, and other essentials. The Port also leases space to seafood processors (FCS Group 2014). The North Shore Development Area of the Port is Newport's working waterfront, which includes a 214-slip marina that is used primarily by commercial fishers and the Newport-based distant water fleet (Port of Newport 2013). In addition to these and other amenities, there is over 240 feet of floating moorage for boat maintenance, and a 220-foot fixed moorage that contains four hoists of varying capacities, enabling vessels to perform gear changes, off-load fish product, and do other maintenance or repair work (Port of Newport 2013). In 2000, the most recent year for which data were available, 393 commercially registered vessels (residents and non-residents) delivered landings to Newport (NOAA 2007).

The subsea cables, WECs, mooring and anchor systems, navigational buoys, and monitoring equipment, would likely be transferred from other locations to Newport, Toledo, or other nearby ports for mobilization and transfer to the project site. Project components, other than WECs and subsea cables, are expected to be staged on land for the installation vessels to pick up and transport to the project site.

The primary Yaquina Bay estuarine activities would include:

- Berthing one or more WECs dockside in the Port of Newport prior to being towed to the WEC test site.
- Vessel traffic in and out of Yaquina Bay to transport WECs, anchors, and other project components, as well as operations and maintenance and environmental monitoring crews.

Project-related vessels would stay within navigation channels and specifically designated areas for vessel use in Yaquina Bay. WEC test clients would use marine industrial facilities that have been and continue to be dredged to a sufficient depth. For example, the International Terminal is dredged to 33 feet.

2.2.5 Project Operations and Maintenance

OSU is proposing an Operation and Maintenance Plan comprised of seven components.

1. Continuous Onshore System Monitoring

Onshore monitoring of project facilities is anticipated to be conducted on a continuous basis via the SCADA system that would be part of the UCMF site. A system operator would be responsible for monitoring the sensor and alarm systems and identifying when a potential unexpected event or system failure has occurred. The system operator would be the first point of contact for notification by operations and maintenance personnel, regulatory agencies, and the general public of a potential incident. Emergency call-out arrangements and assistance would be in place to respond to major incidents. Routine work would be carried out during normal facility working hours, weather permitting and with consideration for safety and protection of personnel, the general public, and the environment.

2. Preventive Maintenance and Site Inspections

Offshore site inspections are planned to occur quarterly, weather permitting, and would include inspection of all components visible from the sea surface to check connections, corrosion, and general wear and tear. Inspections would be made of all corner marker buoys and other Aids to Navigation and of all environmental monitoring instruments. OSU proposes to visually inspect clients' WECs, moorings, and floats and notify clients if a potential issue is identified. WEC clients would be required to inform OSU if any operational or maintenance issues with any component of the projects are identified. As part of the environmental monitoring plans, ROV inspections would be conducted in and around offshore project components. Even if no WECs are being tested, all project components would be inspected by OSU at least every 3 years. Inspections would likely occur more frequently at the start of operations to determine rates of corrosion, and general wear and tear. As described in the APEA Appendix I Protection Mitigation and Enhancement Measures (PM&E measures or measures), ROV inspections would be conducted along the routes of the buried subsea cables between the WEC test site and the HDD breakout point[21] 0.6 nautical miles offshore from Driftwood. Two cables routes would be surveyed each year to reveal if any portions of the cables have become unburied. Project personnel would alert the system operator if they learn of any issue from other ocean users (e.g. entangled gear, malfunctioning navigation lights). Where practicable, offshore instruments and buoys would be fitted with tracking systems to alert project personnel if components move off station. At least once a month, the system operator or qualified designee will visit the UCMF location for a routine inspection. The UCMF site would be fenced, alarmed, and monitored by closed circuit television (CCTV). A compete diagnosis of the project facilities would be conducted remotely via the SCADA system a least once per week, followed by a written inspection report.

3. Routine Maintenance

Corner marker buoys would be serviced on a regular schedule every 2 to 3 years. The frequency of service would depend on the hardware installed and rates of corrosion, wear and tear, and weather conditions. Full-service maintenance would generally require a buoy to be brought to shore, where it would be de-fouled, scraped, and repainted. Worn parts would be replaced, lights checked, and all mooring hardware would be replaced. OSU would ensure that any paints are fully cured before the buoy is redeployed.

Subsea connectors would be inspected when WECs are being connected or disconnected and serviced on a schedule determined by the manufacturer. For example, MacArtney recommends that their Greenlink inline connector be serviced every 5 years

---

[21] The breakout point is the location where the HDD installed conduits carrying the subsea transmission cables from onshore at Driftwood would surface from the seabed in approximately 10 meters of water, 0.6 mile offshore.

even if no WECs have been connected to it. The connector would be serviced at sea by winching it onto the deck of a suitable vessel and lowered back to the seafloor when servicing is complete.

Environmental monitoring equipment would be serviced when instruments are retrieved to download data and/or replace batteries, or on a schedule determined by the manufacturer. Instrument mooring systems would be serviced and replaced on a regular basis. Instruments may require periodic cleaning at sea during deployments to remove excessive bio-fouling.

The following project components do not require routine maintenance:

- Subsea cables running to shore;
- Auxiliary cable running to the WEC test site;
- HDD conduits;
- Beach manholes/splice vaults at Driftwood;
- Terrestrial cables running to the UCMF; and
- Pull boxes on the UCMF site.

Planned offshore maintenance would typically be carried out over the summer months. A maintenance schedule would be established for the UCMF and other infrastructure at that facility, as determined by the manufacturer or recommended by CLPUD.

4. Unplanned Maintenance

Any unscheduled maintenance would be completed as necessary, with consideration for weather conditions, safety of personnel, and protection of the environment.

5. Supporting Documentation

Reports would be made available following each quarterly inspection, equipment inspection, and maintenance procedure in accordance with the project operating procedures.

6. Management and Storage of Spare Parts

Spare parts would be provided as required for maintenance at the project from OSU, or from suppliers of instruments and other equipment. Once the project is operational, the need for spare parts would become clearer and the inventory of spares parts can be adjusted as necessary.

7. Special Environmental Considerations during Operations and Maintenance

As discussed in the next section, OSU is proposing PM&E measures that include: (1) taking field measurements; (2) monitoring for various types of potential impacts; and (3) identifying and mitigating risks to protected resources. During O&M activities, OSU would carry out any obligations under those PM&E measures (e.g., reporting marine mammal sightings and conducting opportunistic visual inspections for derelict gear). Similarly, during PM&E-related site visits, OSU would conduct visual inspections of the project works as provided above. Any O&M concerns identified during such activities would be reported to the systems operator.

2.2.6 Proposed Environmental Measures

OSU proposes the following environmental measures.

General

Project Operation

- Implement the Adaptive Management Framework filed as part of the application (APEA, Appendix J), which would guide the evaluation of monitoring results, identification of unanticipated adverse effects, and implementation and/or modification of response actions to include mitigation or revised monitoring (APEA, Appendix I) in consultation with resource agency stakeholders.

- Prepare and file a Five-Year Report, that includes the following information on past and future project operations, beginning 5.5 years after deployment of the first WEC at the project, and recurring every 5 years thereafter.
    - a review of all WEC deployments and associated project activities from the prior 5 years including a description of the types and number of WEC devices deployed, frequency and duration of WEC deployments, monitoring activities and results, and any adaptive management criteria or response actions that were applied or modified.
    - a description of WEC deployment activities that are planned or that are reasonably foreseeable in the next 5 years including the types and number of WEC devices likely to be deployed, and the likely duration of such deployments.

- Develop a decommissioning plan to remove project facilities and restore the site in the future as the license term nears its end and implemented when the project is decommissioned.

Geologic and Soil Resources

Project Construction

- Use HDD to install the subsea transmission cables under the nearshore and intertidal habitat (to approximately the 10-meter isobath) to minimize substrate disturbance.

- Use HDD to install a maximum of three conduits that carry the onshore transmission lines from the beach manholes at Driftwood to the UCMF site, and from the UCMF to the Highway 101 grid connection point, to minimize terrestrial habitat disturbance.

- Develop an erosion and sediment control plan to minimize potential effects of project construction, operation, and maintenance activities on sediment and soils.

- Follow best management practices during installation, operation, and removal activities to avoid or minimize potential effects to sediment, including:
    - Minimize the time that the seafloor is disturbed, sediment is dispersed, and the associated effects by completing cable laying and other construction activities within one construction season, to the extent practicable, during appropriate weather-related construction windows.

Project Operation

- Avoid grounding of project components on the bottom substrate during transport to protect nearshore and estuarine habitats.

- Minimize the frequency of anchor installation/removal cycles and reuse installed anchors.

Water Resources

Project Construction

- Develop a stormwater management plan[22] for onshore construction activities with spill prevention, response actions, and control protocols, and provisions to

[22] OSU is proposing a stormwater containment plan, but we refer to this plan as the stormwater management plan in the EA to be consistent with the name given to the plan by NMFS term and condition 3.

maintain existing drainage patterns and prevent contamination of streams with hazardous materials runoff.

- Develop an HDD contingency plan to minimize the potential adverse effects of any inadvertent return[23] of drilling fluids, with provisions for timely detection to include monitoring, containment, response and notification procedures for protection of water quality.

Project Operation

- Follow industry best practices and guidelines for antifouling applications (e.g., free of the biocide tributyltin (TBT)) on project structures such as marker buoys, subsurface floats, and WECs.

- Minimize storage and staging of WECs outside of existing dock, port, or other marine industrial facilities to protect water quality from toxic materials.

- Implement the Emergency Response and Recovery Plan (APEA, Appendix G) with spill prevention, response actions, and control protocols for offshore activities, including provisions for recording types and amounts of hazardous fluids contained in WECs and other project components; require all vessel operators to comply with the plan during installation and maintenance of offshore project components.

Aquatic Resources and Threatened and Endangered Species

General

Project Construction

- Bury subsea cables at a depth of 1-2 meters, to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor. Protect portions of the cable on the seafloor in areas where it cannot be buried or persistently becomes unburied with split pipe, concrete mattresses, or other cable protection systems.

[23] An inadvertent return or frac-out is an unanticipated discharge of drilling fluids to the ground surface or surface waters, including wetlands, associated with HDD or other trenchless construction methodologies.

- Utilize shielding on subsea cables, umbilicals, and other electrical infrastructure, to the maximum extent practicable, to minimize electromagnetic field (EMF) emissions.

- Require all project-chartered or -contracted vessels to comply with current federal and state laws and regulations regarding aquatic invasive species prevention and control (measure to also be implemented during project operation).

- Notify agencies with regulatory authority as soon as possible in the event of an emergency in which fish or wildlife are being killed, harmed, or endangered by project facilities or operations in a manner that was not anticipated, and take action to promptly minimize the impacts of the emergency, based on guidance from those agencies they notify (measure to also be implemented during project operation).

Project Operation

- Implement the EMF Monitoring Plan (APEA, Appendix H) to measure project-related EMF emissions and implement measures based on the monitoring results to mitigate unanticipated adverse effects on marine aquatic resources (APEA, Appendix I).

Fish and Invertebrates

Project Construction

- Avoid crossing areas with rocky reef and hard substrate when installing the subsea cable, to the maximum extent practicable, to protect sensitive habitat features.

- Develop a vessel anchoring plan that establishes protocols to avoid anchoring in known rocky reef or hard substrate habitats, to the maximum extent practicable, and minimize the use of anchors within the project area wherever practicable by combining onsite activities to avoid or minimize adverse effects to hard substrate habitat (measure to also be implemented during project operation).

Project Operation

- Implement the Organism Interactions Monitoring Plan (APEA, Appendix H) to detect behavioral changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to or affected by the installed project components due to the potential for reduced fishing pressure, or biofouling on the anchors/WECs.

Marine Mammals, Sea Turtles, and Seabirds

Project Construction

- Require vessels in transit to/from the project site to avoid close contact with marine mammals and sea turtles and adhere to NMFS's "Be Whale Wise" guidelines to minimize potential vessel impacts to marine mammals (measure to also be implemented during project operation).

- Provide marine mammal observers for certain project-related vessel-based activity (e.g., sub-bottom profiling) (measure to also be implemented during project operation).

- Minimize construction activities during key Phase B gray whale migration periods (April 1-June 15) (measure to also be implemented during project operation).

- When using Dynamic Positioning Vessels (DPV)[24] to install project facilities or other equipment that may exceed NMFS's published threshold for injury to marine mammals (measures to also be implemented during project operation):
    - Avoid use of these vessels to the maximum extent practicable during Phase B of the gray whale migration (April 1-June 15). If construction activities are proposed during this migration period, consult with Oregon DFW regarding the timing of such activities including cable-laying in state waters.
    - With technical assistance from NMFS, establish and carry out the following actions and protocols necessary to maintain an appropriate acoustic zone of influence in accordance with NMFS's published harassment threshold (120 decibels (dB)) during DPV operations to minimize behavioral disturbance and protect marine resources:
        - Post qualified marine mammal observers on vessels during daylight hours.
        - Conduct dynamic positioning (DP) activities during daylight hours when feasible to ensure observations may be carried out.
        - Implement DP start up for cable laying during daylight hours.
        - Ramp-up DP thrusters upon initial operation and, except during cable laying, reduce power to the extent practicable if a mammal approaches the acoustic zone of influence and increase power once the zone is clear of marine mammals, as may be modified by agreement of the licensee and NMFS..

---

[24] DPVs are computer-controlled to automatically maintain the vessel's position and heading through use of propellers and thrusters.

Project Operation

- To minimize potential stranding, entanglements, impingements, injuries, or mortalities of marine mammals and seabirds associated with entangled fishing gear:
    - Once per quarter each year for the term of the license, conduct opportunistic (i.e., non-systematically collected) visual observations, including review of any underwater visual monitoring, at the project site to detect and remove any entangled fishing gear and other debris that has the potential to increase the risk of marine species entanglement.
    - Conduct annual surface surveys of active WEC berths for entangled fishing gear and other debris during the spring season (mid-March through mid-June) following the peak storm season and period of maximum activity for the Dungeness crab fishery.
    - Conduct annual subsurface surveys of moorings and anchor systems using ROV or other appropriate techniques with approval by NMFS concurrent with spring (mid-March through mid-June) monitoring under the Organism Interactions Monitoring Plan (APEA, Appendix H).
    - If entangled fishing gear or marine mammal (or sea turtle) stranding, entanglements, impingements, injuries or mortalities are detected, notify FWS, NMFS, and Oregon DFW and remove fishing gear as appropriate and make every effort to return the fishing gear to the owners (APEA, Appendix I).

- Ensure that WECs are maintained in good working order to minimize sounds that might injure marine mammals or alter their behavior due to faulty or poorly maintained equipment.

- Make opportunistic visual observations of pinnipeds when conducting operations, maintenance, or environmental monitoring work at the WEC test site. If pinnipeds are observed to be hauled out on project structures, follow the reporting and haulout protocols specified in APEA, Appendix I.

- Ensure that WEC cables and moorings are designed and maintained in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement, the maximum extent practicable, and follow the reporting and haulout protocols specified in APEA, Appendix I.

- Implement the BBCS Plan (APEA, Appendix B) that includes the following measures to minimize impacts to seabirds:
    - Once per quarter for the term of the license, conduct opportunistic visual observations at the project site to determine if seabird perching and nesting

results in equipment fouling or interference with project operations and, if necessary, develop a plan in consultation with FWS to discourage perching and nesting with minimal impacts to seabirds.
  - Use low-intensity flashing lights and bird-friendly wavelengths on project structures to minimize seabird attraction based on specifications for project lighting developed in consultation with the FWS and USCG.
  - Minimize lighting used at night by service and support vessels at the WEC test site and at the UCMF (e.g., use low intensity, bird-friendly wavelengths, shielded lighting not providing upward-pointing light or light directed at the sea surface) to reduce the potential for seabird attraction.
  - Require vessel operators to follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout.[25]
  - Require vessel operators to remain 500 feet away from seabird colonies during the nesting season to minimize disturbance to nesting seabirds.

Terrestrial Resources and Endangered Species

Project Construction

- Minimize or avoid terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species) during project construction.

- Minimize ground disturbance and maintain protective buffers around wetlands to avoid adverse environmental effects.

- Develop a revegetation plan for using native species to the extent practicable to revegetate areas disturbed during construction to minimize impacts to local plant communities and wildlife populations.

- Avoid disturbance of snags and wildlife or legacy trees, including live or dead trees that provide benefit to wildlife, to the maximum extent practicable. If unavoidable, conduct additional species-specific surveys prior to construction activities to minimize effects.

---

[25] Fallout can occur when seabirds, that normally use natural light (e.g., moonlight) to navigate out to sea, become disoriented by artificial lighting causing them to repetitively circle lights and collide with structures which results in exhausted and injured seabirds “falling out” of the sky making them potentially vulnerable to other threats.

- Avoid disturbance of forested wetlands, to the extent practicable.

- Avoid, to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Restore natural hydrology after construction is complete and develop a restoration plan that includes a provision for monitoring, as necessary, until successful restoration can be determined.

- Minimize disturbance of streams that support fish or are connected to fish-bearing streams. Unavoidable work within or adjacent to fish-bearing streams may be subject to in-water work windows based on consultation with Oregon DFW, FWS, and NMFS. Consult with NMFS if terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the ESA, to identify measures to avoid and minimize any potential effects.

- Avoid to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood. Where unavoidable, conduct species-specific surveys on properties outside of Driftwood but within the construction footprint to determine the extent of occupied habitat and associated mitigation.

- Develop measures that would limit the introduction or spread of invasive species, to be included in the proposed revegetation and restoration plan.

- Implement the BBCS Plan (APEA, Appendix B) that includes the following measures to minimize effects to bats and landbirds, including the federally listed western snowy plover:
    - HDD construction equipment or construction activities would not occur on Driftwood beach within suitable snowy plover nesting, roosting, or foraging habitat, and would be limited to the Driftwood parking lot, at least 164 feet (50 meters) from any potentially suitable habitat.
    - HDD operations in the parking lot would occur during daylight hours, but if lighting is required at night, it would be appropriately shielded and directed to minimize artificial light reaching western snowy plover nesting habitat. Animal-proof litter receptacles and related signage and coordination would be provided to minimize potential attraction of nest predators.
    - If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), conduct surveys of suitable nesting habitat prior to operation of the HDD. If nests are detected, implement measures specified in the BBCS Plan, including noise monitoring and implementation of engineering controls, if appropriate (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers).

- Conduct surveys for nesting birds prior to any vegetation clearing that occurs within the nesting season and implement the following measures for active nests found during the surveys:
    - Remove nest-starts for any birds other than raptors or listed species when observed if found within the project footprint and within 100 feet of a construction zone, and where feasible.
    - If an active nest is found, determine the extent of a construction-free buffer zone to be established around the nest (typically 300 feet for raptors and 100 feet for other species), to ensure that no nests of species protected by the MBTA would be disturbed during project construction.
    - If necessary, the no-disturbance nesting buffers may be adjusted to reflect existing conditions including ambient noise, topography, and disturbance with approval of Oregon DFW.
    - If nesting bald or golden eagles are identified, restrict activities near nest sites according to guidelines outlined in the National Bald Eagle Management Guidelines (FWS 2007b).
- If construction activities would not be initiated until after the start of the nesting season, remove all potential nesting substrates (e.g., bushes, trees, snags, grasses, and other vegetation) in late winter, prior to the start of the nesting season.
- Conduct preconstruction surveys for roosting bats to identify sites to minimize construction impacts from high frequency sound disturbance, night lighting, and air quality degradation near roosts by implementing bat roost buffers, or excluding bats within bat roost buffers, or developing species and equipment specific buffers, use noise controls, and monitor bat roost activity before, during and after construction.

Recreation, Ocean Use, and Land Use

Ocean Use and Recreation

- Mark project structures with appropriate navigation aids, as required by the USCG.

- Conduct outreach to inform mariners of project structures or activities to be avoided in the area (e.g., Notice to Mariners, flyers posted at marinas and docks).

- Install subsurface floats at sufficient depth to avoid potential vessel strike.

- Work cooperatively with commercial, charter, and recreational fishing entities and interests to avoid and minimize potential space-use conflicts with commercial and recreational interests during construction and operation.

Terrestrial Use and Recreation

- If acceptable to Oregon PRD, develop a plan to install an interpretive display describing PacWave South in the Driftwood.

- Use construction fencing to isolate work areas from park lands to provide safe access for visitors to the beach and to recreational facilities unaffected by construction activities within Driftwood.

- Maintain pedestrian public beach access at Driftwood during construction activities, if practicable, and coordinate with the Oregon PRD to mitigate impacts to public access and use of the site.

- Conduct ground-disturbing construction activities and staging within previously disturbed areas, as practicable.

Socioeconomic Resources

- See Recreation, Ocean Use, and Land Use measures.

Cultural Resources

- Should historic properties be identified in the future, modify the project to exclude the historic property from the project's APE (i.e., avoid any potential project effects to the historic property) or develop a historic properties management plan (HPMP) to consider and manage historic properties throughout the term of the license.

2.2.7 Modifications to Applicant's Proposal – NMFS ESA Terms and Conditions

The following terms and conditions have been provided in the NMFS biological opinion and are evaluated as part of the licensee's proposal.

Biological Opinion Terms and Conditions

NMFS filed a biological opinion for the project on December 20, 2019 (EA, Appendix B), to include the following terms and conditions: (1) implement the Acoustic Monitoring Plan and associated mitigation measures for impacts of sound from WECs and their mooring systems on marine resources as part of the adaptive management framework; (2) implement the EMF Monitoring Plan and associated mitigation measures for potential impacts of EMF on marine resources as part of the adaptive management framework; (3) develop a stormwater management plan for the UCMF and re-paving of the Driftwood parking lot addresses multiple components such as runoff containment, treatment of pollutants, and implementing BMPs; (4) submit annual reports that document the extent of incidental take described in the Incidental Take Statement (ITS) is not exceeded to include: (a) the results of the benthic sediments, organism interactions, acoustics, and EMF monitoring; (b) WEC installation and removal activities; and (c) one report on construction completion that describes HDD installation of the terrestrial transmission lines, and HDD and jet plow installation of the subsea transmission cables.

2.3 STAFF ALTERNATIVE

Project Construction

The staff alternative includes all of the measures proposed by OSU, and all of the terms and conditions provided by NMFS in the biological opinion, with the following modifications and additional measures developed by Commission staff.

- Develop an HDD plan that is based upon criteria outlined in the Commission's HDD Plan Guidance (FERC 2019. *Guidance for Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plans*) and on Commission criteria for HDD crossings beneath wetlands (FERC 2013. *Wetland and Waterbody Construction and Mitigation Procedures*) to reduce risks of construction complications and inadvertent releases, and to minimize adverse environmental effects of HDD for protection of natural resources.

- Notify Oregon DOT at least 3 months in advance of construction-related closures of the Driftwood site that would be 90-days in duration, or longer, and coordinate with Oregon DOT to ensure adequate signage is posted to inform motorists in advance of any closure.

- Modify Acoustics Monitoring Plan to require that annual reports address the adequacy of the data to meet plan objectives.

- Modify the proposed revegetation plan to include: (1) details of specific measures to be implemented to revegetate disturbed areas and control the spread of invasive plant species; (2) survey requirements and methods; and (3) determination of the specific mitigation and enhancement measures to be implemented to ensure that habitat for the elfin butterfly is maintained in the long term, including transplanting or replanting kinnikinnick plants.

- Modify the proposed BBCS Plan to include:

- modified measures for marbled murrelet and western snowy plover provided in the revised biological assessment filed by OSU on August 27, 2019;
- consult with Oregon PRD, FWS, and Oregon DFW to define what constitutes suitable nesting habitat for western snowy plover when finalizing the development of the BBCS Plan (or other relevant plans) to ensure nesting habitat is properly identified for implementing any relevant measures to minimize effects to nesting plovers and their habitat;
- consult with Oregon PRD regarding the placement of any structures (e.g., sound barriers) and signage to protect western snowy plover.
- observations of western snowy plover nests occurring near the proposed project location from surveys conducted in 2017, 2018, 2019;
- results from bat maternity roost surveys conducted in July 2019.

3.0 ENVIRONMENTAL ANALYSIS

In this section, we present: (1) a general description of the project vicinity; (2) an explanation of the scope of our cumulative effects' analysis; and (3) our analysis of the proposed action and other recommended environmental measures. Sections are organized by resource area (aquatic, recreation, etc.). Under each resource area, historic and current conditions are first described. The existing condition is the baseline against which the environmental effects of the proposed action and alternatives are compared, including an assessment of the effects of proposed mitigation, protection, and enhancement measures, and any potential cumulative effects of the proposed action and alternatives. Staff conclusions and recommended measures are discussed in section 5.1, *Comprehensive Development and Recommended Alternative* of the EA.[26]

3.1 GENERAL DESCRIPTION OF THE AREA

Ocean areas surrounding the project area support diverse assemblages of marine species and offer important economic and recreational opportunities for the surrounding communities. The Oregon coast near Newport is a high wave-energy, dynamic ocean environment. General marine habitat features in the project area include soft bottom subtidal, some hard bottom, open water pelagic, and surf zone habitats. Areas of hard bottom substrate occur closer inshore of the WEC test site and to the north of the subsea cable route. The terrestrial areas of the project are mainly low mountains of the Coast Ranges, covered in Douglas fir and Sitka spruce, along with residential housing. The coastal uplands typically have a mild, marine-influenced climate that has an extended winter rainy season and minimal seasonal temperature extremes.

Oregon's coastal areas typically have mild temperatures, with mean summer temperatures in the low 60s (degrees Fahrenheit; °F) and mean winter temperatures in the low 40s (°F). Average annual precipitation is 75 to 90 inches. Strong winds typically strike in advance of winter storms and can exceed hurricane force. Winter weather, which is typically wet, is generally influenced by counterclockwise-rotating low-pressure systems that cross the North Pacific, resulting in frontal cyclonic storms characterized by heavy rains and high south to southwesterly winds. Summers are relatively dry and fair, with mild north-northwesterly winds, driven by a persistent, seasonal, offshore high, and frequent strong afternoon breezes and coastal fog.

---

[26] Unless otherwise indicated, our information is taken from the license application, including the APEA and appendices filed by OSU on May 31, 2019 and amended on August 28, 2019.

3.2 SCOPE OF CUMULATIVE IMPACTS ANALYSIS

According to the Council on Environmental Quality's regulations for implementing NEPA (40 C.F.R. §1508.7), a cumulative impact is "the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time," including offshore renewable energy and other land and water development activities.

The following resources that have the potential to be cumulatively affected by the project, in combination with other recent, on-going, or proposed activities in these resource areas: geology and soils; aquatic resources; threatened and endangered species, critical habitat and essential fish habitat; recreation, ocean use, and land use; and socioeconomic resources. These specific resource issues were identified in the scoping process, as described in Scoping Document 2. The cumulative impacts are described by each resource topic within their respective sections.

3.2.1 Geographic Scope

The geographic scope of analysis for cumulatively affected resources defines the physical limits or boundaries of: (1) the proposed action's effect on the resources that may be cumulatively affected and (2) contributing effects from other marine activities in the area. The general geographic scope for the cumulatively affected resources encompasses Oregon State territorial waters from the shoreline of the Lincoln County coast offshore 6 nautical miles west into the OCS. However, because the proposed action would affect resources differently, the geographic scope for each resource may vary. For example, the geographic scope of cumulative effects analysis for the gray whale and loggerhead turtle extends from Alaska to Baja, Mexico, and the geographic scope of the analysis for salmon and green sturgeon includes the full migratory range of the stocks that may be affected by the project.

3.2.2 Temporal Scope

The temporal scope of analysis includes a discussion of the past, present, and reasonably foreseeable future actions and their effects on the following resource areas: geology and soils; aquatic resources; threatened and endangered species, critical habitat and essential fish habitat; recreation, ocean use, and land use; and socioeconomic resources. Based on the potential term of the proposed license, this analysis looks 25 years into the future, concentrating on the effect of reasonably foreseeable future actions.

3.2.3.1 Activities in Project Vicinity

There are four types of existing or reasonably foreseeable activities that could or do occur in the vicinity of PacWave South: (1) offshore marine and hydrokinetic energy development, (2) dredged material disposal, (3) deployment of sensor arrays for oceanographic monitoring, and (4) commercial fishing. These proposed actions, in combination with the PacWave South Project, could result in cumulative impacts on resources.

Offshore Marine and Hydrokinetic Energy Development

PacWave North

PacWave North is a 1-square-mile, non-grid connected MHK test site located 2 to 3 nautical miles offshore of Newport, Oregon, approximately 9 nautical miles northeast of the proposed project. It began operation in 2012 by OSU. Primary components include the Ocean Sentinel instrumentation buoy, wave measurement buoys, and associated mooring systems. It can accommodate short-term testing of up to two WECs at a time. WEC(s) being tested and the Ocean Sentinel are moored approximately 150 meters apart and connected by a power and communications cable. Developers must obtain test-specific permits to deploy WECs at PacWave North.

Camp Rilea Ocean Renewable Energy Project

The Camp Rilea Ocean Renewable Energy Project would be located just south of the Columbia River mouth approximately 100 nautical miles north of the proposed PacWave South. It may consist of multiple types of WECs up to approximately 9 nautical miles offshore with a cable connection to shore. As of August 2018, only one deployment has occurred at Camp Rilea, the M3 Wave Device, with a proposed deployment by Resolute Marine Energy most likely sometime in 2020 (personal communication with Rick Wouldiams, Oregon Applied Research, August 28, 2018).

Yaquina Ocean Dredged Material Disposal Site

The Yaquina Ocean Dredged Materials Disposal Site includes two areas (the "North site" and the "South site") located approximately 1.75 nautical miles offshore from the Yaquina Bay entrance channel. These disposal sites are located approximately 5 nautical miles northeast of PacWave South. Each site occupies an area of 597 acres of sea floor and has the capacity to receive dredged materials for 20 years. Since the Ocean Dredged Materials Disposal Site began receiving dredged material in 1928, over 21 million cubic yards of dredged material have been placed at this site (USACE and U.S. EPA). Active disposal took place at the North site until about 2011; the South site recently became active and is presently used for dredged material disposal.

Ocean Observatories Initiative

The Ocean Observatories Initiative (OOI) includes the Endurance Array, a multi-scaled array utilizing fixed and mobile technologies to observe cross-shelf and along-shelf variability in the coastal upwelling region of the Oregon and Washington coasts. The Endurance Array has two cross-shelf moored array lines, the Oregon Line (also called the Newport Line) and the Washington Line (also known as the Grays Harbor Line). Each line includes ocean sensors and infrastructure (e.g., surface and subsurface moorings at 25, 50, 80, 150, and 500-meter depths, and buoys), linked by a submarine cable providing power and data connectivity to shore.

Commercial Fishing

Commercial fishing for a variety of species occurs in the project area, including coastal pelagic and migratory fish, crab, salmon, shellfish, and shrimp (NOAA 2007), as described in Section 3.3.6.1. For purposes of this analysis, it is reasonable to assume that the existing level of commercial fishing is the baseline, which would continue into the future, and the effects on marine resources would be commensurate to those of past fishing activities.

3.3 PROPOSED ACTION AND ACTION ALTERNATIVES

In this section, we discuss the project-specific effects of the project alternatives on environmental resources. For each resource, we first describe the affected environment, which is the existing condition and baseline against which we measure project effects. We then discuss and analyze the site-specific environmental issues.

Only the resources that would be affected, or about which comments have been received, are addressed in detail in this EA. Based on this, we have determined that geology and soils, water quality, aquatic resources, terrestrial resources, threatened and endangered species and essential fish habitat, recreation, ocean and land use, aesthetic resources, cultural resources, and socioeconomic resources may be affected by the proposed action and alternatives. We present our recommendations in section 5.1, Comprehensive Development and Recommended Alternative.

3.3.1 Geology and Soil Resources

3.3.1.1 Affected Environment

Marine Geology and Soils

Oregon's continental shelf is relatively narrow and extends about 10 to 46 nautical miles off the coast (Electricity Innovation Institute 2004). A rocky submarine bank, Stonewall Bank, begins about 15 nautical miles offshore of Newport and extends southwest offshore about 40 nautical miles south to the Siuslaw River, where the shelf is about 30 nautical miles across (Electricity Innovation Institute 2004; USACE and EPA 2001). The project would be located shoreward of the Stonewall Bank, where sediments are mostly sand to depths of 300 feet (91 meters) (Figure 3-1), with a small percentage of silt and clay. The sediments present at PacWave South are typical of much of the Oregon coast, with small variations in the concentration of fine-sized particles in the seafloor sediments due to local currents (USACE and EPA 2001).

Sediment sampling by OSU within and surrounding the PacWave South Project area from August 2013 to June 2015 at water depths from 30 to 70 meters (total sample size = 117) indicated high spatial and temporal variability in the sediment conditions (Henkel 2016a). Generally, coarser sediment (average median grain size [mgs] = 364 micrometers (µm) was found at the 60 to 70 meter stations compared to the 30 to 50 meter stations inshore (average mgs = 313 µm). When all samples were analyzed together, median grain size of the sediment did not appear to vary seasonally, though percent fines did, ranging from 0.98 percent fines to 0.12 percent. In contrast, at the 60 and 70 meter stations directly within and surrounding the project Site, strong seasonal differences in median grain size were detected. These variations with season were not consistent, however. For example, in April 2015 median grain sizes were larger at the 70 meter stations while in June 2015 median grain sizes were smaller as compared to the 60 meter stations. This is consistent with the observations made during the June 2014 mapping effort that indicated finer sand in the deeper half of the study area. Based on data collected at Ocean Dredged Material Disposal Sites off the coast of Newport, local sediments near PacWave South are consistent with those found on much of the Oregon shelf, consisting predominantly of medium-grained sand with some shell debris and a minor amount (less than 2 percent) of silt and smaller material (USACE and EPA 2011), presumably as a result of winnowing by wave energy.

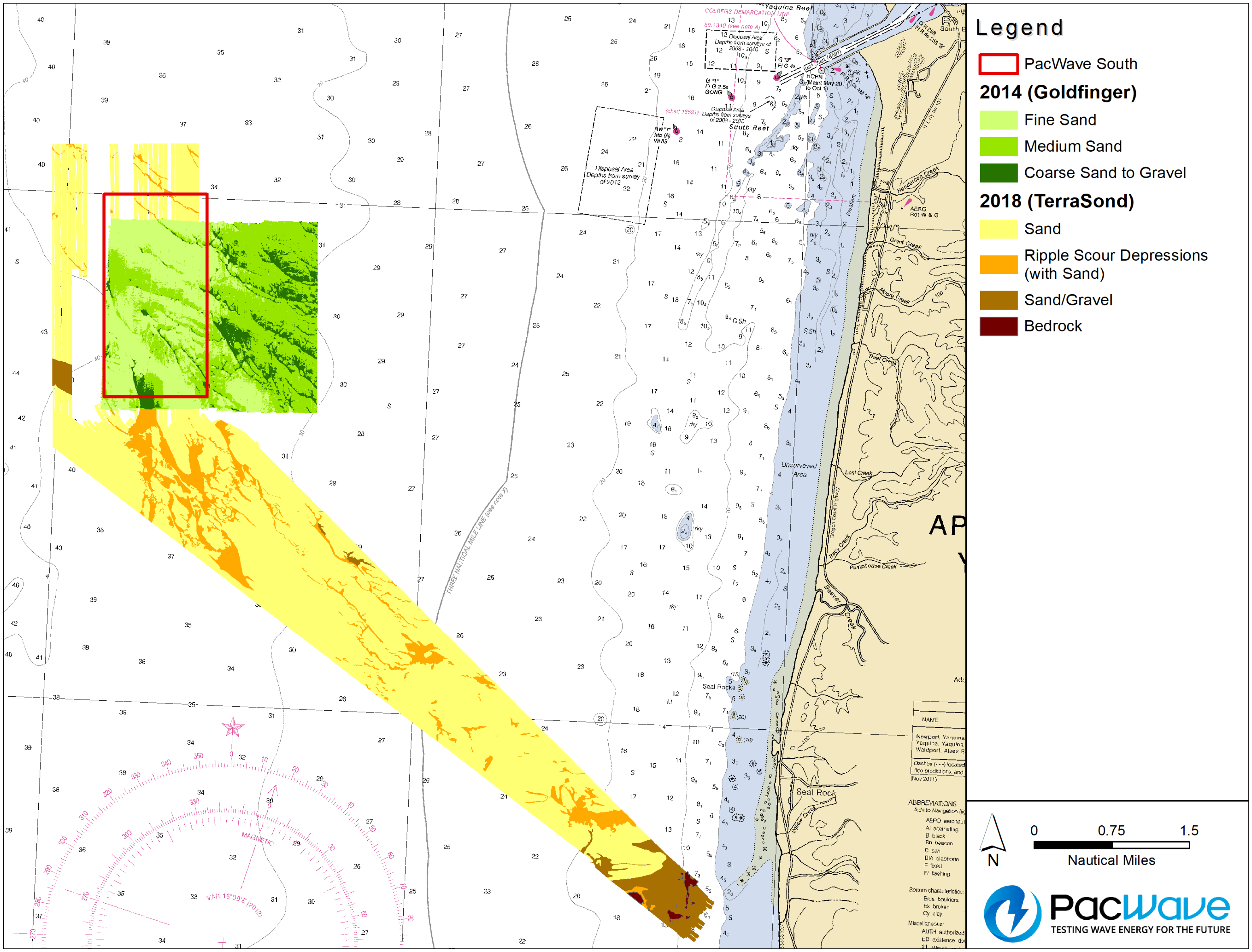

Figure 0-1. Sediment classification at PacWave South by Goldfinger (in 2014) and TerraSond (in 2018).

In 2014, OSU conducted marine geophysical surveys at the proposed PacWave South and along a number of potential subsea cable routes (Goldfinger et al. 2014). The 2014 surveys included: (1) a high-resolution chirp multibeam sonar survey producing detailed bathymetry and backscatter coverage of the WEC test site and potential alternative subsea cable routes, (2) a chirp sub-bottom survey, (3) a boomer seismic survey, and (4) a magnetometer survey. The marine project area (the WEC test site and cable route) can be characterized as a fold-thrust belt associated with the Cascadia Subduction Zone, and locally dominated by the North-South trending Seal Rock Anticline, which brings Miocene-age rock to the surface in the inshore parts of the subsea cable route. The older rocks are intruded and modified by the Columbia River Basalt group flows that crop out on shore at Seal Rock. PacWave South would be located in the synclinal sedimentary basin that lies between these two major structures. The major rock outcropping in the area is the Miocene Astoria Formation/Nye Formation rocks of the Seal Rock Anticline (Goldfinger et al. 2014).

Goldfinger et al. (2014) noted that the geology of the WEC test site appears to be primarily an extensive field of paleo dunes. The height of the eroded dunes ranges from 1 to 5 meters but are typically 2 to 3 meters high and spaced about 100 to 400 meters apart. In the swales between the dunes, the backscatter data and limited core data suggest fine sand to silt fills in the low areas (Figure 3-2). The dunes themselves are likely composed of medium to coarse sand and may be partially indurated (i.e., consolidated). The steeper faces of the dunes are eroded in dendritic and formless patterns that expose material of high backscatter 0.5 to 1 meter below the surface of the dunes. The high backscatter material is most likely the ubiquitous transgressive gravel lag deposit encountered in numerous localities nearby. In the southern part of the WEC test site, the dunes gradually transition to sandy surface substrate formed into short wavelength, low-amplitude sand waves that may represent active sediment transport (Goldfinger et al. 2014).

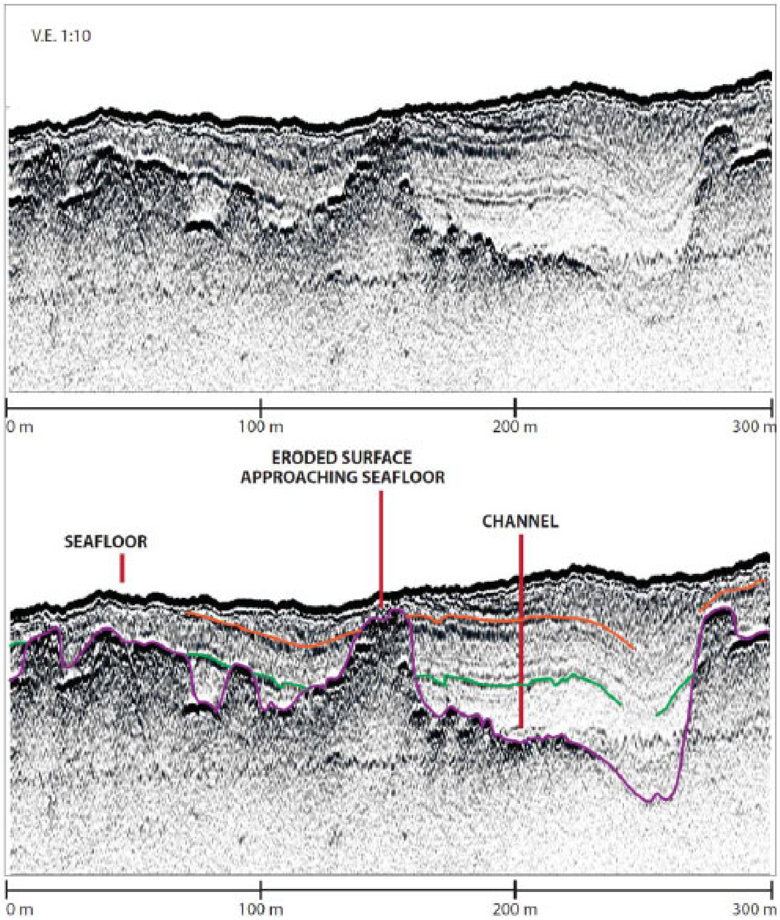

Figure 0-2. Chirp profile in PacWave South showing subsurface paleo-topographic surface, a buried channel, and overlying transgressive sand cover (Goldfinger et al. 2014).

OSU conducted additional geophysical and geotechnical surveys in 2018 at PacWave South and within the subsea corridor (TerraSond 2019). The 2018 survey included a: (1) side scan sonar survey, (2) sub-bottom profiler survey, (3) high-resolution multibeam sonar survey, and (4) magnetometer survey (TerraSond 2019). Review of the sidescan sonar data showed:

> "... a range of lower reflectivity interpreted to be relatively finer grained sands, to medium to strong reflectivity interpreted to be coarser grained sands, to very strong reflectivity interpreted to be rock. Rippled scour depressions ... were recognized in the area by Goldfinger et al. (2014) and observed in the western part of the cable corridor and across the width of the (PacWave) area. The features are visible in (multibeam and side scan sonar) data. Rippled scoured depressions are observed in continental shelf areas worldwide (Davis et al., 2013) and are thought to be formed by storm generated currents. They are often elongate, shallow (less than 2 meters

deep) depressions filled with relatively coarser grained seabed sediments (with higher SSS reflectivity) relative to the surrounding seabed sediments." (TerraSond 2019)."

The purpose of the 2014 and 2018 geophysical surveys of the subsea cable route from PacWave South to Driftwood was to help ascertain the best route to shore, with the primary focus being to avoid hard substrates and maximize burial depth.

Terrestrial Geology and Soils

OSU conducted a geophysical survey along the proposed terrestrial transmission line route in 2019 (Siemens & Associates 2019). Surface geology nearshore ranges from sand and coastal terrace deposits to sandstone, mudstone, and occasional basalt. The surface geology at Driftwood consists of Coast Terrace deposits with Yaquina formation sandstone and possible mudstone layers below (3U Technologies LLC 2013). Sand is the predominant surface material in the beaches, dunes, and lower elevations of this area. Basalt is found in the Seal Rock area and is likely present in the form of thin layers below the surface at nearby sites. Soil types in the terrestrial portion of the project include (generally west to east) Waldport fine sand with 0 to 30 percent slopes for the Study Area closest to the Pacific Ocean, Yaquina fine sand with 0 to 3 percent slopes running north/south parallel and east of that, Urban land-Nelscott complex with 0 to 12 percent slopes, Nelscott loam with 12 to 50 percent slopes, and Bandon fine sandy loam with 3 to 12 percent slopes (NRCS 2016). These soil types range from somewhat poorly drained to excessively drained, with the well and moderately-well drained areas being around Highway 101 at the entrance of the Driftwood and in the southernmost portion of the Study Area

In 2019, OSU completed sampling of the subsurface geology at one site located on the southern edge of the Driftwood parking lot. OSU conducted geotechnical exploration boring drilled through overburden materials using hollow stem augers and standard penetration test sampling, drilled into bedrock using rock coring methods to a total depth of 300 feet (Terracon 2020). Overburden materials consisted of very loose to dense poorly graded sand with silt, with thin beds of fat clay to a depth of 55 feet. Bedrock consisted of gray to black, slightly to extremely fractured, fresh to slightly weathered, laminated siltstone.

3.3.1.2 Environmental Effects

Project construction, installation, maintenance, operation, and removal would require land-disturbing activities associated with HDD methods for the transmission cables and lines, construction at Driftwood including excavation of the underground cable vaults and parking lot, and construction of the UCMF site buildings, which can result in soil erosion and sedimentation and adverse effects on aquatic habitat and organisms. Offshore project activities requiring disturbance of the seabed associated with the HDD, jet plow subsea cable installation, and installation and removal of WECs and anchors would also result in the temporary and long-term disturbance of the seafloor.

Installation of Anchors and Subsea Transmission Cables

The installation of subsea cables, subsea connectors, and anchors have the potential to suspend sediment at the seabed during installation and redeployments.

OSU conducted seafloor surveys to identify geologic hazards, hard bottom areas, and sensitive seafloor habitats in order select a subsea transmission cable route that avoids these features to the greatest extent possible and maximize burial depth. OSU proposes to implement the following measures to minimize the extent of disturbance of geologic and soil resources in the marine environment:

- Use HDD to install the cables under the nearshore and intertidal habitat (to approximately the 10-meter isobath) to minimize substrate disturbance.
- Follow best practices during installation, operation, and removal activities to avoid or minimize potential effects to sediment, including:
    - Minimize the time that the seafloor is disturbed, sediment is dispersed, and the associated effects by completing cable laying and other construction activities within one construction season, to the extent practicable, during appropriate weather-related construction windows.
- To the extent possible, minimize frequency of anchor installation/removal cycles and reuse installed anchors.

Oregon DFW recommends (10(j) recommendation 9) that OSU: (1) use HDD to install the subsea transmission cable conduits under the nearshore and intertidal habitat (out to approximately the 10-meter isobath) to minimize substrate disturbance; (2) provide refined information on the entire subsea cable route and describe how all subsea transmission cables would avoid rocky substrate and achieve continuous burial; and (3) minimize the time that the seafloor is disturbed by project facilities and sediment is dispersed. Oregon DFW explains that the Territorial Sea Plan Part 4 requires continuous burial of subsea cables unless the approving state agencies make findings that burial cannot be practically achieved and all affected parties agree that adverse effects of not burying the cable have been reduced, avoided, or mitigated to the extent practicable. In addition, Oregon DFW states that split pipe, concrete mattresses, or other mechanisms to protect unburied pipe could increase scour effects on seafloor habitat and introduce ecological and fishing hazards.

In its reply comments to Oregon DFW, OSU states that its proposal to use HDD to install the subsea transmission cables and to minimize the time that the seafloor is disturbed by project facilities is consistent with OSU's recommendations, and states that it has provided geophysical and geotechnical reports on the subsea cable route and proposed to avoid rocky substrate, to the extent practicable, but is unable to commit to avoiding all rocky substrate.

Our Analysis

During project construction and during each deployment, connection, disconnection, and retrieval event of project facilities, sediment from the seabed would be disturbed. Sediment would be disturbed as a result of placement of project components on the seafloor. Subsequently, sediment would be disturbed during recovery as it is likely that the project components (anchors, cables) would have become buried to varying degrees.

OSU anticipates that it would take up to 7 days to install each mooring system and 1 to 2 days to attach the WEC to the mooring. If an array is installed (an array being a number of WECs on individual mooring systems), this process would need to be repeated for each device. Deployment activity would not necessarily be continuous as weather and unforeseen issues could interfere with operations. However, actual at-sea activities are not expected to take more than 9 days to install one mooring system and WEC. It is anticipated that each WEC would be deployed for a year or more. The number of WECs deployed throughout the license term would vary and fewer WECs would likely be deployed in the initial years of operation.

The suspension of sand during these events would be temporary and localized, including during initial project construction (e.g., jet plowing of the subsea cables), and periodic as sediment would be temporarily suspended during deployment, connection, disconnection, and retrieval events that would occur throughout the license term. Sediment transport modeling completed for the subsea cable installation for the Deepwater Wind Project off Block Island, Rhode Island (Tetra Tech 2012a), estimated that, in areas characterized by mostly coarse sand (particle diameter > 130 µm), sediment suspended during jet plow operations dropped quickly to the seafloor, and major plumes would not form in the water column. Suspended sediment concentrations within a few meters of the jet plow would be elevated, though outside of this nearfield zone, and no concentrations would exceed 100 milligrams per liter (mg/L). Concentrations above 10 mg/L would be confined to an area primarily within 50 meters (160 feet) of the jet plow route and would last for approximately 10 minutes. This modeling also estimated that sediment deposition would exceed 10 millimeter (mm) (0.4 inch) immediately adjacent to the trench, and sediment re-deposition would not exceed 1 mm beyond 40 meters (130 feet) from the plow path (Tetra Tech 2012a).

Sediment transport modeling conducted for the Virginia Offshore Wind Technology Advancement Project estimated that suspended sediment (particle diameter <200 µm) during subsea cable burying would extend vertically about 2 meters above the trench and horizontally up to 100 to 160 meters, sediment would deposit on the seafloor within 6 to 7 minutes, and sediment re-deposition would not exceed 1 mm within 100 meters of the activity (BOEM 2014).

Grain sizes at and inshore of PacWave South are larger (mean median grain size = 364 μm) than the grain sizes evaluated by the studies in Virginia and Rhode Island; accordingly, less suspension and faster settling are expected with cable laying, subsea connector installation, and anchor installation and removal at PacWave South.

It is expected that the local conditions at the project site would differ from those at the Rhode Island and Virginia sites. Different water depths, salinities, currents and other hydrodynamic forcing and water quality parameters all combine to affect the magnitude and extent of sediment advection and transport. However, because coarse, non-cohesive sediments exist at all locations, it is reasonable to assume that the sediments would settle out of suspension rapidly after re-suspension. Coarse sediments that are advected away from the site would also likely settle out rapidly. Fine sediments, if re-suspended, would be advected the furthest away before depositing.

Rough estimates of the settling velocity of grain sizes in the 200-600 μm diameter size range, the grain sizes at the PacWave South site, are 2.5 centimeter per second (cm/s) for 200 μm diameters and 8.5 cm/s for 600 μm diameters (Hallermeier 1981, Van Rijn 1984, both from Soulsby 1997). These estimates are slightly conservative as they are based on ideal conditions where there is no water current or additional turbulence from construction activity or hindered settling. However, for a practical example, if these sediment grains were suspended 10 meters into the water column as a result of the construction activities, it would take the 200 μm and 600 μm sediments approximately 6.5 minutes and 2 minutes to settle out of suspension, respectively, given the settling velocities above. Given the uncertainties involved in estimating the settling velocities, the likely ambient current speeds, the range of particle sizes that would be resuspended, and the impacts of hindered settling, these settling estimates may vary, but are anticipated to remain on the order of minutes or tens of minutes.

Anchors

Anchor types would vary to suit the different types of WECs. The footprint of each anchor would vary, as would the depth to which it would penetrate the seafloor. Suction and plate anchors are placed into and under the seafloor, and therefore, would have minimal footprint other than the hardware used to connect the mooring lines from the anchors up to the WEC. Some mooring configurations could use one anchor for adjoining WECs, in which case the footprint on the seafloor would be further reduced.

The largest type of anchor that would sit on the seafloor would be a gravity anchor, one of which could have a footprint on the seafloor of up to 908 ft^2. For the two scenarios being evaluated – the initial development and full build-out scenarios (see Section 2.2.1.1), the estimated total footprint of the anchors is shown in Table 3-1.

Table 0-1. Estimated maximum anchor footprints for initial development and full build-out scenarios by berth.

Scenario	WEC Type	No. WECs	Total No. Anchors	Maximum Seafloor Anchor Footprint (ft^2)*
Initial Development				
Berth 1	Point absorber	1	6	5,448
Berth 2	OWC	1	4	3,632
Berth 3	Attenuator	1	4	3,632
Berth 4	Point absorber with shared anchors	3	7	6,356
				Maximum Total Anchor Footprint = **19,068 ft^2 (0.4 acre)**
Full Build-Out				
Berth 1	Point absorber	5	30	27,240
Berth 2	OWC	5	20	18,160
Berth 3	Point absorber	5	30	27,240
Berth 4	Attenuator	5	20	18,160
				Maximum Total Anchor Footprint = **90,800 ft^2 (2 acres)**

* Based on the total footprint of 34-ft-diameter gravity anchors (908 ft^2 per anchor), representing the largest possible footprint per anchor; other anchor types would have a considerably smaller footprint.

The maximum footprint of the anchors would be 19,068 ft^2 (0.4 acre) for the initial development and 90,800 ft^2 (2 acres) for the full build-out, which is approximately 0.1 percent of the total project site surface area (2 acres out of 1,695 acres). The estimates are based on exclusive use of large 34-foot-diameter gravity anchors; however, other types of smaller anchors would likely be used for some of the WECs, and shared anchors may be used for some WECs when feasible, so the actual seafloor footprint is expected to be considerably smaller than these estimates. As noted previously, anchor deployment periods would align with WEC test durations, so they would likely be in place for 3-5 years at a time. Anchors could be in place up to 25 years if the anchors are to be used for multiple WEC tests throughout the term of any license issued for the project.

The placement of anchors on the seafloor could result in localized areas of scour or deposition. Benthic sampling at both PacWave South and PacWave North indicate that substrate composition along this section of the Oregon coast consists of medium to coarse sand, with larger grain sizes found at the greater depths present at the WEC test site (Henkel et al. 2014, Henkel 2016a). The particle size range found at PacWave South is thus less susceptible to movement than areas with finer-grained sediment (percent fines in the PacWave South area were very low, less than 1 percent, Henkel et al. 2014, Henkel 2016a). Scour is analyzed in Section 3.3.3.2 *(Effects on the Benthic Community from Project Structures*); in summary, it is anticipated that scour depths may be up to 1 meter, and scour widths may extend as far from the anchors as 20 meters.

Subsea Connectors

Seabed sediment would be disturbed slightly upon initial installation of the subsea connector. The connector would be lowered by winch to the seafloor, the result likely being a small amount of sediment re-suspension, benthic disruption, and possibly settling of the connector into the sediment slightly. The subsea connector would be hoisted to the water surface to be connected to the WEC umbilical or hub. During this process, the sediments and macrofauna that exist on the connector and cable would be shed as the connector is brought to the surface. The result would likely be a low sediment concentration plume that drifts off the connector and cable as it is being brought to the surface. The sediments and macrofauna would settle out of suspension rapidly, according to the ambient hydrodynamic turbulence, elevation above the seafloor, water depth, and fall velocity.

After being connected to an umbilical or hub, the connector, connector cable and umbilical would be lowered back to the seafloor. The sediment (which may or may not be in the same location on the seafloor) would be disturbed again. Sediment would be re-suspended due to the impact of the components on the bed, benthos may be disrupted, and there may be some settlement into the seafloor again. The disturbance process would repeat itself on a periodic basis over the project license term, as new WEC umbilicals or hubs are connected, old ones are disconnected, and subsea connectors are retrieved and deployed. Given the nature of the test site, and that WECs would periodically be deployed and retrieved throughout the license term, there would be intermittent, though localized, temporary disturbances throughout the license term. Suspended sediment resulting from cable laying, subsea connector installation, and anchor installation/removal at the project is expected to last for minutes or tens of minutes.

Subsea Transmission Cables

The subsea transmission cables would be installed with HDD and jet plow construction methods. Use of HDD to install conduits and subsea transmission cables onshore from Driftwood through the intertidal area, and out to the breakout point about 0.6 mile offshore would avoid effects to geological resources (rocky substrates) in the nearshore, intertidal, and sand dune areas crossed by the cables. From the breakout point offshore to the WEC test site, a total distance of 7.7 nautical miles, the subsea transmission cables would be buried 1 to 2 meters beneath the seafloor using a jet plow or similar method. Jet plowing is a common technique that uses a plow share and high-pressure water jets to simultaneously lay and embed underwater transmission cables in areas with soft sediment; as a result, sand and fine sediment would be temporarily suspended into the water column.

The placement of the subsea cables would displace sand and fine sediment as the cables are buried using jet plow or other similar methods. The skids or wheels of the jet plow would be expected to impact about a 2 meters wide swath of substrate along each of the cable paths, but the jet plow would fluidize a pathway less than approximately 1 meter wide. Part of the displaced sand would be placed back in the trench to cover the cable, and another portion would be dispersed by currents and resettle onto the seafloor (FERC 2010). The re-deposited layer of sediment is expected to be thin beyond the immediate vicinity of the trench (FERC 2010). This disturbance could cause small-scale topographic changes in the seafloor along the path of the cable; however, the natural movements of the sediments by ocean currents would reestablish natural bottom topography. For example, a study of the Monterey Accelerated Research System (MARS) cable in California, using ROV video transection and sediment samples, found little detectable impact to seafloor geomorphology and no detectable change in mean grain size after cable installation at both 18 and 37 months (Kuhnz et al. 2011). Suspended sediment is discussed further in Section 3.3.2.2.

Although OSU proposes a subsea cable route that, to the extent practicable, avoids rocky substrate and would allow OSU to bury cables, it does not eliminate the possibility that segments of the cables cannot be buried. OSU has collected refined subsurface geological information in its selection of a proposed cable corridor. OSU initially investigated three potential subsea cable routes in the nearshore environment to determine the best route to shore from the WEC test site, to avoid rocky substrates and maximize burial depth. Results of geophysical surveys conducted in 2014 by OSU (Goldfinger et al. 2014) determined that the southern-most route to an onshore landing at Driftwood held the best potential for avoiding rocky substrate. OSU notes that this route is significantly longer than the most direct path and, as a result, would increase construction costs substantially, while attempting to avoid rocky substrate.

Upon conducting additional detailed geophysical and geotechnical surveys in 2018 (TerraSond 2019), OSU determined some rocky substrate is likely present within the nearshore portion of the proposed subsea cable corridor to Driftwood. However, OSU believes that based on the 2018 survey results, the majority of the subsea cable segment would, to the extent practicable, be buried to a target depth of 1 to 2 meters from the WEC test site back to the HDD conduits. In short sections where burial is not feasible (due to unsuitable seafloor conditions), OSU proposes to lay the subsea cables on the seafloor and protect them with split pipe, concrete mattresses, or other cable protection systems, consistent with industry best practice. The placement of cable protection systems would bury benthic organisms and permanently alter soft bottom habitat to hard bottom habitat in some areas. In other areas, the systems could be placed on bottom habitat already classified as hard bottom substrate. Cable segments covered by concrete mattresses or other cable protection systems are likely to be colonized as hard substrate by benthic organisms. However, the type of organisms recolonizing over the cable protection system may differ from the original benthic community if portions of the original substrate were soft sediment. In addition, OSU has concluded that unburied but armored cable segments should not interfere with local fishing practices in the nearshore environment based upon consultations with fishermen who have been involved with cable installations in Oregon waters, including members of Fishermen Involved in Natural Energy. In this case, OSU has done everything technically and financially feasible to bury the cable, and it appears complete burial cannot be practically achieved.

In summary, the marine components of the project would have negligible effects on geology and bottom sediments over the term of the license. The footprint of the anchors, even under full build-out using the largest types of anchors, would be fairly small – approximately 2 acres total, spread out over the 1,695-acre WEC test site (i.e., 0.1 percent of the test site), resulting in localized areas of scour or deposition. Other components on the seafloor, such as the four subsea connectors and the umbilical cables lying on top of the seafloor (from below the WECs to the subsea connectors), would be smaller still. Jet plow installation of the buried portions of the subsea cables (from the offshore WEC test site to the seaward end of the HDD bores) in separate trenches would result in a temporary disturbance of the sand bottom. In the nearshore areas where the cables have the potential to not be buried, the rocky substrate would be covered by another artificial hard substrate secured in place to protect the cables, which would result in minor, long-term effects on geology and result in localized scour and deposition of bottom sediments.

Installation of the Terrestrial Transmission Lines and Construction of the UCMF Structures

OSU proposes to install buried transmission lines from Driftwood, under small sections of five or six private properties located on either side of Highway 101 to the OSU-owned UCMF parcel east of the highway, and then to CLPUD's distribution lines on the west side of Highway 101. The total distance of the terrestrial transmission lines would be about 0.5 mile.

OSU conducted a geophysical survey along the proposed terrestrial transmission line route in 2019 (Siemens & Associates 2019) and a geotechnical exploration at one site located on the southern edge of the Driftwood parking lot (Terracon 2020), and determined that HDD installation of the transmission line would be technically feasible. OSU proposes to implement the following measures to minimize the extent of disturbance to geology and soil resources at Driftwood and at the UCMF site during installation of the transmission line and construction of buildings on the UCMF site:

- Use HDD with up to three bores to install the conduits that carry the terrestrial transmission lines from the beach manholes at Driftwood to the UCMF site and from the UCMF site to the CLPUD grid connection point to minimize habitat and substrate disturbance.
- Follow best practices during installation and construction activities to avoid or minimize potential effects of soil erosion.
- Minimize the time that ground is disturbed and the associated effects by completing transmission line installation and other construction activities during appropriate construction windows and within one construction season to the extent practicable
- Develop and implement an erosion and sediment control plan to minimize effects of ground-disturbing activities associated with installation of the terrestrial transmission lines and/or other terrestrial construction.

Oregon DFW and FWS recommend (10(j) recommendation 8 and 4, respectively) that OSU use HDD to install the terrestrial transmission lines to avoid the removal or disturbance of important coastal terrestrial habitat.

Our Analysis

Effects to geology and soils resulting from installation of the terrestrial transmission lines would be minimized by development and implementation of an HDD plan (as discussed in the section 3.3.2). The HDD drill rig would be set up in the paved parking lot at Driftwood. Soils and drill cuttings resulting from the HDD activities would be stored temporarily on site and then disposed of at an approved disposal location. The HDD drilling is a one-time disturbance associated with construction of the project. Disturbance of soils associated with HDD activities and construction of the cable landing vaults at Driftwood would result from excavating and site preparation. When construction is complete OSU proposes to repave the approximately 2.0 acre Driftwood parking lot to eliminate the potential for erosion and return it to its intended use.

Disturbance of soils associated with excavation for installation of the cable vaults at Driftwood and construction of the UCMF would result from clearing and site preparation for approximately 1.2 acres to accommodate the UCMF buildings, the paved and fenced exterior laydown area, parking, and NW Wenger Lane. During construction, the soils in the disturbed area would be compacted and covered by an impervious surface. Proposed site restoration measures after the HDD installation and onshore construction is complete would further minimize any potential for soil erosion from site construction activities. Effects to geology and soils resulting from project construction would be minimized by development and implementation of an erosion and sediment control plan and implementing best management practices (BMPs; e.g., minimizing impacts to wetlands by maintaining buffers around wetlands, and maintaining natural surface drainage patterns). Standard construction BMPs for terrestrial components of the project would minimize effects of ground disturbance.

Discussion of project effects on geological resources as they relate to impacts on biological resources are discussed in Section 3.3.3.2.

3.3.1.3 Cumulative Impacts

The project would have negligible effects on area geology and soils because of the small footprint of the project on the seafloor and temporary nature of the installation and removal activities. Therefore, it is not expected that the project, in combination with WEC testing at PacWave North and the Camp Rilea Ocean Renewable Energy Project, dredged material disposal at the Yaquina Ocean Dredged Material Disposal Sites, and operation of the OOI Project would result in cumulative impacts on geology and soils.

3.3.2 Water Resources

3.3.2.1 Affected Environment

Marine - Wind, Waves, and Currents

The high level of wave energy that exists on the Oregon coast is caused by prevailing western winds and the large fetch of the North Pacific Ocean (Boehlert et al. 2008). Wave energy on the coast varies considerably by season, such that the wave energy flux is approximately eight times greater during winter than summer (Bedard 2005). Episodic winter storms bring large waves from the west and southwest. Currents generated by these waves are uniform throughout the water column and may have a substantial influence on the transport of fine sediments (silt and clay) at depths of greater than 120 feet (USACE and EPA 2001). The regional-scale circulation of ocean surface waters on Oregon's continental shelf varies seasonally with changing wind stress patterns and is dominated by the southward-flowing California Current (USACE and EPA 2001). During the summer, offshore high-pressure weather systems and associated northerly or northwesterly winds drive upwelling of deep, dense, cold water toward the ocean surface. In contrast, low-pressure offshore weather systems during winter drive southwesterly storm winds that result in downwelling of nearshore surface water, and nearshore surface circulation is dominated by the northward-flowing Davidson Current.

On the inner continental shelf (depths less than about 35 meters), water circulation is influenced by a combination of wind-driven currents, wind waves, tidal currents, and estuarine-induced currents (USACE and EPA 2001). On the middle continental shelf (depths of 35 to 90 meters), water circulation is influenced mainly by wind-driven currents, whereas on the OCS (90 to 180 meters), shoaling waves and regional-scale currents control water circulation seasonally (USACE and EPA 2001). The net direction of bottom currents on the mid- to outer-OCS is northward; the subsurface part of the Davidson Current is believed to flow northward year-round (USACE and EPA 2001).

Based on site-specific surveys, water depth at the project site ranges from 65 to 79 meters (Goldfinger et al. 2014). Figure 3-3 illustrates bathymetry at the offshore WEC test site; bathymetry along the proposed cable route is shown in Figure 3-4. (Note that both figures are based on less accurate, pre-survey data.)

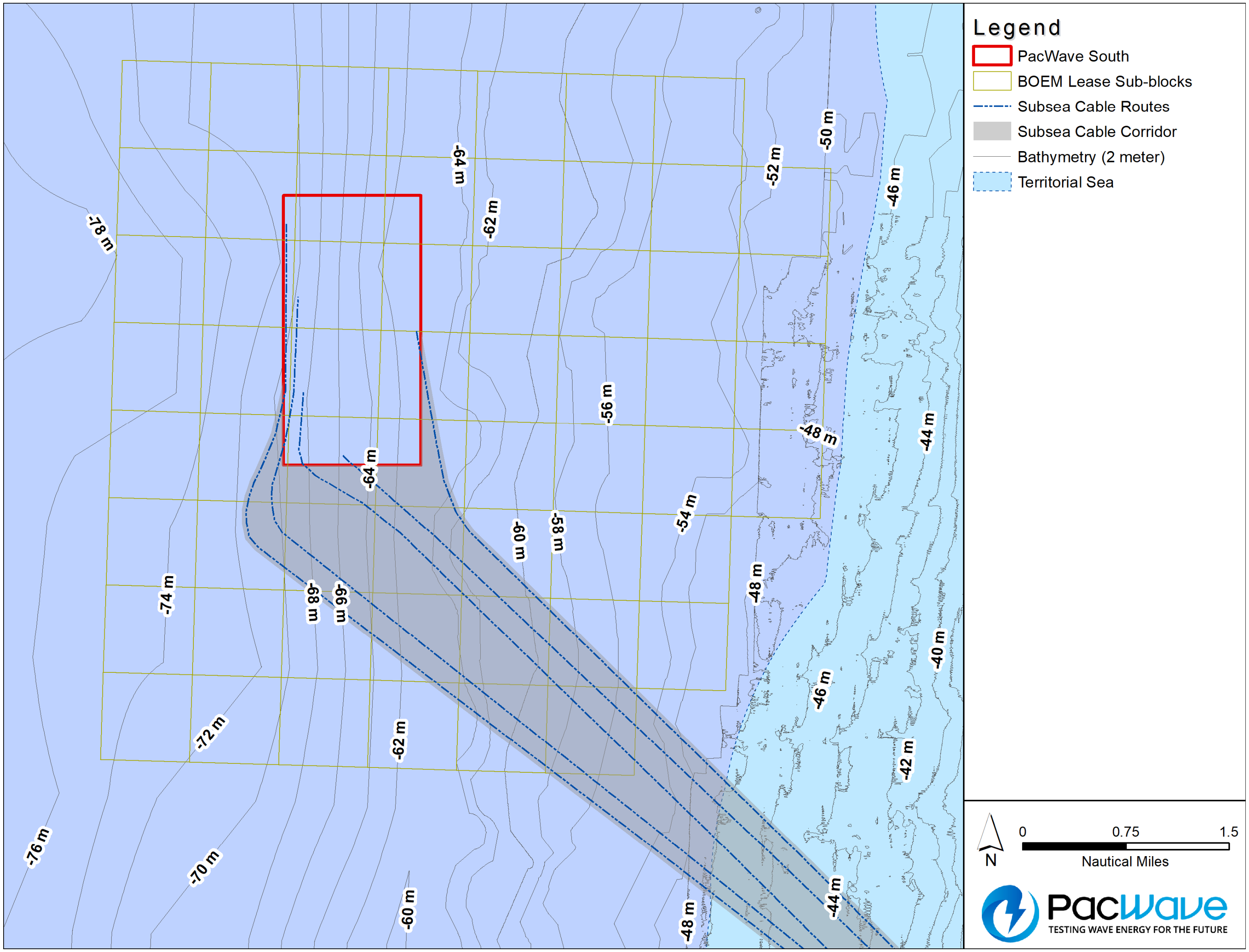

Figure 0-3. PacWave South bathymetry.

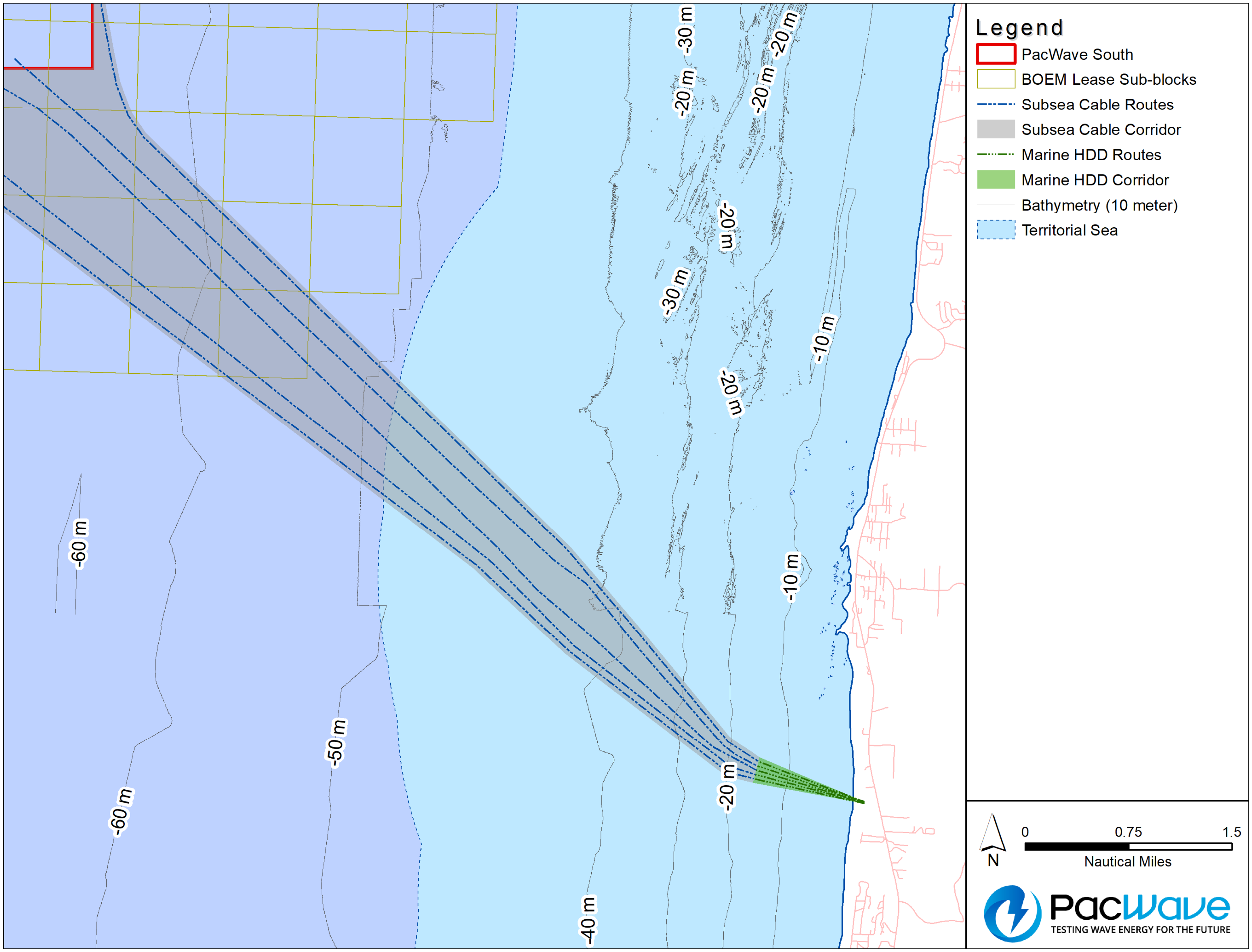

Figure 0-4. Cable route bathymetry.

Direct measurements of wave climate information have been collected through in-situ measurements at PacWave North (Cahill 2014), which is considered to be reasonably representative of PacWave South given the relative proximity of the two sites (the sites are 9 nautical miles apart). Cahill (2014) compared wave measurements at PacWave North collected from August to October 2012 and August to October 2013, to the National Data Buoy Center (NDBC) Buoy 46050, located 20 nautical miles west of Newport, to develop a representative, 18-year dataset of wave parameters for PacWave North. Annual average wave heights are approximately 2 meters, with the highest annual average exceeding 2.5 meters. The annual average wave energy flux fluctuates between approximately 30 kilowatts per meter (kW/m) and 60 kW/meter. The average wave power across the entire 18-year period of record was 40 kW/m. Strong seasonal trends were documented from this analysis: during winter, as would be expected, higher wave height, longer wave period, and a greater available wave energy resource occurs. Wave power during December is on average approximately eight times greater than in June, July, and August (Cahill 2014).

Terrestrial - Surface Waters

Streams and rivers are distributed statewide in Oregon and Washington, forming a continuous network connecting high mountain areas to lowlands and the Pacific coast. The western Cascades in Washington and Oregon are composed of volcanically derived rocks and are more stable than streams typically found in other parts of the Pacific Northwest. They have low sediment-transport rates and stable beds composed largely of cobbles and boulders, which move only during extreme events. The project area is located within the Beaver Creek-Waldport Bay Watershed (HUC 1710020505), a subset of the Northern Oregon Coast Watershed.

One named stream, Friday Creek, was identified in the Driftwood during surveys conducted in May 2016 and June 2017 (Figure 3-5). No streams were identified at the UCMF site. Friday Creek flows from north to south at the eastern extent of northern end of the project area. The stream leaves the project area at this location and re-enters the project area further south, flows west through a culvert under Highway 101, then flows south in a roadside ditch for approximately 270 feet on the west side of the highway. The stream enters a culvert under the entrance to Driftwood, exits on the south side of the entrance and continues to flow south through scrub-shrub wetland in an open channel where it flows into Buckley Creek. The channel width just south of the park entrance is approximately 2 feet wide and ranges from 5 to 10 feet wide north of the entrance (HDR 2017).

In 2019, a wetland and waterway survey was conducted along the terrestrial HDD corridor, which included Buckley Creek, Friday Creek, and “Stream 4” (Figure 3-5). In this area, Buckley Creek was approximately 4 to 5 feet wide with depths ranging from 1 to 2 feet, and Friday Creek was approximately 2 to 10 feet wide with depths ranging from

1 to 1.5 feet. "Stream 4" flows into the project area from the northeast through Wetland D before flowing into Friday Creek and Buckley Creek. The wetted width of this channel was approximately 4 feet wide and depths were around 6 inches during the field survey (HDR 2019). Wetlands in the project area are discussed later in Section 3.3.4, and a detailed description of each wetland and stream is provided in the Wetland Delineation Report (HDR 2017, 2019).

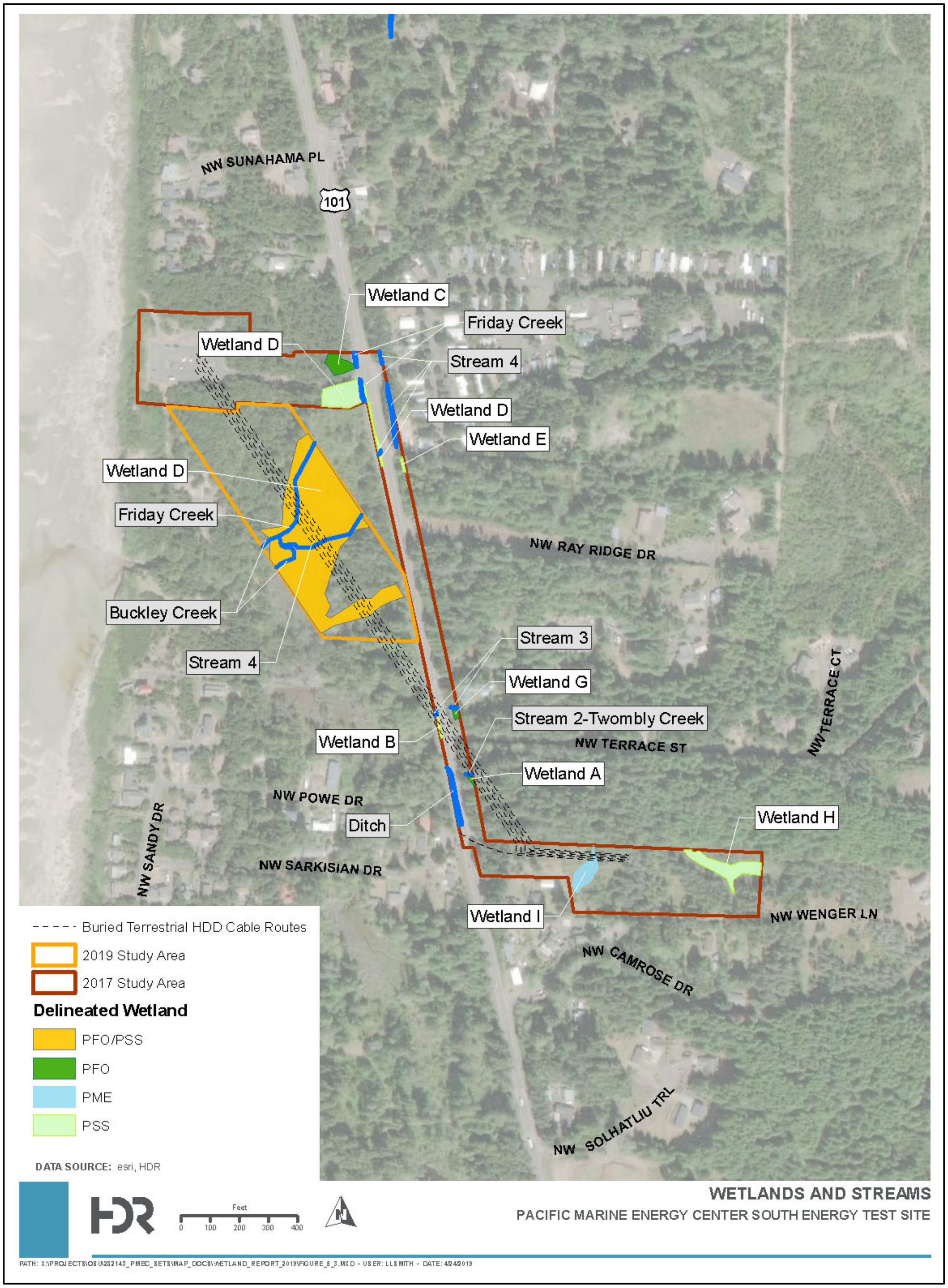

Figure 0-5. Surface waters and wetlands in the terrestrial project area (PFO=palustrine forested; PSS=palustrine scrub-shrub; PME=palustrine emergent).

Water Quality

Part of the project's subsea cable route would be located within the 3-mile boundary of Oregon territorial waters, and installation of the subsea cables must comply with the water quality standards outlined in the Oregon Administrative Rules (OAR) 340-041. Relevant rules applicable to the project are the following:

(1) support aquatic species without detrimental changes in the resident biological communities;
(2) prevent a reduction in ambient dissolved oxygen concentrations;
(3) maintain pH between 7.0 and 8.5;
(4) prevent water temperature increases that adversely affect fish or other aquatic species; and
(5) prevent the introduction of toxic substances above natural background levels in amounts, concentrations, or combinations that may be harmful to aquatic life, public health, or other designated beneficial uses.

Marine Project Area

The designated beneficial uses for marine waters adjacent to the Mid-Coast (which contain the project area) are industrial water supply, fish and aquatic life, wildlife and hunting, fishing, boating, water contact recreation, aesthetic quality, commercial navigation, and transportation.

Oregon DEQ administers 15 statewide narrative criteria for water quality, per OAR 340-04; these include the following criteria relevant to this project:

(1) creation of tastes or odors or toxic or other conditions deleterious to aquatic life or affecting the potability of drinking water or the potability of fish or shellfish;
(2) formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to aquatic life or injurious to public health, recreation, or industry;
(3) objectionable discoloration, scum, oily sheens, or floating solids, or coating of aquatic life with oil films; and
(4) aesthetic conditions offensive to human senses of sight, taste, smell, or touch.

Water quality on the Oregon coast varies seasonally. During winter, temperatures of nearshore surface waters are generally around 9 to 10°C and salinities range from about 30 to 32 practical salinity units (PSU, Boehlert et al. 2008, Landry et al. 1989). Light transmission is higher during winter and decreases with the transition to spring/summer upwelling conditions, when phytoplankton blooms occur (Boehlert et al. 2008). Spring/summer upwelling results in a net transport of shallow water to the west, bringing deeper, colder, more saline water onto the inner shelf. Summer surface temperatures are about 8 to 14°C and salinities are about 30 to 32 PSU (Boehlert et al. 2008, Landry et al. 1989). Wind and wave conditions are relatively calm during the early spring (March and April), and early fall conditions (September and October) transition between oceanographic regimes (Boehlert et al. 2008).

Water quality data taken in proximity to the marine project area are available in the Oregon DEQ 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, Oregon DEQ collected water quality data just west of PacWave South (Site ID 30223). Two readings were taken every half meter throughout the water column (e.g., near surface to near bottom at 60 m). The average is provided at three sampling depths in Table 3-2. Chlorophyll α, water temperature, dissolved oxygen concentrations, and transmittance differed most substantially near the surface. All parameters, with the exception of transmittance and salinity, typically decreased with increasing depth.

Table 0-2. Average water quality data from Oregon DEQ Site 30223.

Parameter	Sampling Location		
	Near Surface (2 m)	**Mid-Water (30 m)**	**Near Bottom (60 m)**
Chlorophyll *a* (µg/L)	14.5	0.6	0.2
Dissolved oxygen (mg/L)	10.0	5.9	3.1
Salinity (ppt or PSU)	31.5	33.0	34.0
Temperature (°C)	12.0	8.2	7.5
Transmittance (percent)	76.0	94.0	93.5
Dissolved oxygen (percent saturation)	113.5	61.5	32.0

Source: ODEQ 2014. Notes: µg/L = micrograms per liter, mg/L = milligrams per liter, ppt = parts per thousand (equivalent to PSU), °C = degrees Celsius

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 2001). The 18 sample locations are in the open waters offshore of Yaquina Bay, an area that, like the WEC test site 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 the USACE's Sediment Evaluation Framework for the Pacific Northwest (USACE et al. 2009). All detected concentrations of organic compounds were either below the USACE's Sediment Evaluation Framework screening levels or below laboratory reporting limits.

Terrestrial Surface Waters

Oregon identifies receiving waterbodies as water quality limited through a state biennial assessment report, as required by Section 305(b) of the CWA. Section 303(d) of the CWA requires that states (e.g., Oregon DEQ) periodically prepare a list of all surface waters in the state for which beneficial uses, such as drinking, recreation, aquatic habitat, and industrial use are impaired by pollutants. The most recent list approved by the EPA for Oregon was in 2010 and was updated in 2012 (ODEQ 2012). Friday Creek and Buckley Creek were not listed as impaired by Oregon DEQ (ODEQ 2012).

3.3.2.2 Environmental Effects

Construction and operation of the project is not expected to affect total dissolved gases, water temperature, circulation, or pH in the surrounding waters. Potential adverse effects of the project on water quality include the following:

- Effects of sediment suspension caused by anchor and subsea transmission cable installation on water quality;
- Effects of HDD inadvertent return of drilling fluids; and
- Effects of toxins introduced by the project on water quality, including:
    - Antifouling paint or coatings;
    - Accidental spills of fuel, lubricants, and hydraulic oil; and

OSU proposes to implement mitigation measures and monitoring plans, developed in consultation with various stakeholders, to address the uncertainty associated with the installation and operation of this new technology and to mitigate for these effects. We discuss each of these effects below.

Effects of Anchor and Cable Installation on Water Quality

Potential effects of subsea cable installation and anchor and subsea connector deployment and removal on water quality could result from disturbance of the seabed and increased levels of turbidity.

OSU proposes to use jet plow and HDD methods to bury the subsea transmission cables to minimize interaction with fishing gear (see section 3.3.6) and reduce the exposure of marine resources to EMF emissions (see section 3.3.3). OSU proposes to minimize the time that the seafloor is disturbed, and sediment is dispersed by completing cable installation within one construction season to the extent practicable. In addition, if an incoming WEC could use anchors already installed, the anchors could be left in place between tests, to reduce turbidity, otherwise the anchors would be removed prior to a subsequent WEC test.

Oregon DFW encourages actions that minimize disturbance to the seafloor, including reuse of anchors, and to remove anchors that would not be used before the subsequent WEC test.

Our Analysis

Burying the subsea cables by jet plowing (or similar method) would cause sediment to become temporarily suspended into the water column, which would temporarily affect water quality. OSU would minimize the extent of substrate disturbance by using HDD to install conduits to carry the subsea cables beneath the seabed from approximately 0.6 mile offshore at the 10-m isobath to onshore beneath the beach and dunes to Driftwood. Installation of anchors and the subsea connectors would also cause temporary suspension of sediment in the water column. Anchors placed on the seafloor surface, such as gravity anchors, would result in minimal sediment suspension, whereas anchors placed under the seafloor, such as embedment or suction anchors, would result in greater sediment suspension. Benthic sampling at both PacWave South and PacWave North indicate that substrate composition on the mid- to inner-shelf along this section of the Oregon coast consists of sand, with larger grain sizes found at greater depths (Henkel et al. 2014, Henkel 2016a).

Sediment transport modeling completed for the subsea cable installation for the Deepwater Wind Project off Block Island, Rhode Island (Tetra Tech 2012a), estimated that, in areas characterized by mostly coarse sand (particle diameter > 130 μm), sediment suspended during jet plow operations dropped quickly to the seafloor, and formation of major plumes would not occur in the water column. Suspended sediment concentrations within a few meters of the jet plow would be elevated, though outside of this nearfield zone, no concentrations would exceed 100 mg/L. Concentrations above 10 mg/L would be confined to an area primarily within 50 meters (160 ft) of the jet plow route and would last for approximately 10 minutes. This modeling also estimated that sediment deposition would exceed 10 mm (0.4 inches) immediately adjacent to the trench, and sediment re-deposition would not exceed 1 mm beyond 40 meters (130 feet) from the plow path (Tetra Tech 2012a).

Sediment transport modeling conducted for the Virginia Offshore Wind Technology Advancement Project estimated that suspended sediment (particle diameter <200 μm) during subsea cable burying would extend vertically about 2 meters above the trench and horizontally up to 100 to 160 meters, sediment would deposit on the seafloor within 6 to 7 minutes, and sediment re-deposition would not exceed 1 mm within 100 meters of the activity (BOEM 2014). Grain sizes at and inshore of PacWave South are larger (mean median grain size = 364 μm) than the grain sizes evaluated by the studies in Virginia and Rhode Island; accordingly, less suspension and faster settling are expected with cable laying, subsea connector installation, and anchor installation and removal at PacWave South.

It is expected that the local conditions at the project site would differ from those at the Rhode Island and Virginia sites. Different water depths, salinities, currents and other hydrodynamic forcing and water quality parameters all combine to affect the magnitude and extent of sediment advection and transport. However, because coarse, non-cohesive sediments exist at all locations, it is reasonable to assume that the sediments would settle out of suspension rapidly after re-suspension. Coarse sediments that are advected away from the site would also likely settle out rapidly. Fine sediments, if re-suspended, would be advected the furthest away before depositing.

Rough estimates of the settling velocity of grain sizes in the 200-600 μm diameter size range, the grain sizes at the PacWave South site are 2.5 cm/s for 200 μm diameters and 8.5 cm/s for 600 μm diameters (Hallermeier 1981, Van Rijn 1984, both from Soulsby 1997). These estimates are slightly conservative as they are based on ideal conditions where there is no water current or additional turbulence from construction activity or hindered settling. However, for a practical example, if these sediment grains were suspended 10 meters into the water column as a result of the construction activities, it would take the 200 μm and 600 μm sediments approximately 6.5 minutes and 2 minutes to settle out of suspension, respectively, given the settling velocities above. The settling velocities would be affected by ambient current speeds, the range of particle sizes that would be resuspended, and any impacts of hindered settling, these settling estimates may vary, but are anticipated to remain on the order of a factor of 1-3 times the zero-flow settling velocities (i.e., less than 20 minutes).

Similar to cable deployment, subsea connector deployment and anchor installation and removal would be expected to result in a very temporary (minutes) and localized increase in turbidity. As with cable installation, subsea connector installation would only occur during initial project construction. Anchor deployment would occur periodically over the term of the license, but it would be infrequent because anchors would remain in place for the duration of the WEC deployment periods (which are expected to be 3-5 years). It is unlikely that anchors would be changed out during a WEC test due to the high costs associated with installing and removing them. Further, if an incoming WEC could use anchors already installed, the anchors could be left in place between tests.

In summary, the project would result in only minor, short-term disturbance of sediments during deployment of the subsea connectors and cables, and sediment suspension caused by periodic installation and removal of anchors would be temporary and localized. Following these activities, it is expected that re-suspended sand would quickly settle; therefore, it is not expected that the project would increase turbidity to the extent that it would degrade water quality. For these reasons, sediment suspension caused by the project would not cause permanent or significant effects on water quality.

Effects of HDD Inadvertent Return of Drilling Fluids

Potential effects of HDD on water quality could result from turbidity/sediment runoff and discharges of drilling mud and fluids by inadvertent return[27] (frac-out) during HDD operations.

OSU proposes to develop and implement a plan with HDD contingency measures that would minimize the effects of a potential inadvertent return of drilling fluid by providing timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the HDD contractor.

Oregon DFW recommends (10(j) recommendation 8) that the HDD installation of the conduits that carry the terrestrial transmission lines be designed to reduce the risk of inadvertent return of drilling fluid by developing an HDD plan, including: (1) a description of how OSU would minimize risks of inadvertent return in the marine environment; (2) a description of the HDD locations (both marine and terrestrial), maps, coordinates and spatial dimensions; (3) protocols for locating the depth of the water table and an assessment of the risks of avoiding or drilling through the water table; (4) a description of the HDD laydown area location at Driftwood, the manhole spacing (e.g. 20 feet apart), and the protocols for drill site preparation and set up; (5) a description of the HDD target minimum depth beneath dunes, beach, wetland and stream habitat, diameter of the HDD hole, and approximate dimensions (distance, width, depth) of the HDD subsea cable and transmission line corridors; (6) a description of the geotechnical analysis conducted by OSU to ensure successful HDD and reduce the risk of inadvertent return to the maximum extent (e.g. identify vulnerabilities or hazards and how they will be avoided) (7) the HDD methods (e.g. drill and leave); (8) the HDD scope (e.g. five separate marine HDD bores, one large terrestrial HDD bore) to include installation of the terrestrial transmission lines in a single HDD bore hole to increase the likelihood of maintaining bore hole stability and reduce the potential for an inadvertent return; (8) the schedule and timing of HDD installation (e.g. one month per marine borehole, 6-8 months in total); (10) the construction best operating procedures designed to minimize the potential for inadvertent return of drilling fluids; (11) a description of anticipated support services such as marine vessels or divers; (12) a description of inspection procedures to facilitate timely detection of inadvertent return or leaks, if any; (13) protocols for monitoring (e.g. drill mud pressure and volume), containment, response

---

[27] An inadvertent return of HDD fluid or frac-out is a condition that can develop despite: 1) appropriate subsurface investigation; 2) engineering design and analyses of the drill path; 3) evaluation of subsurface pressures; 4) use of appropriate drilling fluids; 5) following the drill path that was designed; and 6) monitoring and adjusting drilling fluid pressures throughout the drilling process.

recovery and clean-up of inadvertent return, and notification procedures, including notification of Oregon DFW; (14) protocols for storing emergency response equipment on-site during HDD operations; (15) descriptions of alternate or contingency crossing methods should the primary method fail as a successful cable and transmission line installation location; (16) a map of alternative vehicle beach access points and description of consultation procedures with Oregon PRD to inform the public; (17) a map of environmentally sensitive sites (e.g. western snowy plover potential habitat, seaside hoary elfin potential habitat, streams, wetlands, dune habitat); (18) approved locations for spoil piles on previously disturbed, paved, areas selected to avoid impacts on habitat; (19) a list of additives used in drilling fluid and procedures and approved disposal sites for spoils and drilling mud; and (20) a description of demobilization procedures for HDD machinery and equipment.

FWS states that it appreciates the efforts by OSU to avoid disturbing the important wetland habitats in the terrestrial areas of the project by using HDD to install the transmission line, because HDD is far preferable than removal or disturbance of coastal wetland habitats. FWS adds that while HDD is the preferred methodology, it is not without its own risks, particularly of frac-out, with drilling fluids extruded to the land surface. FWS notes that although OSU proposes a plan with contingency measures, it would only address actions that OSU would take once frac-out occurs, which are likely to prove insufficient to address damage to sensitive wetlands. FWS believes that measures to avoid or limit the potential for a frac-out should be provided. As a result, FWS recommends (10(j) recommendation 4) that OSU limit the number of HDD bores beneath the wetland habitat to three or fewer and combine the transmission lines into three or fewer conduits.

Our Analysis

Using HDD to install buried subsea transmission cables and terrestrial transmission lines is less intrusive than traditional open-cut trenching and minimizes land and wetland disturbance. But because HDD uses non-toxic slurry and drilling fluids under pressure, the fluid may be forced to the surface (an inadvertent return) resulting in adverse environmental effects, if appropriate planning and precautions are not taken.

OSU believes that the risks of an inadvertent return for both the marine and terrestrial transmission line segments would be minimized by drilling at Driftwood deep beneath the beach and dune system and nearshore intertidal zone, to approximately 0.6 nautical mile offshore, where the conduits would resurface from beneath the seabed, and deep below the Buckley Creek wetland system and Highway 101, 0.5 mile to the UCMF site. Although OSU does not propose to develop a detailed HDD plan, it has conducted geophysical and geotechnical surveys and prepared maps and a general description of the HDD routes and installation methods. From Driftwood, OSU would drill through any unconsolidated sediments and terrace deposits and offshore, into the seabed substrate, and onshore, into moderate to higher strength sedimentary rock (e.g. Nye, Yaquina and Alsea Formations) below the wetland area.

OSU notes that the risks of an inadvertent return are extremely low onshore because the HDD bore is expected to reach depths of over 200 feet and would be in the moderate to higher strength rock when passing under the Buckley Creek wetland system and Highway 101. OSU notes that between the start and end points of the HDD routes, no environmental effects are anticipated unless there is an accidental return of drilling fluids to the surface through an unidentified weakness or fissure in the subsurface geology and soil. As a precaution, OSU proposes to develop a plan with HDD contingency measures that would minimize the effects of an inadvertent return of drilling fluid, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the HDD contractor.

HDD has a potential for inadvertent returns if drilling fluids leak through an unidentified weakness or fissure beneath the seabed. The drilling fluids are non-toxic but could result in increased suspended sediment and turbidity and possibly affect aquatic organisms. As the suspended material settles out of the water column, sedimentation would partially or entirely cover the waterbody substrate and any sessile benthic organisms, although effects would be minor, localized, and temporary. Inadvertent return during HDD or boring operations is considered highly unlikely. While there is some potential for the release of bentonite or drilling fluids to the marine environment from HDD, the resulting turbidity would be minor and the non-toxic materials raise little concern. The small amount of material that would escape would be quickly diluted in the waters of the Pacific Ocean.

OSU proposes to use a maximum of three bore holes for HDD installation[28] of the conduits which carry the terrestrial transmission lines but says that Oregon DFW's recommendation for one bore hole is not based upon expert engineering analysis. OSU points out that such a recommendation would impose an inappropriate engineering restriction on the project that may prevent it from being constructed, if OSU is unable upon consultation with its selected HDD contractor, to have the 5 lines carried in a single conduit from Driftwood to the UCMF. Given the geophysical and geotechnical survey information that is available for the project site, the risks of an inadvertent return are extremely low onshore because OSU's proposed maximum of three HDD borings would

[28] In its reply comments to FWS and Oregon DFW's REA comments to limit the number of HDD bore holes, OSU proposes to use a maximum of three HDD bore holes to install the terrestrial transmission lines instead of the five bore holes proposed in the FLA.

be located in moderate to higher strength rock to maintain bore hole stability when passing under the Buckley Creek wetland system and Highway 101.

As OSU notes, subsequent consultation with an HDD contractor would be necessary before final HDD technical engineering details and specifications are developed. Development of an HDD plan, to include OSU's proposed contingency measures and Oregon DFW's recommended measures, by an expert contractor based upon criteria outlined in the Commission's HDD Plan Guidance[29] (FERC 2019. Guidance for Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plans) would reduce risks of construction complications, inadvertent releases, and minimize adverse environmental effects of HDD. Following additional Commission criteria for HDD crossings beneath wetlands[30] in development of OSU's HDD plan would further minimize the potential for an inadvertent return to the Buckley Creek wetland system. Including contingency measures in the plan would minimize the effects of a potential inadvertent return of drilling fluid.

Implementing an HDD plan developed by OSU as discussed above would provide for drilling in a manner that avoids the potential for substantial inadvertent releases to the marine or terrestrial environment. Monitoring of the drilling process, as described in the HDD Plan Guidance, would aid in the detection of any seepage of the fluid and identification and implementation of any corrective measures (e.g., rerouting the drill route or stopping drilling to allow the fracture to seal). OSU's HDD contingency measures would include steps drill contractors would follow to avoid leaking drilling fluid into the surrounding bed stratum, water column, and land surface, and to conduct appropriate monitoring, which would ensure a low likelihood of an inadvertent return of drilling fluids associated with installation of the subsea transmission cable and terrestrial transmission line during project construction.

Effects of Fabricating, Staging, Transporting, and Testing Project Components on Water Quality

Project construction and operation have the potential to adversely affect water quality from the discharge of hazardous and toxic substances. To minimize adverse effects on water quality from toxic substances introduced during project construction and operation, OSU proposes the following environmental measures:

---

[29] The Commission's HDD Plan Guidance includes specific criteria for contingency planning.

[30] The Commission's *Wetland and Waterbody Construction and Mitigation Procedures* at section V.B.6.d requires a site-specific plan prior to beginning construction for all HDD crossings of wetlands and waterbodies.

- Follow industry best practices and guidelines for antifouling applications (e.g., TBT-free) on project structures such as marker buoys, subsurface floats and WECs.
- Minimize storage and staging of WECs outside of existing dock, port or other marine industrial facilities.
- Prevent project components such as WECs from grounding and disturbing the bottom substrate in the estuary and nearshore habitats during transport in and out of the ports.
- Develop and implement an emergency response and recovery plan for installation and maintenance of offshore facilities, with spill prevention, response actions, and control protocols, and provisions for recording types and amounts of hazardous fluids contained in WECs and other project components and require all vessel operators to comply with the plan.

To minimize impacts on estuary habitat, Oregon DFW 10(j) recommendation 5 calls for: (1) fabrication of project components at existing permitted land-based facilities, allowing all coatings and paints to fully cure prior to deployment into the estuary; and (2) restrict use of the estuary to commercial dockage that has been designed, permitted and is used for dockage, where the docks have been and continue to be dredged. FWS 10(j) recommendation 2 calls for a measure identical to Oregon DFW measure 1 above and a second measure that all project use of the estuary be restricted to commercial navigation channels, and existing permitted docks and dredged areas (this would include storage and staging of WECS).

In its reply comments to FWS and Oregon DFW recommendations to restrict the location of fabricating, storing, staging, and transporting project components, OSU stated it does not have the ability to impose fabrication location requirements before WEC test clients are under contract with OSU and that some fabrication could occur in other states or countries. OSU objects to FWS and Oregon DFW's recommendation to broaden the estuary use restriction to project use generally (not just storage of WECs), which would restrict a wide range of operation and maintenance activities thwart the project purpose.

Our Analysis

Mooring buoys and any subsurface floats would be treated with antifouling applications (i.e., paints and coatings) to prevent marine life from colonizing these components. Antifouling applications are commonly used in marinas, offshore structures, and ships (Schiff et al. 2007). Antifouling marine applications can leach copper, zinc, iron, and ethyl benzene over time, which could impact water quality (ODEQ 2011). Exposure to dissolved copper at relatively low concentrations has been shown to impair the olfactory sense in freshwater fish, resulting in an impaired avoidance of predators and may also reduce growth rates. In freshwater or sterile seawater, these effects were seen at concentrations between 1-3 µg/L over varying exposure durations, but in saltwater with a normal load of dissolved organic material, copper ions bind with dissolved organic material, decreasing the bioavailability of copper and partially protecting organisms against copper's neurotoxicity (Hecht et al. 2007, City of San Jose 2005).

WEC developers would fabricate project components (i.e., WECS, subsea power cables, anchor and mooring systems, navigational buoys, and monitoring equipment) at land-based facilities and transport them to staging areas, mainly at the Port of Newport but may include the Port of Toledo. Once at the staging area, one or more WECs at a time would be moored dockside in Newport or Toledo prior to transport to the WEC test site.

Antifouling paints could leach from the project site, or from the WECs in port when the WECs are moored dockside, as well as during transport from port to the test site. The Port of Newport moors many vessels which are coated in antifouling paint and are docked for many months or that transit waters off the coast of Oregon. WEC developers would likely use the Port of Newport dockage or other commercial facilities within Yaquina Bay that have been designed, permitted, and are used for dockage. Antifouling paints are already present and in use on vessels and structures in the Port of Newport and nearshore marine waters.

OSU proposes to minimize storage and staging of WECs outside of existing docks, ports, or other marine industrial facilities within Yaquina Bay, which would be similar to activities that already occur in the bay at existing marine industrial infrastructure and facilities. Using existing facilities for these purposes and ensuring that during transport in or out of the bay, project components such as WECs do not ground and disturb the bottom substrate, OSU would prevent nearshore and estuarine adverse environmental effects.

Fabrication of WECs and other project components by developers, including coatings and painting, at properly equipped and properly located facilities would minimize potential effects on water quality and on the estuary in Yaquina Bay. Use of commercial and noncommercial dockage by WEC developers and OSU, to store and stage project components including WECs, that are designed and permitted for industrial use, with existing dredged channels, would minimize effects on water quality and on turbidity or direct shading to sensitive eelgrass habitat within or adjacent to the permitted dock facility.

The potential impacts on the estuary in Yaquina Bay described above are too attenuated from the Commission's authority over the construction and operation of the PacWave South Project to require the recommended resource agency measures. Further, existing state or federal requirements regulating industrial fabrication, storage, and transport within the Ports of Newport and Toledo should ensure those activities are done properly to minimize effects on the aquatic environment of the estuary.

The WEC test site is 65 to 79 meters deep. At these depths, ocean advection along the continental shelf would quickly dissipate any toxins released from antifouling applications, preventing them from reaching high concentrations, and there is good understanding of the potential effects certain chemicals may have if leached into the marine environment because each commercially available paint and coating has undergone rigorous approval testing and processes (Copping et al. 2016). Concentrations of antifouling substances in sediment and the adjacent water column depends on the water flow and on specific characteristics such as whether the body of water is enclosed (e.g., harbors and marinas), the number of vessels/area with antifouling coatings; typically, higher concentrations are found in enclosed waters such as bays and harbors, where there are a large number of commercial and recreational vessels docked, and lower in the open ocean (Konstantinou and Albanis 2004). In addition, the sandy bottom offshore at the project reduces the likelihood that antifouling paint contaminants would adhere to the sediment or reenter the water column.

For the Reedsport Project, Oregon DEQ concluded that the concentration of constituents released from antifouling paint from 10 WECs and associated subsurface floats would be well below the water quality criteria (both chronic and acute criteria) to protect marine life (where applicable), as shown in Table 3-3 (ODEQ 2011, FERC 2010, Reedsport OPT, LLC 2010). This conclusion is relevant to both the initial development scenario (six WECs) and the full build-out scenario (20 WECs) for PacWave South as the offshore project site would be at similar depth to the Reedsport Project and exposed to similar current patterns. For example, considering there would be 20 WECs at the project, doubling the calculated concentrations for the 10-WEC project shown in Table 3-5, yields values well below the standards, and only represents a minor adverse effect. In addition, OSU would use industry best practices and guidelines for antifouling applications (e.g., TBT-free) on project structures such as marker buoys, subsurface floats and WECs.

Table 0-3. Constituent concentration comparison with criteria for 10-WEC Reedsport OPT Wave Park.

Constituent Name	Calculated Concentration with Project Boundary (µg/l/day)	Calculated Concentration with Project Boundary (µg/l) over 4 days	Protection of Aquatic Life*	
			Marine Chronic Criteria (µg/l)	Marine Acute Criteria (µg/l)
Total Copper	0.02	0.08	2.9	2.9
Total Zinc	0.09	0.36	95	86
Total Iron	0.01	0.04	NA	NA

Ethyl Benzene	0.0	0	NA	NA

* The acute criteria refer to the average concentration for one (1) hour and the chronic criteria refer to the average concentration for 96 hours (4 days), and that these criteria should not be exceeded more than once every three (3) years.
Source: ODEQ 2011

A number of vessels, including tugs, installation vessels, and other workboats would be used for the construction, operation, and maintenance of the project. These vessels contain fuel, hydraulic fluid, and other potentially hazardous materials. Accidental spills of hazardous materials (e.g., fuel) from vessels used during construction and operation, or from the WECs, are not expected, but may occur. Accidental spills of hazardous material may possibly occur from project-support vessels or WECs in the Port of Newport or during transit from the Port of Newport to the WEC test site.

Although WECs are designed for survivability at sea and to minimize the potential for leaks, they can contain fluids toxic to marine life, such as hydraulic fluid. The volume of fluids used in each WEC would be expected to be relatively small. For example, the WEC deployed at PacWave North in 2012 contained less than 25 gallons of hydraulic fluid (DOE 2012). The point absorber WEC that would have been used at the Reedsport Project, contained 198 to 264 gallons of hydraulic fluid; by comparison, an average commercial crabbing boat contains 10,000 to 30,000 gallons of diesel fuel (Reedsport Ocean Power Technologies [OPT] Wave Park, LLC. 2010).

Petroleum-based contaminants, such as fuel, oil, and some hydraulic fluids, contain polycyclic aromatic hydrocarbons, which can kill fish and marine life at high levels of exposure and cause sublethal effects such as compromised immune response, increased susceptibility to pathogens, reduced reproductive success and reduced growth rates at lower concentrations (Arkoosh and Collier 2002, Spromberg and Meador 2006).

According to a 2013 BOEM study on the environmental risks, fate, and effects of chemicals associated with offshore wind turbines on the Atlantic OCS (Bejarano et al. 2013), the likelihood of catastrophic spills would be very low (one time in 1,000 years). Even in the highly unlikely event of an accidental release, based on the most likely types and amount of releases for a wind turbine, which are similar to the WEC's, it is estimated that the 20 WEC's proposed for the project would release up to a few thousand gallons of oil. Bejarno et al. (2013) stated that these releases would cause minimal effects to water quality and that they would be limited spatially and temporally to the vicinity of the point of release. WECs and related infrastructure have been deployed since 2003 at the Wave Energy Test Site at Marine Corps Base Hawaii, and there has been no evidence of significant effects on marine water quality resulting from deployment and operation (Naval Facilities Engineering Command [NAVFAC] 2014). In the *State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World*, the risk associated with chemical leaching from coatings, or from accidental spills, was rated as "low" for small-scale and large-scale commercial marine energy projects (Copping et al. 2016).

Accidental release of oil or toxic substances offshore is unlikely to occur because OSU would develop and implement an emergency response and recovery plan that includes spill prevention measures and control protocols to minimize the potential for spills and, if needed, response actions to accidental release of oils and toxic chemicals into the marine environment, and provisions for recording types and amounts of hazardous fluids contained in WECs and other project components. OSU would ensure contractor implementation of the spill response plan. OSU would require operators of vessels used for installation and maintenance to have vessel-specific spill response plans. Such measures would be adequate to prevent and minimize adverse effects of a hazardous material spill.

The project would have minimum adverse effects on water quality from toxic or hazardous materials in the project area. The concentrations of antifouling paints in the marine environment due to the project are expected to be undetectable. Spill control and response measures proposed by OSU would greatly reduce the likelihood that a spill of hydraulic fluids or other petroleum-based contaminants would be large enough to adversely affect more than a few individual fish, or to affect habitat function. In addition, the location of WEC test site in the open ocean further minimizes the likelihood of adverse effects, because any minor effects on water or sediment quality would quickly dissipate. Occurrence of many species are likely to be low and/or short-term/transitory in the project area, thus their potential exposure to toxic substances, if they are released, would likely be very low. For these reasons, toxic substances are not expected to adversely affect marine life that could be in the project area.

Effects of Terrestrial Ground-disturbing Activities

Project construction at Driftwood and the UCMF site haves the potential to adversely affect water quality from the discharge of sediment and hazardous and toxic substances. To minimize adverse effects on water quality from runoff containing sediment or toxic substances during project construction, OSU proposes the following environmental measures:

- Develop and Implement a stormwater management plan.
- Implement appropriate BMPs (e.g., minimizing impacts to wetlands by maintaining buffers around wetlands, and maintaining natural surface drainage patterns).

OSU's proposed stormwater management plan is also required by NMFS term and condition 3 and EFH recommendation 4. NMFS provides a detailed list consisting of multiple measures and components, which OSU is required to include in the plan to avoid construction related runoff at Driftwood and the UCMF site and minimize adverse effects on aquatic resources.

Our Analysis

Construction of the UCMF site buildings and excavation for cable vault installation at Driftwood would create about 1.2 acres of new impervious surfaces at the UCMF site and repaving the parking lot at Driftwood would maintain about 2 acres of impervious area. Construction activities require the use of fuel and other chemicals, such as coolants, hydraulic fluids, and brake fluids, to operate heavy equipment and vehicles. If not managed properly, runoff during construction of these facilities has the potential to discharge to nearby streams or wetlands and ultimately into the Pacific Ocean.

Adverse effects on water quality could occur during ground-disturbing activities at Driftwood and the UCMF site if sediment-laden runoff or hazardous materials from construction work areas enters nearby streams and the Pacific Ocean. These potential adverse effects would be minimized or avoided by developing and implementing OSU's proposed erosion and sediment control plan, and storm water management plan, and implementing appropriate BMPs (e.g., minimizing impacts to wetlands by maintaining buffers around wetlands, and maintaining natural surface drainage patterns).

3.3.3 Aquatic Resources

3.3.3.1 Affected Environment

Marine Vegetation and Algae

Marine plants offshore the coast of Newport are nonvascular and include phytoplankton and sessile algae. Phytoplankton are simple free-floating uni- and multi-cellular organisms like cyanobacteria, diatoms, dinoflagellates, silicoflagellates, and coccolithophorids. Sessile algae, commonly termed seaweeds, include many species of large brown, green, and red algae. Sessile algae occur in rocky intertidal and subtidal areas of the coast within the photic zone (water depths to which sunlight can penetrate), generally a maximum of 25-meter depth (Oregon DFW 2006). The largest such algae include several species of brown kelp, that along the Oregon coast consist almost exclusively of bull kelp, which grows subtidally. Kelp is valued commercially as a raw material and provides habitat for protected fish species (USACE and EPA 2001, 2008). As a result, canopy kelp has been identified as a Habitat Area of Particular Concern (HAPC) (NOAA 2014c).

No hard or rocky substrate is known to occur within the vast majority of the project area. Rocky geology with the potential to support kelp growth is present in the nearshore area to the north of the subsea cable route. Macrophytes are not expected to occur in the project area because it is primarily deep and sandy, though some macrophytes could occur near any rocky areas in the shallows near shore. Bull kelp, native eelgrass, sea palm, and surf grass are the four species of macrophytes identified in the Oregon DFW's *Oregon Nearshore Strategy* (Oregon DFW 2016).[31] Bull kelp occurs in shallow reef areas. Eelgrass occurs only in intertidal and shallow subtidal habitat with soft sediment and adequate light. Sea palm occupies high-energy rocky shores. Surf grass (*Phyllospadix* spp.) typically occurs in mixed rocky/sandy shores. The cable route has been sited to avoid these habitats, so these species are not expected to occur along the cable route.

Zooplankton, Crab Larvae, and Fish Larvae

The zooplankton community offshore of central Oregon consists of small invertebrate organisms that either spend their entire life cycle in the water column (holozooplankton) or spend only a brief developmental time in the water column before a metamorphosis to an adult life in a nektonic or benthic habitat (merozooplankton). Species composition changes seasonally and is also influenced by various periodic and episodic factors including prevailing ocean currents, coastal upwelling, and offshore wind direction. The coastal zooplankton community offshore of central Oregon is dominated by copepods (EPA 2008, 2009, *cited in* Peterson and Keister 2003). Of the total 58 copepod species reported as being present in these waters, only eight occur throughout the year, seven occur only during the summer, and six occur only in the winter. Abundance is typically lower in the winter than in the summer. During summer, when the offshore winds blow predominantly from the northwest, surface waters move southward and offshore, allowing the deeper, colder, more saline, and nutrient-rich waters to upwell along the coast. Between January and May, the megalops larvae of the Dungeness crab are abundant inshore (DOE 2012).

The plankton community offshore of Oregon also includes gelatinous planktonic animals such as jellyfish, salps, doliolids, and ctenophores. Jellyfish, including the

---

[31] The *Oregon Conservation Strategy* and its marine component, the *Oregon Nearshore Strategy*, provide a conservation blueprint for actions to benefit Oregon's native fish and wildlife and their habitats. The Nearshore Strategy does not create or recommend any specific regulations, but rather, it presents recommendations that prioritize Oregon DFW's management of marine fish and wildlife and identifies potential areas of opportunity for other public or private entities, state and local agencies, and tribes to contribute to the sustainability of Oregon's nearshore resources. Using these criteria, 53 Strategy Species were designated, based on the species status (overharvested, rare, declining population, etc.), ecological importance, vulnerability to human or natural factors, and economic, social and cultural importance fisheries, tribal significance, etc.

brown sea nettle, may be numerous in certain locations in summer and fall (NMFS 2012c).

In general, species assemblages of fish larvae in Oregon are classified into three categories: coastal, transitional, and offshore. Of these, species belonging to the coastal assemblage occur in the project area and are typically dominated by smelt larvae, accompanied by English sole, sand lance, sanddab, starry flounder, and Pacific tomcod larvae (DOE 2012). The highest fish larval abundance typically occurs between February and July (USACE and EPA 2001). Northern anchovy, slender sole, rockfish, northern lampfish, and blue lanternfish are the dominant taxa along the Newport Hydrographic Line (43.65°N), which is a major long-term regional monitoring line, and includes a NOAA zooplankton sampling transect that runs west of Newport for approximately 200 nautical miles (Auth et al. 2007).

Benthic Invertebrates

Benthic invertebrate communities inhabiting the nearshore marine environment provide important secondary production in marine food webs and are integral to the breakdown and recycling of organic material in the marine ecosystem. They also provide a key food source for important commercial and recreational fish and macroinvertebrate species like Dungeness crab, as well as for other protected or managed fish species.

OSU has conducted surveys at least three times per year for 5 years at PacWave North, and EPA's Ocean-Dredged Material Sites dredge disposal monitoring has also occurred in the area since 1986. Therefore, the range of variability in species composition and abundance in the area and seasonal and inter-annual patterns are well characterized. To further characterize the bottom type in and around the project area and describe the presence and abundance of macrofaunal invertebrate species, benthic habitat stations at PacWave South and PacWave North were surveyed from 30 to 60 meters from August 2013 to June 2015 (8 total surveys), and in 2015 a 70-meter station was added at the WEC test site, which was surveyed in April and June (Figure 3-6) (Henkel 2016a).

Thirty-nine macrofaunal taxa were collected during box core sampling in 2013 (selected to show representative data) at PacWave South (approximately 60-meter depth) and 117 macrofaunal taxa were collected in the larger benthic study area (30-60-meter depths, Figure 3-6). Abundance of species with more than 10 organisms collected during the 2013 sampling from 28 0.1-m^2 grabs is summarized in Table 3-4. Polychaetes were the most abundant taxa at the project site. The macrofaunal species assemblages identified at PacWave South were consistent with those collected at PacWave North over the same time period (2013-2015), and they varied in response to depth and median grain size (Henkel 2016a). Two major "assemblages" of macro-invertebrates were described for the vicinity of PacWave South: a deeper, larger grain size-associated assemblage, and a smaller grain size-associated assemblage. At 50-meter, two different assemblages were detected; however, the stations with larger median grain size (PUD and SBC; Figure 3-6) had similar invertebrates to the 60-meter stations. This suggests that, at these depths, differences in species assemblage are more strongly related to the sediment characteristics than the specific depth (Henkel 2016a).

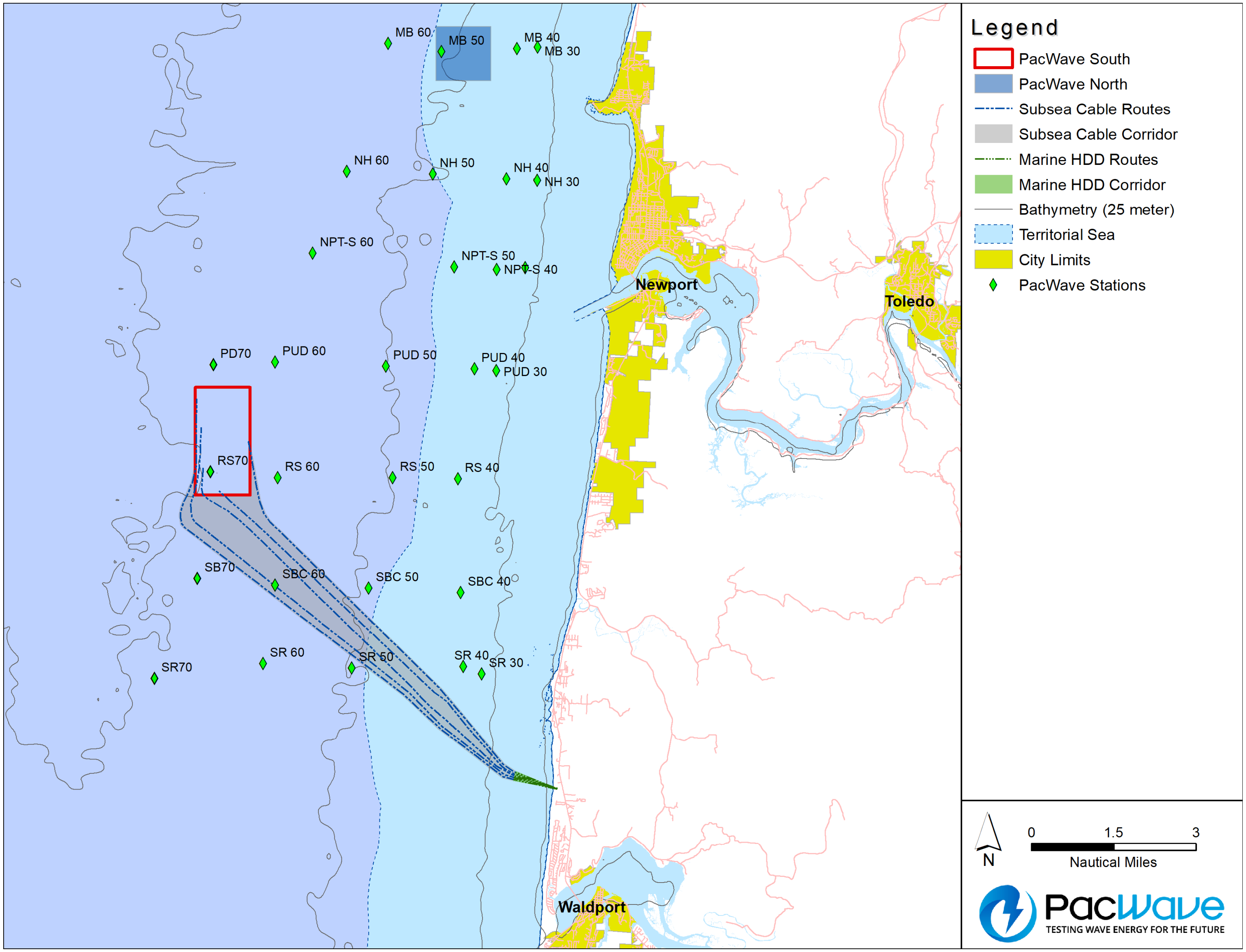

Figure 0-6. OSU sampling stations at PacWave South and vicinity (2013-2015).

Table 0-4. Most abundant invertebrates (more than 10 organisms) collected in 2013 at depths ranging from 30-60 meters.

Species	Total	PacWave South	Species	Total	PacWave South
Molluscs – Bivalves			**Polychaetes**		
Acteocina sp.	13		*Axiothella rubrocincta*	25	6
Axinopsida serricata	286	8	*Chaetozone bansei*	59	
Macoma carlottensis	28		*Chaetozone* sp.	21	
Nutricola lordi	663	56	*Euclymeninae* juv	31	7
Tellina nuculoides	74	20	*Glycera oxycephala*	20	9
Molluscs – Gastropods			*Glycinde armigera*	10	1
Alia gausapata	51	1	*Heteromastus filiformis*	11	1
Callianax baetica	59	11	*Leitoscoloplos pugettensis*	12	
Callianax biplicata	26		*Magelona sacculata*	339	
Callianax pycna	67		*Mediomastus californiensis*	19	
Cylichna attonsa	118	8	*Nephtys caecoides*	75	3
Crustaceans			*Nephtys* sp. juv	45	5
Ampelisca careyi	53	2	*Notomastus latericeus*	10	1
Balanus crenatus	20		*Onuphis iridescens*	23	
Bathycopea daltonae	10		*Ophelia assimilis*	165	43
Cheirimedeia cf. macrodactyla	26		*Phyllodoce hartmanae*	28	5
Cheirimedeia macrocarpa ss. americana	24		*Scolelepis squamata*	83	31
Cylindroleberididae	11	1	*Spio cf. thulini*	111	1
Diastylopsis dawsoni	14	14	*Spiophanes berkeleyorum*	43	
Eohaustorius sawyer	30		*Spiophanes norrisi*	3,685	173
Gibberosus myersi	7	3	**Nemerteans**		
Majoxiphalus major	43		*Carinoma mutabilis*	100	1
Photis macinerneyi	21		*Micrura* sp.	14	2
Rhepoxynius vigitegus	22		*Tubulanus* sp. A	20	2
			Echinoderms		
			Dendraster excentricus	151	
			Phoronids		
			Phoronis sp.	44	

Note: Results presented are number of organisms collected for larger project vicinity (*Total*, 28 grab samples) and within the project Site (*PacWave South*, 4 grab samples).

Principal findings from benthic monitoring (box cores, trawls, and videography) at PacWave North from May 2010 to December 2011 (10 total surveys; Henkel 2011) included:

- Two distinct sediment types: silty sand at approximately 30 meters, and potentially shallower; and nearly pure sand at 40 meters and deeper;
- Distinct macrofaunal invertebrate assemblages occur in the two sediment types;
- Distinct macrofaunal invertebrate assemblages occur at the deeper stations; and
- Mysid and crangonid shrimp are highly abundant and likely form the basis of the food web in this nearshore zone, as opposed to the euphausiid (krill)-supported food web farther offshore.

The soft-bottom habitat offshore at the project is also used by crabs, and the use and distribution of Dungeness crab are of particular interest due to its high value as a commercial fishery. Red and Pacific/brown rock crabs are also high value species that may occur near the project area, but these species prefer harder substrates such as the areas surrounding the Seal Rock Reef.

OSU conducted eight sampling trips in 2013-2015 to characterize crab use near the project area and vicinity by deploying modified crab pots to measure along-shelf and cross-shelf crab distribution (Henkel 2016b). Within the 40-meter contour, there were no differences in crab abundance between the project area and stations to the north or south; likewise, within the 60-meter contour, there were no differences between the project area and stations to the north or south. There were significantly more crabs collected from the 40-meter stations than at the 60-meter stations. There were some temporal differences in the number of crabs collected, the ratio of males to females, and the size of collected crabs; however, no consistent seasonal patterns were apparent.

Oregon DFW identified 14 invertebrate species as strategy species under its Oregon Nearshore Strategy: blue mud shrimp, California mussel, Dungeness crab, flat abalone, native littleback clam, ochre sea star, Olympia oyster, Pacific giant octopus, purple sea urchin, razor clam, red abalone, red sea urchin, rock scallop, and sunflower star (ODFW 2016). Most of the invertebrates are associated with rocky shore or rocky subtidal habitat and therefore a low likelihood that these rocky habitat-associated species would regularly occur in the project area. Dungeness crab and giant octopus area associated with soft bottom habitats and are expected to regularly occur in the project area. Similarly, razor clams occur in sandy beaches like the beach areas that would be crossed by the subsea cable.

Fish

Marine Project Area

The nearshore and offshore regions of the project area encompass soft bottom subtidal habitats and the open water pelagic environment and are in the vicinity of rocky bottom habitats. This area, therefore, supports a variety of fish species that typically inhabit all three habitats with frequent movement of fish between them. Typical fish species that inhabit these areas are discussed below. Although hard bottom substrate is not known to be present in the project site or along the cable route, natural subtidal reefs closer inshore of the WEC test site and to the north of the cable route support pelagic and benthic fish communities that are associated with rocky, rather than soft, substrates.

Fish species commonly observed in sandy and soft bottom areas offshore of the coast of Newport include English sole, butter sole, Pacific sanddab, speckled sanddab, and starry flounder (USACE and EPA 2010, Henkel 2011). Other fish species commonly associated with shallow and deep soft bottom habitats include bat ray, calico surfperch, grunt sculpin, lumptail sea robin, Pacific electric ray, Pacific hooker sculpin, pricklebreast poacher, pygmy poacher, roughback sculpin, saddleback gunnel, sailfin sculpin, sharpnose sculpin, silver surfperch, spotfin surfperch, sturgeon poacher, tubesnout, walleye surfperch, and white surfperch (ODFW 2006). Sampling at PacWave North found butter sole, English sole, and speckled sanddab as the most abundant species during the spring and fall in 2012 (Table 3-5), which may also be representative of the fish species that occur at PacWave South.

Table 0-5. Total number of fish (by species and month) collected in 2012 beam trawl tows at PacWave North.

Common name	Scientific name	June (9 tows)	September (9 tows)	November (7 tows)
Butter sole	*Isopsetta isolepis*	130	20	6
English sole	*Parophrys vetulus*	77	47	56
Speckled sanddab*	*Citharichthys stigmaeus*	80	149	65
Pacific sanddab*	*Citharichthys sordidus*	9	35	23
Sanddab spp.*	*Citharichthys* spp	36	7	3
Sand sole	*Psettichthys melanostictus*	37	7	1
Pacific Tomcod	*Microgadus proximus*	43	46	0
Pacific sand lance	*Ammodytes hexapterus*	3	4	0
Whitebait smelt	*Allosmerus elongatus*	0	12	0
Juvenile smelt	*Osmeridae* spp.	2	0	0
Pacific staghorn sculpin	*Leptocottus armatus*	1	3	0
Showy snailfish	*Liparis pulchellus*	1	0	0
Snailfish sp.	*Liparidae* spp.	2	0	0
Warty poacher	*Chesnonia verrucosa*	5	0	1

Common name	Scientific name	June (9 tows)	September (9 tows)	November (7 tows)
Tubenose poacher	*Pallasina barbata*	0	0	2
Big skate	*Raja binoculata*	0	1	2
Spotted ratfish	*Hydrolagus colliei*	0	1	0
Rex sole	*Glyptocephalus zachirus*	1	0	0
Dover sole	*Microstomus pacificus*	0	1	0
Bay pipefish	*Syngnathus leptorhynchus*	0	1	1
Canary rockfish	*Sebastes pinniger*	0	1	0

Note: *Reduction in sanddab spp. from June to September and increased numbers of speckled and Pacific sanddab is because fish were larger later in the year and able to be identified to species. The same transition is the case for smelt.

Rocky subtidal or hard bottom habitats typically experience a wide variety of wave and current regimes, substrates, depths, and food sources, producing diverse biological communities (ODFW 2006). Rocky reefs provide important habitat for fish species that include sculpins, surf perch, and rocky reef fish. Shallow reefs up to 20 meters (66 ft) in depth are dominated by black rockfish, while deeper reefs (20-50 m) are dominated by lingcod, yellow rockfish, and black rockfish (USACE and EPA 2001). Although areas of rocky subtidal habitat are located outside the project area, juvenile lingcod and rockfish would likely use pelagic and soft bottom habitats, and older mature fish typically associated with rocky subtidal habitats would often be found swimming in the deeper soft bottom regions. For example, reef associated canary rockfish and tubenose poacher were captured in low numbers during beam trawls at PacWave North (Table 3-5). Accordingly, lingcod and rockfish may be present in the project area to a limited extent.

A number of environmental factors affect the fish species present in the pelagic zone, including light penetration, water temperature, proximity to river plumes, and underwater currents (ODFW 2006). Pelagic species commonly found in the area include Pacific herring, northern anchovy, and Pacific Ocean perch. The area is also used by salmon, steelhead, and shad that migrate alongshore, including some stocks that migrate through the Yaquina Bay estuary to spawn upriver (USACE and EPA 2001).

The species predominantly caught by sport fisheries in ocean waters outside of the Port of Newport and to the immediate north and south, including the project site, consist of various species of rockfish, salmon, lingcod, tuna, and Dungeness crab. Pacific halibut and salmon fishing are the most popular recreational fishing activities (Pacific Recreational Fishing Information Network from the years 2004 to 2009 *cited in* DOE 2012). Commercial and recreational fishing are further discussed in Section 3.3.6. Federally listed species are discussed in Section 3.3.5.

Oregon requires state agencies to protect and promote the recovery of state listed endangered or threatened species. Such listed species that may occur in the project area include Lower Columbia River Coho salmon (endangered), Snake River Chinook salmon (threatened), green sea turtle (endangered), leatherback sea turtle (endangered), loggerhead sea turtle (threatened), and the Pacific Ridley sea turtle (threatened; ODFW 2018). These species are also federally listed and discussed in Section 3.3.5.

Oregon also identifies fish species in its Oregon Nearshore Strategy for special management consideration; these include the bony and cartilaginous fish listed in Table 3-6 (ODFW 2016). In general, fish species associated with neritic and soft bottom subtidal habitat are most likely to occur in the project area. However, some fish species associated with rocky habitat may still use soft bottom habitat, like those present in the project area, for some portion of their life history. Therefore, all fish species identified in the Oregon Nearshore Strategy could be present in the project area at some time with the possible except of wolf eel, which are solely associated to rock reef habitat.

Table 0-6. Strategy Species habitat usage, by life history phase: Adult (A), Spawning/Mating (S/M), Eggs/Parturition (E/P), Larvae (L), Juveniles (J).

Strategy Species	Rocky Shore	Sandy Beach	Rocky Subtidal	Soft Bottom Subtidal	Neritic	Estuarine	Habitat Unknown	Comments
Big skate *Raja binoculata*				A, S/M, E/P, J				Soft seafloor spawning habitat. May be affected by wave energy development.
Black rockfish *Sebastes melanops*	J		A, J	J	A, L, J	A, J	S/M, E/P	
Blue rockfish *Sebastes mystinus*	J		A, S/M, J	J	L, J	J	E/P	
Brown rockfish *Sebastes auriculatus*			A, S/M, E/P, J			A, S/M, E/P, L, J		
Cabezon *Scorpaenichthys marmoratus*	J		A, S/M, E/P, J		L, J	A, S/M, E/P, L, J		
Canary rockfish *Sebastes pinniger*	J		A, E/P, J	J	L, J		S/M	Would inhabit artificial reefs.
China rockfish *Sebastes nebulosus*			A, E/P, J		L, J		S/M	Would inhabit artificial reefs.
Chinook salmon *Oncorhynchus tshawytscha*			A		A, J	A, J	A, J	Anadromous; substantial data gaps regarding habitat usage in nearshore waters; sometimes caught near rocky reefs and in open neritic waters.
Chum salmon *Oncorhynchus keta*					A, J	A, J	A, J	Anadromous; substantial data gaps regarding habitat usage in nearshore.
Coastal cutthroat trout *Oncorhynchus clarki*					A, J	A, J	A, J	Anadromous; substantial data gaps regarding habitat usage in nearshore waters.
Coho salmon *Oncorhynchus kisutch*					A, J	A, J	A, J	Anadromous; substantial data gaps regarding habitat usage in nearshore waters.
Copper rockfish *Sebastes caurinus*			A, J	J	E/P, J	A, S/M, E/P, L, J		Would inhabit artificial reefs.
Deacon rockfish *Sebastes diaconus*	J		A, S/M, J	J	A, L, J	A, J	J	Newly described cryptic species found in OR waters.
Eulachon *Thaleichthys pacificus*					A, L, J	A, L		Anadromous; spawn in fresh water. Also school offshore.
Grass rockfish *Sebastes rastrelliger*	J		A, E/P, J	J	L			Shallow rocky reefs; sometimes found in tidepools.

Strategy Species	Rocky Shore	Sandy Beach	Rocky Subtidal	Soft Bottom Subtidal	Neritic	Estuarine	Habitat Unknown	Comments
Green sturgeon *Acipenser medirostris*	A		A	A	A	A, S/M, E/P, L, J		Northern DPSlisted as species of concern. Uses all nearshore waters and estuaries. Most marine-oriented of sturgeon species.
Kelp greenling *Hexagrammos decagrammus*			A, S/M, E/P, J		L, J	A, S/M, E/P, L, J		Would inhabit pilings and jetties.
Lingcod *Ophiodon elongatus*			A, S/M, E/P, J	A, J	L, J	A, S/M, E/P, L, J		Would inhabit pilings and jetties.
Longfin Smelt *Spirinchus thaleicthys*					A, J	A, J		Anadromous fish that utilizes estuaries and coastal waters but spawns in freshwater rivers. Life cycle requires estuarine conditions. Only known to occur in waters near Columbia River, Yaquina Bay, and Coos Bay in Oregon and those estuaries and rivers
Northern anchovy *Engraulis mordax*					A, S/M, E/P, L, J			Pelagic forage fish; commonly found in nearshore kelp beds and bays.
Pacific herring *Clupea pallasii*					A, J	A, S/M, E/P, L, J		Pelagic forage fish. Utilizes estuary spawning habitat in OR.
Pacific lamprey *Entosphenus tridentatus*							A	Anadromous. Requires fine gravel beds in freshwater for spawning. Gaps in knowledge of habitats used in marine life history phase.
Pacific sand lance[2] *Ammodytes hexapterus*		S/M, E/P			A, L, J			
Pile perch *Rhacochilus vacca*			A	A		A	S/M, E/P, J	Rocky shores; around kelp, pilings and underwater structures. Unknown habitat associations for some life history stages.
Quillback rockfish *Sebastes maliger*			A, E/P, J	J	L, J	A, S/M, E/P, L, J		Would inhabit artificial reefs.
Redtail surfperch *Amphistichus rhodoterus*				A		S/M, J	E/P	Juveniles and adults found in estuaries along CA and OR coasts. Unknown habitats for some life history stages. Estuaries and sandy surfzone.
Rock greenling *Hexagrammos lagocephalus*			A, E/P, J	A		S/M, J	E/P	Found in subtidal algae beds and rocky reefs during spawning.
Shiner perch *Cymatogaster aggregata*			A	A		A, J	S/M, E/P	Adults are common in estuaries as prey for salmonids.

Strategy Species	Rocky Shore	Sandy Beach	Rocky Subtidal	Soft Bottom Subtidal	Neritic	Estuarine	Habitat Unknown	Comments
Spiny dogfish *Squalus acanthias*			A, J	A, E/P, J	A, S/M, J	A, E/P, J		
Starry flounder *Platichthys stellatus*			L, J	A, S/M, J	E/P, L	A, S/M, E/P, L, J		Would inhabit areas with pilings.
Striped perch *Embiotoca lateralis*			A, J		A	A, J	S/M, E/P	Unknown habitats for most life history stages.
Surf smelt *Hypomesus pretiosus*		S/M, E/P		S/M	A, L, J	A		Extremely specialized habitat requirements for spawning beaches (temperature for substrate and air, light). Intertidal spawning habitat on beaches.
Tiger rockfish *Sebastes nigrocinctus*			A				S/M, E/P, L, J	Rocky reefs. Note that this is designated shelf rockfish in federal FMP, but defined as nearshore fish in ORS and is a component of both commercial and sport fishery harvest in nearshore waters. Would inhabit artificial reefs.
Topsmelt *Atherinops affinis*			A	A	A, J	A, S/M, E/P, L, J		Specialized spawning habitat in shallow waters with vegetation for eggs to adhere to.
Vermilion rockfish *Sebastes miniatus*			A, J	J	L, J		S/M, E/P	Rocky reefs; life stage history gaps. Would inhabit artificial reefs.
Western river lamprey *Lampetra ayresii*							A	Anadromous. Movements and habitat use of adult life stage for the approximately 10 weeks they are in marine habitats are poorly understood, but thought to be limited to nearshore and estuarine areas.
White sturgeon *Acipenser transmontanus*				A		A, L, J		Anadromous. Movements in marine habitats poorly understood.
Wolf-eel *Anarrhichthys ocellatus*			A, S/M, E/P, J		J		L	Benthic, rocky subtidal.
Yelloweye rockfish *Sebastes ruberrimus*			A, E/P, J				S/M, L	Would inhabit artificial reefs. Juvenile usage of nearshore.
Yellowtail rockfish *Sebastes flavidus*	J		A, S/M, E/P, J	A, S/M, E/P, J	L, J			Juvenile usage of nearshore.

Source ODFW 2016.

Aquatic Invasive Species

Washington Sea Grant has reported that aquatic invasive species which have the potential to be transported to Northwest coastal waters by marine vessels include the Chinese mitten crab and European green crab. Relicensing studies did not document the occurrence of these species within the marine project area.

Surface Waters

The terrestrial project area is located in the Beaver Creek-Waldport Bay watershed (HUC 1710020505), a subunit of the Northern Oregon Coast watershed. Aquatic habitat in the watershed is limited by factors including spawning gravel quantity, summer rearing habitat complexity, and large wood (OWEB 2008). Streams in the project area are low gradient with high sediment loads and highly vegetated banks. One fish-bearing stream was identified in Driftwood during a wetland and waterway survey in May 2016 and June 2017. In addition to Friday Creek, two other fish-bearing streams, Buckley Creek and "Stream 4", were also identified during the 2019 wetland and waterway along the terrestrial HDD corridor (Figure 3-5). Buckley Creek is reported by Oregon DFW to support anadromous coastal cutthroat trout (*Oncorhynchus clarkia clarkii* [Kelly 2016]) (HDR 2019).

In addition to cutthroat trout, typical freshwater fish species known to occur in smaller streams in the Middle Coast basin include Pacific and brook lamprey, several species of dace, redside shiner, squawfish, chum salmon, coho salmon, rainbow trout, summer and winter steelhead, several species of sculpin, and suckers (ODFW 1972). Regional ESUs of chum salmon, coho salmon, and steelhead are all listed under the ESA and are discussed in detail in Section 3.3.5.1.

Marine Birds

The rocky islands and rugged habitats of the Oregon coast provide habitat for about 1.3 million nesting seabirds of 15 species. The most abundant nesting seabirds include common murres, concentrated in colonies in both northern and southern Oregon, and Leach's storm-petrels, with colonies concentrated in southern Oregon (Naughton et al. 2007, Suryan et al. 2012). The north-central Oregon coast, where the project is located, has extensive sandy beaches and hosts relatively few nesting seabirds (about 6 percent of the Oregon seabird breeding population). Eleven seabird species are known to nest in this region (Table 3-7) with the majority nesting at Yaquina Head located about 15 kilometers northeast of the project. Cormorant and gull species as well as pigeon guillemots, and black oystercatchers nest along the shores south of Newport, potentially in the general vicinity of the shore cable landing. Black oystercatchers, which are restricted to foraging in terrestrial shore habitats, may occur near the proposed terrestrial portion of the project. The other seabird species that nest in the area could also occur in and forage in waters around the proposed marine project facilities.

Table 0-7. Breeding seabirds on the North-Central Oregon Coast.

Species	Scientific Name	Number of Breeding Birds[1]
Leach's storm-petrel	*Oceanodroma leucorhoa*	112
Brandt's cormorant	*Phalacrocorax penicillatus*	6,047
Double-crested cormorant	*Phalacrocorax auritus*	843
Pelagic cormorant	*Phalacrocorax pelagicus*	2,396
Black oystercatcher	*Haematopus bachmani*	117
Common murre	*Uria aalge*	98,315
Pigeon guillemot	*Cepphus columba*	1,329
Cassin's auklet	*Ptychoramphus aleuticus*	20
Rhinoceros auklet	*Cerrorhinca monocerata*	5
Tufted puffin	*Fratercula cirrhata*	15
Western/Glaucous-winged gull	*Larus occidentalis/Larus glaucescens*	2,224

[1] Based on the most recent survey data (2008-2009) from Colony Groups 8-16 (Suryan et al. 2012).

In addition, Oregon coastal waters also provide important foraging habitat for several seabird species throughout the year, particularly in the fall, as millions of marine birds that breed elsewhere (e.g., auklets, albatrosses, shearwaters, loons, grebes, sea ducks, and gulls) migrate to Oregon's productive coastal waters to feed (Naughton et al. 2007, Suryan et al. 2012). Based on aerial surveys conducted from 2011-2012 from Fort Bragg, California to Grays Harbor, Washington and from shore to 2,000-meter depth (e.g., inner-shelf waters to continental slope waters), the highest marine bird densities occurred along the entire nearshore (less than 100-meter depth) Oregon coast during fall (49.4 ± 5.0 birds/km^2), with smaller but similar densities in winter and summer (37.4 ± 4.6 birds/km^2 and 37.5 ± 6.4 birds/km^2, respectively; Adams et al. 2014). Common murres and sooty shearwaters are the most abundant seabirds along the Oregon coast in spring and summer (Strong 2009, Suryan et al. 2012, Zamon et al. 2014), including the project area based on boat and aerial surveys conducted in the inner shelf waters (less than 100-meter depth) around Newport from March-August 2003-2009 (Suryan et al. 2012), in 2011-2012 (Adams et al. 2014), and in 2013-2014 (R. Suryan, unpubl. data).

Focused vessel-based strip transect surveys conducted from 2013-2015 around the PacWave South and PacWave North test sites and along the Newport Hydrographic Line (1.6-40 kilometers from shore) reported common murres and sooty shearwaters as the most abundant species in the project area. Densities of common murres and sooty shearwaters were highest in in the spring (800-1,100 murres/km^2) and fall (100-220 shearwaters/km^2), respectively (Porquez 2016). Relative abundance of these species in the project area was lower relative to adjacent areas, although the whole area appears to be productive foraging habitat for many seabird species (Porquez 2016). Brown pelicans and marbled murrelets were also observed inshore of the WEC test site, and black-footed albatross were only detected west of the site (Porquez 2016).

Aerial surveys from 2011-2012 indicated that the inner shelf waters (less than 100-meter depth) around Newport had an influx of seabirds such as shearwaters, northern fulmars, Cassin's auklets, rhinoceros auklets, and brown pelicans in the fall (Adams et al. 2014). Thus, seabirds would likely occur and forage in the WEC test site throughout the year; abundance would likely be highest in the fall, and species composition would change throughout the year. The seabird species included in Table 3-8 represent a list of species that have been reported in nearshore waters (e.g., 0-20 kilometers from shore) in the vicinity of the test site and could be expected to occur at the test site throughout the year. However, some of these species, including scoters, cormorants, loons, and some gull species (e.g., ring-billed and California gulls), generally occur less than 5 km from shore (Strong 2009), and are therefore unlikely to occur at the test site where the WECs would be deployed (more than 11 kilometers from shore).

Table 0-8. Potential marine bird species around the proposed offshore WEC deployment area based on survey data (Strong 2009, Adams et al. 2014, R. Suryan, unpubl. data, Porquez 2016) and Birds of Oregon (Marshall et al. 2006).

Species	Scientific name	Status	Spring/ Summer	Fall	Winter
Surf scoter[1]	*Melanitta perspicillata*	--	U	U[5, 6]	U[5, 6]
White-winged scoter[1]	*Melanitta fusca*	--	U	U[5]	U[5]
Pacific loon	*Gavia pacifica*	--	U	U[5, 7]	U[5, 6, 7]
Common loon	*Gavia immer*	--	U[7]	U[5, 6, 7]	U[5, 6, 7]
Laysan albatross	*Phoebastria immutabilis*	BCC	U	U	U
Black-footed albatross	*Phoebastria nigripes*	BCC	U[6]	U	U
Northern fulmar	*Fulmarus glacialis*	--	U	C[5]	C[6]
Pink-footed shearwater	*Ardenna creatopus*	BCC	C[6]	C[5, 6]	U
Flesh-footed shearwater	*Ardenna carneipes*	--	U[6]	U[6]	U
Buller's shearwater	*Ardenna bulleri*	--	U	C[5]	U
Sooty shearwater	*Ardenna grisea*	--	C[5, 6, 7, 8]	C[5, 6, 7, 8]	C[6, 8]
Short-tailed shearwater	*Ardenna tenuirostris*	--		C[6, 7]	C[6]
Fork-tailed storm-petrel	*Oceanodroma furcata*	S, CS (N)	U[5]	U[6]	U[6]
Leach's storm-petrel	*Oceanodroma leucorhoa*	S, CS (N)	U[5]	U[6]	U[6]
Brandt's cormorant[2]	*Phalacrocorax penicillatus*	--	C[5, 6, 7, 8]	C[5, 6, 7, 8]	C[5, 6, 7, 8]
Double-crested cormorant	*Phalacrocorax auritus*	--	U[6]	U	U[6]
Pelagic cormorant[2]	*Phalacrocorax pelagicus*	BCC	U[5, 6, 7, 8]	U[5, 6, 7, 8]	U[5, 6, 7, 8]
Brown pelican	*Pelecanus occidentalis*	FD, SE, CS (N)	U[6]	U[5, 6]	U
Red-necked phalarope[3]	*Phalaropus lobatus*	--	C[6, 8]	C[5, 6, 8]	
Red phalarope[3]	*Phalaropus fulicarius*	--	U	C[5]	U
South polar skua	*Stercorarius maccormicki*			U	
Pomarine jaeger	*Stercorarius pomarinus*	--	U	U	U
Parasitic jaeger	*Stercorarius parasiticus*	--	U	U	U

Species	Scientific name	Status	Spring/ Summer	Fall	Winter
Long-tailed jaeger	*Stercorarius longicaudus*		U	U	
Common murre	*Uria aalge*	--	C[5, 6, 7, 8]	C[5, 6, 7, 8]	C[5, 6, 7, 8]
Pigeon guillemot	*Cepphus columba*	--	U[6, 7]	U[6, 7]	U
Marbled murrelet	*Brachyramphus marmoratus*	BCC, FT, SE, CS (CR, N)	U[6, 7]	U[6, 7]	U
Ancient murrelet	*Synthliboramphus antiquus*	--	U	U	U
Guadalupe/Scripps's murrelet	*Synthliboramphus hypoleucus/scrippsi*	SOC	U	U	U
Cassin's auklet	*Ptychoramphus aleuticus*	--	U[6, 8]	C[5, 6, 7, 8]	C[5, 6, 7, 8]
Rhinoceros auklet	*Cerorhinca monocerata*	--	U[6]	C[5, 6, 7]	C[5, 6]
Tufted puffin	*Fratercula cirrhata*	SC, CS (CR, N)	U	U	U
Black-legged kittiwake	*Rissa tridactyla*	--	U	C	C[5]
Sabine's gull	*Xema sabini*	--	U	U	
Bonaparte's gull	*Chroicocephalus philadelphia*	--	U	U	U
Heermann's gull	*Larus heermanni*	--	U	U[6, 7]	U[6]
Mew gull	*Larus canus*	--	U	U	U[6]
Ring-billed gull	*Larus delawarensis*	--	U	U[6]	U[6, 7]
Western gull	*Larus occidentalis*	--	C[5, 6, 7, 8]	C[5, 6, 7, 8]	C[5, 6, 7, 8]
California gull	*Larus californicus*	--	C[5, 6, 7]	C[5, 6, 7]	C[5, 6]
Herring gull[4]	*Larus argentatus*	--	U	C[5]	C[5]
Iceland (Thayer's) gull[4]	*Larus glaucoides thayeri*	--	U	U[5]	U[5]
Glaucous-winged gull	*Larus glaucescens*	--	U[5]	C[5, 6]	C[5, 6]
Caspian tern	*Hydroprogne caspia*	BCC, S, CS (CR, N)	U	U[7]	U
Common tern	*Sterna hirundo*	--	U	U	
Arctic tern	*Sterna paradisaea*	BCC	U	U	

Notes: BCC – Birds of Conservation Concern (FWS 2008); FE – Federally endangered; FT – Federally threatened; FD – Federally delisted; EP – Protected under the Bald and Golden Eagle Protection Act; SOC – FWS Species of Concern; ST – Oregon State threatened; SE – Oregon State endangered; S – Oregon sensitive species list, Sensitive in Coast Range (CR) and/or Nearshore (N) ecoregions; SC – Oregon sensitive species list, Sensitive-Critical in Coast Range (CR) and/or Nearshore (N) ecoregions (ODFW 2016); CS – Oregon Conservation Strategy species, designated in Coast Range (CR) and/or Nearshore (N) ecoregions as needing management attention (Krutzikowsky et al. 2016)

C – Common; U – Uncommon

[1] Surf and white-winged scoters were indistinguishable and thus reported together in aerial surveys (Adams et al. 2014)

[2] Brandt's and pelagic cormorants were indistinguishable and thus reported together in aerial surveys (Adams et al. 2014)

[3] Red and red-necked phalaropes were indistinguishable and thus reported together in aerial surveys (Adams et al. 2014)

[4] Herring and Thayer's gulls were indistinguishable and thus reported together in aerial surveys (Adams et al. 2014)

[5] Species reported from aerial surveys conducted 0-100 meter depth offshore of Newport in 2011-2012 (Adams et al. 2014)

[6] Species reported from boat surveys conducted within 20 km of shore around PacWave South in 2013-2014 (R. Suryan, unpubl. data)

[7] Species reported from boat surveys conducted 0-10 km from shore around PacWave North (<10 km north of PacWave South) in 2013-2014 (R. Suryan, unpubl. data)

[8] Reported as a "dominant" species from boat surveys conducted 1.6-40 km from shore around PacWave South and PacWave North in 2013-2015 (Porquez 2016)

While the brown pelican was federally delisted in 2009 (64 FR 59444), the species remains listed as endangered by the State of Oregon. The California brown pelican subspecies occurs in western North America, and nests on islands off southern California and western Mexico. There is a post-breeding movement of brown pelicans in fall, generally following forage fish in nearshore waters along the west coast including offshore Oregon and Washington. Pelicans roost on offshore rocks and islands, sand bars, and manmade structures such as breakwaters, pilings and jetties (FWS 1983). Although uncommon farther offshore, they could occur occasionally in the project area. They could also occur on the beach in the cable landing area.

Bird species potentially occurring in the vicinity of the inland portion of the proposed project are discussed in section 3.3.4, *Terrestrial Resources*.

Marine Mammals

Marine mammals potentially present in the project area include cetaceans (whales, dolphins, and porpoises), pinnipeds (seals and sea lions), and possibly, sea otters. Table 3-9 lists marine mammal species expected to occur in the OCS waters off Oregon, although many of these species are infrequent visitors to nearshore waters. More detailed information on federally listed whale species is found below in section 3.3.5.1.

The Pacific harbor seal is the most commonly observed pinniped in Oregon, with Steller sea lions present year-round in smaller numbers. Male California sea lions are commonly seen in Oregon from September through May, but female sightings are rare in Oregon. Northern elephant seals are occasionally observed in Oregon coastal areas (ODFW 2011). Figure 3-7 shows pinniped haul-out locations and gray whale sightings along the Oregon coast in the project area. The California sea lion, gray whale, harbor porpoise, killer whale, northern elephant seal, Pacific harbor seal, and Steller sea lion are designated as Strategy Species in the Oregon Nearshore Strategy (Krutzikowsky et al. 2016).

Table 0-9. Marine mammal species found in OCS waters off Oregon (Source: letter from Marine Mammal Commission to FERC filed August 4, 2014).

Pinnipeds	
California sea lion *Zalophus californianus*	Northern elephant seal *Mirounga angustirostris*
Guadalupe fur seal *Arctocephalus townsendi*	Northern fur seal *Callorhinus ursinus*
Harbor seal *Phoca vitulina richardsi*	Steller sea lion *Eumetopias jubatus*
Cetaceans	

Baird's beaked whale *Berardius bairdii*	Minke whale (CA/OR/WA stock) *Balaenoptera cutorostrata*
Blue whale (eastern north Pacific stock) *Balaenoptera musculus*	Northern Pacific right whale *Eubalaena japonica*
Bottlenose dolphin (CA/OR/WA offshore stock) *Tursiops truncatus*	Northern right whale dolphin (CA/OR/WA stock) *Lissodelphis borealis*
Cuvier's beaked whale *Ziphius cavirostris*	Pacific white-sided dolphin (CA/OR/WA stock) *Lagenorhynchus obliquidens*
Dall's porpoise (CA/OR/WA stock) *Phocoenoides dalli*	Pygmy sperm whale *Kogia breviceps*
Dwarf sperm whale *Kogia sima*	Risso's dolphin (CA/OR/WA stock) *Grampus griseus*
Fin whale (CA/OR/WA stock) *Balaenoptera physalus*	Sei whale (eastern north Pacific stock) *Balaenoptera borealis*
Gray whale (eastern and western stocks) *Eschrichtius robustus*	Short-beaked common dolphin *Delphinus delphis*
Harbor porpoise (northern CA/southern OR stock) *Phocoena*	Short-finned pilot whale *Globicephala macrorhynchus*
Humpback whale (CA/OR/WA stock) *Megaptera novaeangliae*	Sperm whale *Physeter macrocephalus*
Killer whale (offshore stock, Southern Residents) *Orcinus orca*	Striped dolphin *Stenella coeruleoalba*
Mesoplodont beaked whales *Mesoplodon spp.*	

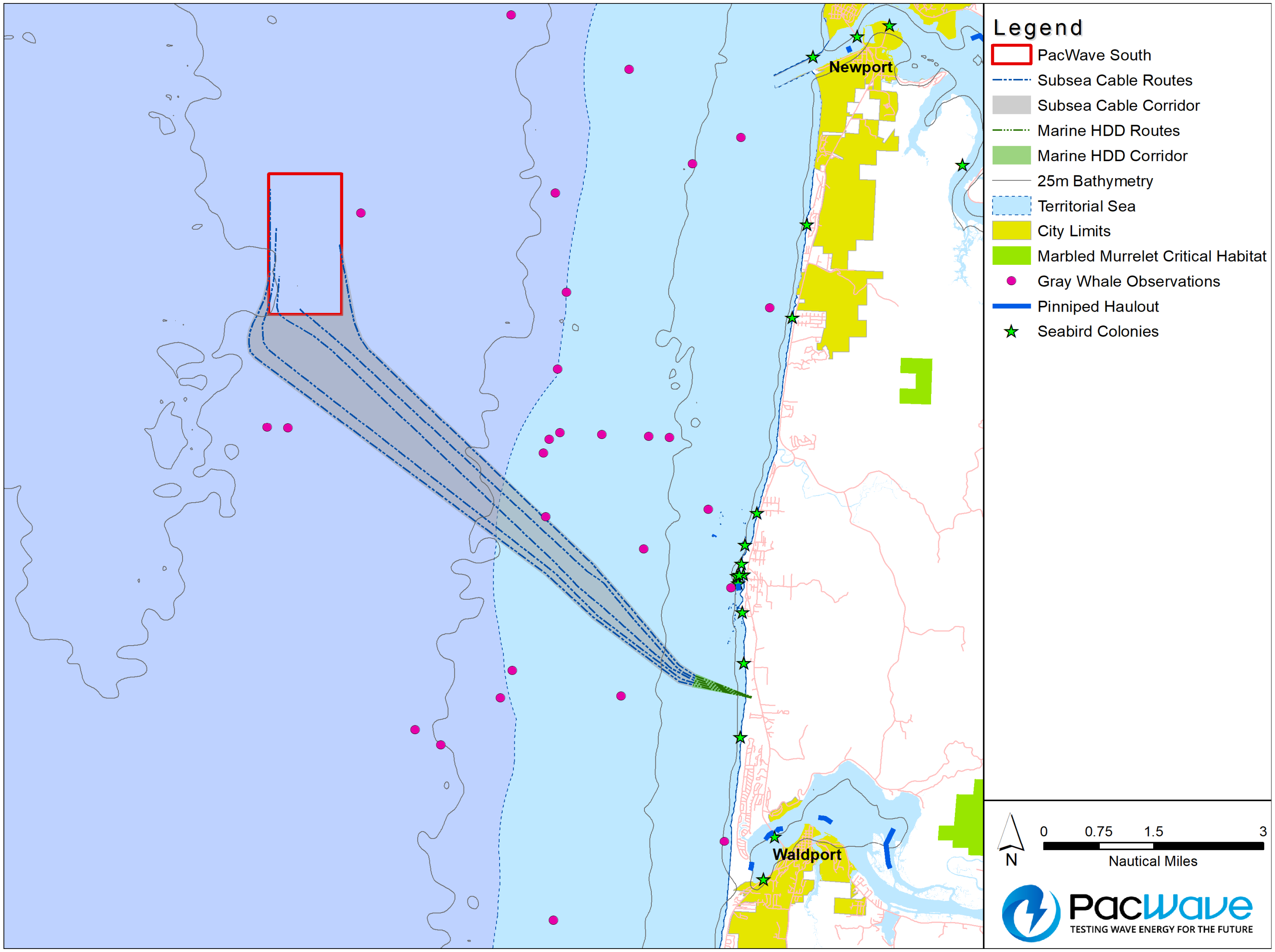

Figure 0-7. Gray whale observations, pinniped haulout sites, seabird colonies, and marbled murrelet critical habitat in project area.

Cetaceans that potentially occur in the project area include transient killer whales, which appear along the Oregon coast in April. Southern resident killer whales are federally listed and are discussed in Section 3.3.5. Cetacean species listed under the federal ESA are also listed as endangered by the state; however, Oregon also lists gray whales as endangered.[32] State threatened species include the sea otter (ODFW 2018), and a few sea otters are occasionally seen along the Oregon coast (FWS 2013). In addition, Oregon DFW considers California sea lion, gray whale, harbor porpoise, northern elephant seal, and Steller sea lion as strategy species in the Oregon Nearshore Strategy (Krutzikowsky et al. 2006).

Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 detected gray whales (17 sightings of 26 total individuals), and rarely, minke whales (1 sighting), at similar depths (0-100 meter depth stratum) as the project area (Adams et al. 2014). Pinnipeds were frequently observed at the 0-100 meter depth stratum; California sea lions were most abundant (76 sightings of 157 individuals), then harbor seals (37 sightings of 53 individuals), northern elephant seals (15 sightings of 16 individuals), Steller sea lion (3 individuals), and northern fur seal (3 sightings of 4 individuals) (Adams et al. 2014).

Gray whales migrate up and down the Pacific Coast between their Alaskan feeding waters (summer) and Mexican breeding grounds (winter). This migration covers 10,000 to 14,000 miles for a round trip (DOI 1989), and it represents the longest migration of any mammal. About 200 to 250 whales from the Eastern North Pacific stock do not migrate to Alaska, but instead remain along the Pacific coast south of Alaska. These animals are referred to as the Pacific Coast Feeding Aggregation (NMFS 2008). Gray whales feed by straining sediment through their baleen, eating primarily invertebrate prey consisting of bottom-dwelling crustaceans, worms and mollusks; the pits generated by their feeding activities are typically less than 15 cm deep (Johnson et al. 1983, Weitkamp et al. 1992). Migrating gray whales occur off Oregon between March and June on their northward migration, and between December and March on their southward migration. OSU researchers conducted three shore-based observational studies on migrating gray whales along the central Oregon coast, using theodolites to provide accurate locations of whales as they passed Yaquina Head (personal communication between OSU and Barbara Lagerquist, Martha Winsor, and Bruce Mate, OSU Marine Mammal Institute, December 1, 2016); the first of these studies characterized the distribution and behavior of gray whales during the 2007/2008 migration, and the other two were part of a study to test the effectiveness of an acoustic deterrent device for gray whales and took place

[32] The gray whale is separated into two DPSs—the eastern and western north Pacific gray whales. Except as noted, gray whale refers to the delisted eastern north Pacific DPS. The federally listed western north Pacific gray whale is discussed in section 3.3.5, *Threatened and En\dangered Species*.

during the 2012 and 2013 migrations. In addition, satellite-tracking studies have also taken place in Oregon and northern California, in 2009, 2012, and 2013, to document long-term movements and distribution of Pacific Coast Feeding Group gray whales. Theodolite observations in 2007/2008 indicated differences between the three migration phases, with locations during southbound migration being the furthest from shore, those during Northbound B migration being the closest, and locations during Northbound A having intermediate distances (Table 3-10). Depths of locations were also significantly different between the three migration phases. Two minke whales, observed during the end of May 2008, were the only other cetaceans seen during the study (Ortega-Ortiz and Mate 2008). Figure 3-7 shows locations of gray whales sighted between 1985 and 2004.

Table 0-10. Distance to shore for gray whale locations obtained using a theodolite at Yaquina Head, Oregon, during shore-based observations of the 2007/2008 migration. (Source: Personal communication between OSU and Barbara Lagerquist, Martha Winsor, and Bruce Mate, OSU Marine Mammal Institute, December 1, 2016).

2007/2008 Distance to shore (nautical miles)							
Migration Phase	**n**	**Mean**	**Standard Deviation**	**Median**	**Min**	**Max**	**Upper Quartile**
Southbound	58	3.9	1.5	4.1	1.4	7.9	5.1
Northbound A	74	2.9	1.1	2.9	0.8	5.4	3.9
Northbound B	38	1.7	1.0	1.5	0.1	4.1	2.6
Overall	170	3.0	1.5	3.0	0.1	7.9	4.0

The acoustic deterrence study was conducted on the southbound and northbound A phases of gray whale migration on the Oregon coast, and did not include any observations from the northbound B phase. Neither distance to shore nor depth of locations differed significantly between southbound and northbound A migration phases in 2012; statistical analysis of 2013 data was not conducted due to heterogeneity of variances (personal communication between OSU and Barbara Lagerquist, Martha Winsor, and Bruce Mate, OSU Marine Mammal Institute, December 1, 2016). The satellite tracking study was conducted on 35 Pacific Coast Feeding Group gray whales tagged between 2009 and 2013 off the coast of central Oregon and northern California. Only high-quality Argos (satellite-based system) locations (those with an error radius of less than or equal to 1,500 m) that fell within the latitudinal borders of Oregon (42.0-46.27 degrees north) were limited to 20 tagged whales with locations within Oregon: mean distance to shore ranged from 0.4-4.6 nautical miles for these 20 whales, and mean depths ranged from 14-76 meters (personal communication between OSU and Barbara Lagerquist, Martha Winsor, and Bruce Mate, OSU Marine Mammal Institute, December 1, 2016).

Harbor porpoises are small cetaceans that occur year-round along the Oregon coast. Porpoise inhabiting the west coast of the U.S. generally do not migrate, rather they have a limited local range (NOAA 2014d). Surveys have shown that harbor porpoise abundance decreases significantly at depths greater than 60 meters (Carretta et al. 2001 *cited in* NOAA 2014d). It is estimated that there are 36,000 harbor porpoises in the northern California/southern Oregon stock, based on 2007-2011 aerial surveys (Forney et al. 2013 *cited in* NOAAd).

Other than gray whales, the seasonal abundance and distribution of marine mammals in Oregon's nearshore waters is not well documented, with a particular lack of data for small cetacean species (porpoises and dolphins). Except for two Global Ocean Ecosystem Dynamics (GLOBEC) surveys conducted in late spring and early summer (Tynan et al. 2005) and gray whale migration observations from shore (Yaquina Head, e.g., Ortega-Ortiz and Mate 2008, personal communication between OSU and Barbara Lagerquist, Martha Winsor, and Bruce Mate, OSU Marine Mammal Institute, December 1, 2016), periodic marine mammal surveys off the Pacific Northwest coast have been restricted to late-summer and fall months (e.g., Carretta et al. 2009). Therefore, OSU conducted visual observations and passive acoustic recordings within and adjacent to the project area to better characterize marine mammal species composition and the spatial and temporal patterns of marine mammal presence in the project area. This effort provides supplemental information on occurrence of species that could interact with project structures or WECs.

In 2014, OSU deployed two seafloor lander hydrophones (similar to the one used at PacWave North for over a year) to record ocean ambient sound levels in frequencies dominated by wind, rain, breaking waves, vessel traffic, and marine mammal vocalizations. The "offshore" lander at PacWave South was placed at a depth of 62 meters in order to locate it near the center of the test site, and the "nearshore" lander was placed at 30-m depth, east of the test site to characterize physical and biological sound sources related to the nearby rocky reef structure. In addition to ambient noise level measurements obtained from acoustic recordings by the hydrophones, a C-POD© was mounted on the offshore PacWave South lander system (Haxel 2019). Species in the greater project area that can be detected by the C-POD include Cuvier's beaked whales, killer whales, false killer whales, short-finned pilot whale, common dolphin, Pacific white-sided dolphin, Risso's dolphin, and harbor porpoise. The offshore lander placed at PacWave South was damaged and not recovered; an acoustic mooring consisting of an AUH hydrophone to record continuously providing frequency content from 5 hertz (Hz)-13 kilohertz (kHz) was then deployed in 2015 (Haxel 2019). The nearshore lander detected humpback whale, killer whale, and harbor porpoise vocalizations during the 4-month period of deployment from April-July 2014. In 2015, Haxel (2019) collected baseline ambient noise levels in the southern region of the PacWave South area for site characterization. During this deployment, humpback whale vocalizations were observed with increasing regularity from early September through the end of recording in November 2015 (Haxel 2019). OSU also made a series of short term (~10 days) deployments between May and October 2014 of lightweight moorings equipped with specialized DMON (Digital Monitoring) tag recorders on lease from Woods Hole Oceanographic Institution. The DMONs recorded on a duty cycle 1 minute of every 10-minute period, capturing acoustic data and targeting bioacoustics signals up to 200 kHz. DMON deployments indicated frequent and regular use of the project area from May-October by harbor porpoise, with higher levels of acoustically active animals at the inshore (30-depth) than offshore (PacWave South) stations (Haxel 2019, Henkel et al. 2019).

OSU conducted vessel-based, standard-line transect surveys from October 2013 to September 2015 (a total of 37 cruises) in the PacWave South and PacWave North Project areas, and along the Newport Hydrographic Line, a cross-shelf line that extends west of Newport for approximately 40 km (Henkel et al. 2019). A total of 209 marine mammals and 10 species were observed (Table 3-11).

Table 0-11. Marine mammal species observed near the PacWave South and PacWave North Project areas and along the Newport Hydrographic Line, October 2013 to September 2015.

Species	Individuals observed
Harbor porpoise	81
Gray whale	24
Pacific white sided dolphin	22
Humpback whale	20
Steller sea lion	20
California sea lion	14
Dall's porpoise	7
Unidentified sea lion	7
Killer whale	4
Unidentified whale	3
Unidentified porpoise	3
Harbor seal	2
Fin whale	1
Unidentified cetacean	1
Total:	**209**

Feeding Biologically Important Areas (BIAs) have been delineated for gray[33] and humpback whales in the general project area (Figure 3-8). The feeding BIA for gray whales is approximately 199 square km (Calambokidis et al. 2015) and occurs inshore of the proposed PacWave South Project area. The feeding BIA for humpback whales is approximately 2,573 square km area (Calambokidis et al. 2015) and includes the project area. Calambokidis et al. (2015) indicated gray whales and humpback whales would primarily occur in the associated feeding BIAs from May to November.

[33] Pacific coast feeding group, a sub-population of Eastern North Pacific gray whales.

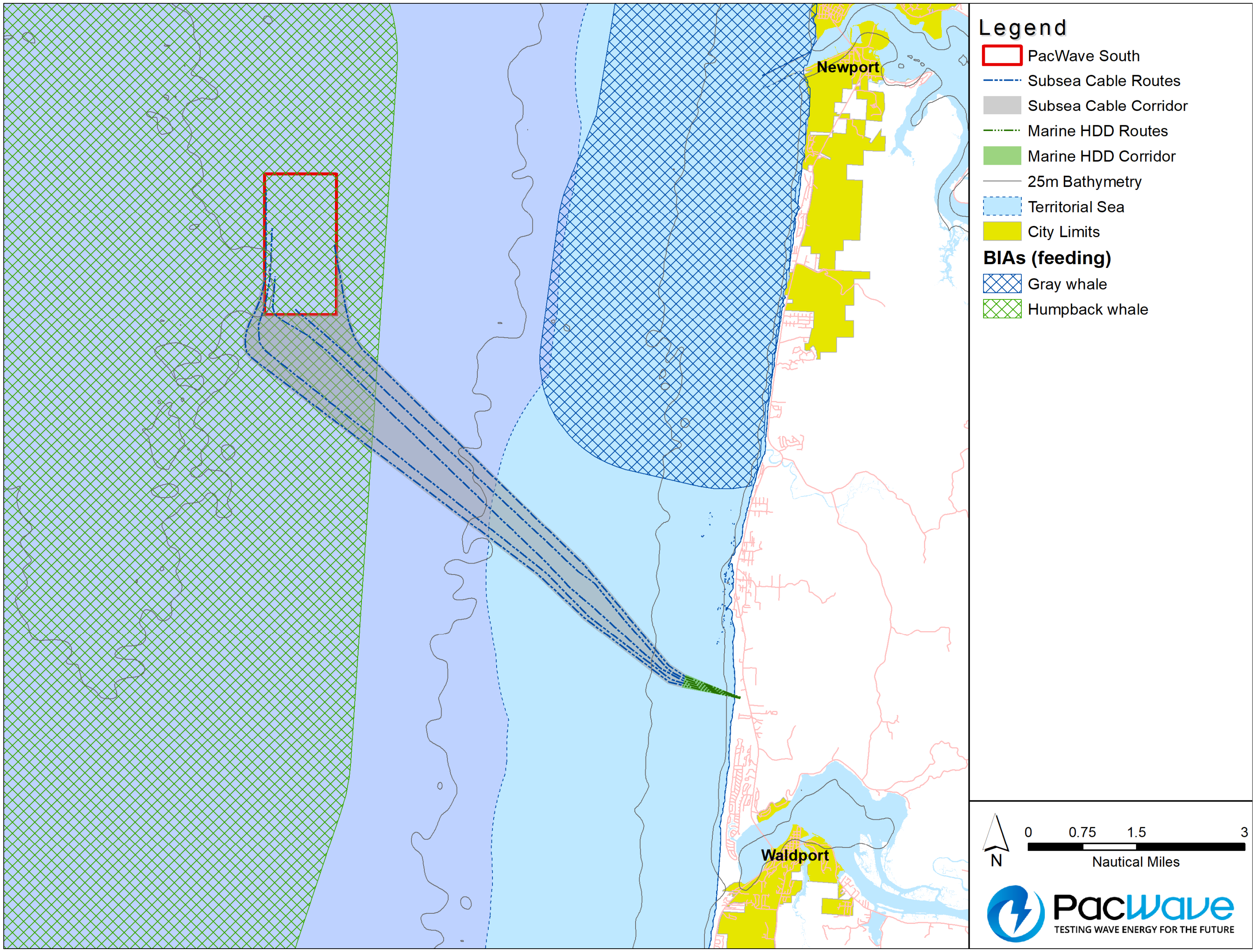

Figure 0-8. Feeding Biologically Important Areas (BIAs) for gray and humpback whales in the project area (NOAA 2018).

Bats in Marine Environment

Bat species that could occur in the marine project area include hoary bats, which are known to migrate south in autumn offshore and along the coast of central California (Cryan and Brown 2007). Although eastern red bats are known to migrate offshore along the mid-Atlantic (Hatch et al. 2013) and western red bats are also known to migrate offshore of central California (Cryan and Brown 2007), western red bats do not occur north of the California-Oregon border. Therefore, western red bats are not expected to occur in the marine project area. No other species of bats are expected to occur in the marine project area based on the lack of museum records and literature. Bat species potentially occurring in the proposed terrestrial portion of the project are discussed in section 3.3.4, *Terrestrial Resources*.

3.3.3.2 Environmental Effects

Effects of Habitat Alteration on the Benthic Community from Project Structures

The presence of project structures on the seafloor would result in disturbance to the benthic community including demersal fish. OSU proposes to bury subsea cables at a depth of 1-2 meters, to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor and to avoid crossing areas with rocky reef and hard substrate to the maximum extent practicable to protect sensitive habitat features. In areas where a cable cannot be buried or persistently becomes unburied, that portion of the cable would be on the seafloor and would be protected by split pipe, concrete mattresses or other cable protection systems. In addition, OSU proposes to develop and implement an anchoring plan for vessels, which may anchor at the project site, that avoids anchoring in known rocky reef or hard substrate habitats to the maximum extent practicable; and minimizes the use of anchors within the project area wherever practicable by combining onsite vessel activities.

OSU proposes to implement (1) the Organism Interactions Monitoring Plan to monitor changes to demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the project facilities or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs, and (2) the Benthic Sediments Monitoring Plan to track changes to benthic habitat in the vicinity of project components (i.e., anchors) to determine what (if any) changes in sediment characteristics result in changes to the benthic invertebrate and demersal fish communities, and implement mitigation measures, if warranted.

The objective of the Organism Interaction Monitoring Plan is to document changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the installed components or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs. Monitoring would assess differences in the timing, abundance, and size classes of fish and invertebrate species or species groups that colonize or associate with different types of project structures and facilities on the bottom and in the water column. The annual monitoring results would be evaluated by the Adaptive Management Committee (AMC) for consistent and predictable species associations over time. After 10 years of monitoring, OSU would consult with the AMC regarding the frequency and need of continued organism interaction surveys.

The objective of OSU's Benthic Sediments Monitoring Plan is to document changes to benthic habitat and potential adverse effects on organisms associated with such habitat changes. If results of the field surveys indicate that statistically significant changes to sediment characteristics and/or benthic organism community metrics are detected. adaptive management and mitigation measures to address the unanticipated adverse effects would be implemented by OSU.

Oregon DFW and FWS recommend (10(j) recommendation 1 and 2, respectively) that OSU implement the Organism Interaction Monitoring Plan and Appendix I measure 4 and the Benthic Sediments Monitoring Plan and Appendix I measure 2. NMFS EFH recommendation 1 requires OSU to implement the Organism Interaction Monitoring Plan, the Benthic Sediments Monitoring Plan, and to implement Appendix I measures 2 and 4.

Our Analysis

The subsea cables, extending from the WEC test site to the HDD conduits near shore, would be installed in individual trenches 1 to 2 meters below the seafloor using jet plowing or other trenching methods. This would cause temporary displacement of unconsolidated sediments as the cable is buried. Benthic and infaunal organisms (e.g., amphipods, bivalves, and polychaetes) within the pathway of the plow would be removed, displaced, or killed during the trenching process. Additionally, as the plow moves along the seafloor, slow-moving infaunal or surface-dwelling organisms located in the path of the plow's skids or wheels that span the trench likely would be killed. Mobile invertebrates (e.g., crabs), fish species that feed on or near the bottom, and species that shelter on the bottom at times would likely move away from the immediate vicinity of the anchors and cable and move to nearby areas during deployment and removal activities (Roegner and Fields 2015).

Benthic fauna (e.g., polychaetes, clams, and amphipods) that inhabit the subsea cable route are likely to be adapted to dynamic ecosystems and likely would be unaffected by sediment burial. For example, Maurer et al. (1982) suggest that certain species of bivalves, amphipod crustaceans, and polychaetes can withstand burial under 3 inches of sediment from ocean dredged material disposal. It was also concluded that dredged material disposal associated with the Yaquina Bay OMDS would not affect green sturgeon prey species because many invertebrate prey species are capable of vertical migration through a deposition layer of 0.8 to 2.8 inches, therefore, rehabilitation of prey species at the site occurs within days (EPA 2011). Suspended sediment during cable laying is expected to dissipate quickly and not reach levels that would harm fish in the project area (Vize et al. 2008), and fish would likely move away from the area of disturbance. The width of the jet plow trench would be only about 3 feet wide and would be surrounded by ample undisturbed habitat from which new recruits could be drawn. It is likely that affected areas would be quickly recolonized from nearby undisturbed areas (DOE 2012). Increases in suspended sediment as a result of installing the subsea cable with a jet plow are not expected to adversely affect demersal fish or invertebrates in the project area.

There would be long-term loss of unconsolidated sand habitat within the footprint of the WEC anchors. Suction caisson and plate anchors would be placed into and under the seafloor, and therefore, would have a minimal footprint on the seafloor other than the mooring hardware and line extending from the anchor under the seafloor up to the WEC. The maximum footprint of the anchors would be 19,068 ft^2 (0.4 acre) for the initial development and 90,800 ft^2 (2 acres) for the full build-out (Table 2-1), which is 0.1 percent of the total project site surface area (1,695 acres). These estimates are based on exclusive use of large 34-ft-diameter gravity anchors; however, other types of smaller anchors would likely be used for some of the WECs, and shared anchors may be used for some WECs when feasible, so the actual seafloor footprint is expected to be considerably smaller than these estimates.

Installation of drag embedment anchors requires dragging the anchor a lateral distance across the seafloor to set them at a sufficient penetration (sediment depth). It is anticipated that most of this disturbance would be below the seafloor surface. The spatial extent of habitat modification would vary depending on anchor type and number of anchors, considering some anchor types would be buried and not rest on the seafloor. As anchors are removed, the disturbed areas are expected to recover over time by natural sediment transport processes.

Additional direct disturbance would result from the footprint of any hub, the four subsea connectors (each with a footprint of approximately 30 ft^2), umbilical cables, and the segment of the cables that would be laid on the seafloor in a U-form (looped) spanning a distance of approximately 300 m, that would not be buried to allow access during maintenance activities (the remainder of the cable routes would be buried).

The placement of anchors on the seafloor could result in localized areas of scour or deposition; however, the particle size range found at PacWave South is likely less susceptible to movement than areas having finer grained sediment. Based on reviews of bottom changes resulting from deployment of artificial reefs and offshore oil platforms (Henkel et al. 2014), sedimentary changes could be expected to occur at least 20 meters away from an anchor installation (the actual distance that scour and sediment change occurs would be monitored in the Organism Interactions and Benthic Sediments Monitoring Plans). Based on surveys at PacWave North, changes to benthic conditions (particularly higher proportions of very coarse sand and shell hash accumulation) may also be expected to occur; however, this accumulation is not expected to have a measurable effect on the composition of the macrofaunal community (Henkel and Hellin 2016). Anchors may also reduce available benthic foraging habitat, although the total area lost by anchors would be small, as quantified above.

Whitehouse (1998) mentions that there is only a limited amount of experimental data and numerical studies of the flow field and scouring around gravity installations. However, physical model results at HR Wallingford[34] for the scour around a large cylinder indicated maximum scour depths of 0.064 times the diameter (D) of the cylinder for collinear waves and currents, plus accretions of 0.028 times D in some areas adjacent to the installation (Rance 1980, from Whitehouse 1998). As a representative calculation, for a 10-meter-diameter gravity base anchor at PacWave South, this would amount to 0.64-meter equilibrium scour depth at the upstream side of the anchor and up to 0.28 meter of accretion in lee of the structure. Field observations of scour in sandy sediment have been reported at 0.5 to 1.0 meter for a 10.5-meter-diameter obstruction (Bishop 1980, from Whitehouse 1998). A second calculation was made using the methods of Sumer and Fredsoe (2002): assuming a water depth of 60 meters, a wave height of 10 meters, a wave period of 15 seconds and a 10-meter-diameter anchor, the maximum scour depth was estimated at 1 meter.[35]

Some additional minor and short-term bottom disturbance would be expected from the anchoring of vessels used for installation, maintenance, and environmental monitoring. As noted above, it is anticipated that it would take up to 7 days to install each mooring system and 1 to 2 days to attach a single WEC to the mooring. If an array was installed, which consisted of up to five WECs on individual mooring systems, this process would need to be repeated for each device. Deployment activity would not necessarily be continuous, because weather could delay the start-to-finish timeframe or postpone completion of certain activities. However, actual at-sea activities are not

[34] HR Wallingford is a hydraulics research station based in Oxfordshire, United Kingdom.

[35] Typical extreme wave conditions for this example were obtained from the NOAA NDBC website for Station 46050 – Stonewall Bank, located 20 nautical miles West of Newport, Oregon.

expected to take more than 9 days to install one mooring system and WEC. Based on the experience at PacWave North, the anchoring of support vessels (e.g., for maintenance and monitoring) is typically not required. Because vessel anchoring would be short-term and represent a small disturbance, any effects on the seafloor would be negligible and similar to the anchoring of vessels that occurs regularly along the Oregon coast.

In summary, it is anticipated that scour depths may be up to 1 meter, and scour widths may extend at least as far from the anchors as 20 meters (the actual distance that scour and sediment change occurs would be monitored in the Organism Interactions and Benthic Sediments Monitoring Plans). Including an additional 20-meter- (65 foot) radius around each 34-foot-diameter anchor to consider scour development and sediment re-deposition, the total direct and indirect disturbance surface area is anticipated to be approximately 21,124 feet^2 per anchor (which assumes a 164-foot-diameter of direct and indirect disturbance). For the initial development scenario with 21 anchors, this could result in approximately 10 acres, or 0.6 percent of the total project site being potentially affected. For the full build-out scenario with 100 anchors, this could result in approximately 48 acres, or 3 percent of the total project site being potentially affected.

Changes in benthic habitat as a result of benthic habitat disturbance in the project area could result in changes to prey type or availability for fish in the project area. The NMFS Biological Opinion for PacWave North stated that best available indicator for the level of incidental take associated with changes to benthic habitat was changes in substrate grain size and distribution over a substantial portion of the WEC test site (NMFS 2012c). The Biological Opinion also indicated that the threshold for ESA consultation reinitiation was a change in substrate type (grain size and distribution) from baseline conditions (188 μm to 462 μm) to another state (e.g., from a fine grained to a coarse sand) over 50 percent of the test site, and changes in substrate types from baseline conditions were well below the 50 percent threshold. The project site is also unlikely to exceed this threshold.

In addition, total area of benthic habitat disturbed at the WEC test site would be minor in comparison to surrounding available habitat (for the full build-out scenario, 0.1 percent (2 acres) for direct effects to the seafloor and 3 percent (48 acres) for indirect effects to the seafloor).

Because it is assumed that the project site is a high energy site (based on the existence of larger median grain sizes and low fine sediment percentages), it is estimated that the physical recovery would occur quickly. High energy sites are typically inhabited by opportunistic organisms tolerant of disturbance (Pemberton and MacEachern 1997). At PacWave North, benthic community recovery was rapid (i.e., within 2 months) and species diversity and relative abundances of benthic macroinvertebrates was "indistinguishable" pre- (2010 and 2011) and post-installation (2012-2014) (NNMREC 2015a). Effects at the project are expected to be minimized given that anchor installation/removal is not likely to occur more than once a year in a berth and anchors would likely be deployed for multi-year (e.g., 3-5 year) periods. More specifically, the number of species and species diversity of invertebrates collected in cores around the Ocean Sentinel anchors at PacWave North (about 45 meters deep) were not different from the number of species and species diversity of invertebrates collected from the reference stations at 40 meter and 50 meter depths (NNMREC 2015b). Assuming non-mobile macroinvertebrates are important groundfish prey as well as the organisms most susceptible to disturbance impacts from the project, the best available science suggests that recovery/recolonization times are minimal and there would be no impacts to predators (e.g., sturgeon and groundfish) of these macrofaunal invertebrates. The abundances of mobile, slightly larger prey, such as Crangon shrimp and small fish did not seem to vary in a way attributable to deployment activities at PacWave North. For Crangon biomass collected at PacWave North across twenty months from 2010 to 2014, the only significantly different month was August 2011 when two exceptionally high catches occurred. Other than that, there has been no significant variability across 19 other months of sampling in Crangon biomass at the nine reference stations around the Ocean Sentinel at PacWave North. Fish density at PacWave North was higher in summer 2013 and 2014 than previous years (2010-2012), although the June catches across all years were not actually statistically significantly different. This general increase began in spring 2013, four months before the Ocean Sentinel installation. Overall, any effects on prey availability due to WECs or anchors (if there are any) would be extremely localized. Therefore, any loss of prey species would not significantly reduce prey availability or abundance for fish.

When anchors are removed at the WEC test site, there may be scour holes or settlement pits remaining on the seafloor that would be initially void of macrofauna (due to the previous existence of the anchor). According to Collie et al. (2000) and Dernie et al. (2003) and depending upon the near-bottom hydrodynamics post-anchor removal, the seafloor is expected to revert back to native physical conditions relatively quickly because the substrate comprises sand as opposed to finer, muddy sediments. It is difficult to predict recovery times of the sediment and benthic habitat because their respective recoveries are dependent upon several variables; namely, the near-bottom current magnitudes and directions following disturbance. Occurrences of high energy (i.e., high current velocity) events may act to reshape the seafloor rapidly following disturbances; however, milder hydrodynamics may result in longer durations before the sediment is re-worked and benthos migrate back to the disturbed areas. Dernie et al. (2003) compared recovery rate of benthic assemblages and habitat parameters in different sediment types.[36]

[36] The Dernie et al. (2003) experiment was restricted solely to the intertidal zone so they could facilitate site access for frequent physical measurements. But the scale of the disturbance was "chosen to be relevant to fishing impacts that occur intertidally and subtidally (e.g., digging, raking, dredging and trawling)."

Dernie et al. (2003) stated that “sediment composition is largely controlled by hydrodynamic forces (Snelgrove and Butman 1994, from Dernie et al. 2003), such that clean, coarse sandy bottoms predominate in high-energy environments. Presumably, the communities that inhabit such different sediment types have adapted to very different environmental disturbance regimes (Hall 1994, from Dernie et al. 2003). Many species that are typical of wave-exposed sandy environments exhibit behaviors that enable them to survive daily tidal scouring events” (Gorzelany and Nelson 1987, from Dernie et al. 2003). In general, they found that “clean sand had the most rapid recovery rate following disturbance. It is generally assumed that communities found in dynamic sandy habitats would recover more quickly following physical disturbance than those found in less energetic muddy environments based on the adaptive strategies of the differing assemblages” (Kaiser 1998, Ferns, Rostron and Siman 2000, both from Dernie et al. 2003). Dernie et al. (2003) determined a time on the order of 100 days to return to pre-disturbed conditions. Collie et al. (2000) came to similar conclusions.

The total area of benthic habitat disturbed at the WEC test site would be very small relative to the range and availability of marine habitat for species that use the project area, and minor in comparison to surrounding available habitat (for full build-out, maximum direct effects to the seafloor would occur for about 0.1 percent of the project area [2 acres] and maximum indirect effects to the seafloor would occur for about 3 percent [48 acres] of the project area). Effects at PacWave South are expected to be minimized given that anchor installation/removal is not likely to occur more than once a year in a berth and anchors may be deployed for multi-year periods. Any effects on prey availability due to WECs or anchors (if there are any) is expected to be extremely minor, localized, and temporary, though intermittent throughout the license term. Thus, benthic habitat disturbance is not expected to adversely affect project area fish and invertebrates. Fish species associated with soft bottom habitats that are listed as Oregon Nearshore Strategy species may occur on the sandy bottom habitat within the footprint of the PacWave South Project. These species are unlikely to be affected because they would likely move away from the immediate vicinity of the anchors and cables and move to nearby areas during deployment and removal activities.

Although no difference in macrofaunal assemblages was detected around the Ocean Sentinel anchors after one year of deployment at PacWave North, uncertainty remains regarding the potential long-term changes to benthic habitat, given that PacWave South would be a larger project and a longer deployment time than PacWave North.

Because of uncertainty associated with this new technology and in order to determine the actual effects on demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the project facilities or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs, OSU would implement the Organism Interactions Monitoring Plan and the Benthic Sediments Monitoring Plan under the Adaptive Management Framework to detect changes to benthic habitat in the vicinity of project components (i.e., anchors) to determine what (if any) changes in sediment characteristics result in changes to the benthic invertebrate communities, and implement mitigation measures, if warranted (APEA, Appendix I - measure 4). In addition, implementing OSU's proposed anchoring plan would avoid anchoring in known rocky reef or hard substrate habitats to the maximum extent practicable and minimize anchors use within the project area wherever practicable by combining onsite activities. Implementation of the proposed measures would minimize potential effects on demersal fish and invertebrates (Dungeness Crab).

Changes in the Marine Community Composition, Presence of Biofouling Species, Species Interaction, and Predator-Prey Interactions

WECs, anchors, moorings, umbilicals, hubs, and subsea connectors would introduce structure on the seafloor, in the water column, and at the surface, which could result in changes to marine community composition and behavior and affect project area aquatic life.

OSU proposes to implement an Organism Interactions Monitoring Plan to evaluate pelagic fish associations and biofouling on the anchors/WECs because of the uncertainty associated with this new technology and potential effects on marine habitat and species interactions.

Oregon DFW and FWS recommend (10(j) recommendation 1 and 2, respectively) that OSU implement the Organism Interaction Monitoring Plan and NMFS EFH recommendation 1 requires that OSU implement the Organism Interaction Monitoring Plan.

Our Analysis

Areas of shelter, structure, or cover often are used by fish for protection from predators (Johnson and Stickney 1989). 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), and water column and/or surface structure of up to 20 WECs (each separated by 50 meters to 200 meters or more) and associated moorings and umbilicals. These structures would be placed on sand substrate that is generally lacking vertical habitat features, which could result in localized seafloor habitat changes as the hard structures (e.g., anchors) are deployed. Based on reviews of bottom changes resulting from deployment of artificial reefs and offshore oil platforms, sedimentary changes could be expected to occur at least 20 meters away from an anchor installation (Henkel et al. 2014). Structures would likely become colonized ("biofouled") by algae and invertebrates, such as barnacles, mussels, bryozoans, corals, tunicates, and tube-dwelling worms and crustaceans, termed "biofouling" (Boehlert et al. 2008). Based on surveys at PacWave North, changes to the benthos (particularly shell hash accumulation) may be expected to occur up to 250 meters away from an anchor installation; however, this accumulation does not appear to have a measurable effect on the composition of the macrofaunal community (Henkel and Hellin 2016).

Areas of shelter, structure, or cover provided by the project have the potential to alter predator-prey interaction with increased forage opportunities that attract these species. The change in habitat complexity resulting from the exposure of anchors above the sea floor and any resulting localized scour or shell mounding might also increase habitat complexity and provide habitat for structure-associated fish. Some types of pelagic fish 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 fish through visual and/or olfactory cues (Dempster and Kingsford 2003). If project-related structures do attract marine life regularly, predictably, and in significant numbers, they might also attract larger fish predators, which could then prey on the attracted organisms. Cormorants and brown pelicans might roost on above-surface structures of WECs, and California sea lions might haul out on the structures, and these species may also occasionally prey on fish species that are present. In general, although there is uncertainty about the degree to which marine animals may be attracted to WEC structures, there is no data that suggest that there would be any significant adverse effects to individuals or populations (Copping et al. 2016).

Structure is familiar and usual in the marine environment along the U.S. West Coast, and includes natural and manmade objects in the water column and at the surface such as navigational buoys, kelp, floating debris, piers, and oil platforms, as well as seafloor structure such as large natural rocky reefs, artificial reefs, marine debris, and oil platforms; some types of fish (e.g., rockfish) are known to associate with these structures (Kramer et al. 2015). The following describes their potential use of seafloor, water column, and surface project structures, and potential effects on marine life as a result of changes to marine community composition, forage opportunities, and predator/prey abundances, in the following paragraphs.

<u>Seafloor Structure</u> – Project structures at or near the bottom (e.g., anchors) may act as an artificial reef and provide habitat for structure-oriented fish, such as rockfish (Danner et al. 1994, Love and Yoklavich 2006). Artificial reefs, defined as any manmade structure intentionally or unintentionally placed on the seafloor, are constructed out of a variety of materials including concrete rubble, quarry rock, scrap automobiles and train cars, pipes, shipwrecks, marine debris, tires, and attraction and concentration to these structures by structure-oriented fish is well-known (Caselle et al. 2002, Broughton 2012, Wilhelmsson and Langhamer 2014). Oil platforms, although not entirely analogous to wave energy facilities, are known to provide habitat for reef-associated fish and invertebrates and even contribute to the production of rockfish offshore of southern California (Claisse et al. 2014). Attraction to project structures could alter the fish

species composition in and around the project area by concentrating structure-oriented fish and may also affect predator/prey interactions (Wilhelmsson and Langhamer 2014). The development of an artificial reef or attraction of structure-oriented fish may in turn also attract other predators, including marine mammals and birds. However, PacWave South would differ from artificially constructed reefs in that the anchors and other components would be spaced throughout the project site, with WECs separated 50 to 200 meters or more. In addition, some anchor types would be deployed below the seafloor, and therefore would not contribute to an artificial reef effect.

Anchors and WECs would be installed and removed, during the license term, so changes to marine community composition due to presence of in-water structures would vary over time and the number of WECs being tested (i.e., single WEC versus array testing). Fish attracted to project components (e.g., anchors) could include the deep rocky reef (>25 meter depth) associated fish species listed in the Oregon Nearshore Strategy, and the structure could provide additional habitat, enhanced forage opportunities, and/or expose some of these fish species to increased predation by predatory fish, seabirds, and/or marine mammals. However, most of the Oregon Nearshore Strategy deep rocky reef fish species are also known to occur at the bottom and midwater structures of oil platforms offshore of southern and central California (Casselle et al. 2002, Love et al. 2010), and negative population-level effects on reef-associated species at these oil platforms have not been reported. In fact, the oil platforms contribute to rockfish productivity and have some of the highest secondary production per unit area of any marine habitat studied globally (Claisse et al. 2014). The project would not be expected to have a population-level impact on rocky reef fish due to the small overall footprint and low density of WECs; however, the offshore oil platform studies suggest that artificial structure does not negatively affect rocky reef fish. Thus, the impact on Oregon Nearshore Strategy fish species due to project structures is expected to be minor.

Water Column/Surface Structure – Project structures in the water column and at the surface are unlikely to act as FADs that would attract pelagic fish. In general, fish associations with FADs are not found in temperate waters like they are known to in tropical waters, based on evaluation of the fish assemblages found at various types of natural and manmade structures in marine waters along the U.S. West Coast and in Hawaii (Kramer et al. 2015). At existing wind and wave energy projects (that have both seafloor and vertical structure) in cold-temperate waters of Europe, none of them 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 rockfish, 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), vertical structures of docks and pilings (Gallagher and Heppell 2010), and "SMURFs" (Ammann 2004, Caselle et al. 2010, Woodson et al. 2012, Jones and Mulligan 2014). Given that pelagic fish, such as juvenile and adult salmonids, are highly mobile and movements generally follow available prey, which includes highly mobile pelagic or surface-oriented crustaceans and fish, they could occasionally occur at project structures in the water column and at the surface but are unlikely to remain there. Therefore, pelagic juvenile rockfish could occur at project structures in the water column and at the surface before settling to the bottom, but other typical FAD-associated taxa, such as piscivorous scombrids, are unlikely to occur at PacWave South due to its location in cold-temperate waters.

Given the small size of the project relative to the available marine habitat, it is not anticipated that the addition of project structures to the marine environment would represent a significant change to marine habitat above existing conditions. Any changes to marine community composition as result of the presence of these structures are not expected to adversely affect marine life that could be in the project area. Because of uncertainty associated with this new technology and in order to determine the actual effects on species interactions and of biofouling on marine habitat, OSU would implement the Organism Interactions Monitoring Plan under the Adaptive Management Framework to detect and, if needed, mitigate any effects of WEC-related adverse effects to predator-prey relations and marine habitat (APEA, Appendix I - measure 4). Implementation of the proposed mitigation measures would minimize potential effects of altered predator-prey interactions and marine habitat.

Aquatic Invasive Species

Aquatic invasive species, such as Chinese mitten crab and European green crab can compete for habitat resources with native species and have the potential to adversely affect aquatic communities. While these species have not been documented in the marine project area during relicensing studies, they have been documented in California coastal waters.

To minimize the threats associated with aquatic invasive species, OSU proposes APEA, Appendix I, measure 12 to require vessels that OSU charters or contracts with to work on the project comply with all current federal and state laws and regulations regarding aquatic invasive species management.

OSU's proposal for managing aquatic invasive species is consistent with Oregon DFW's 10(j) recommendation 6 that OSU implement invasive species control for any vessel or device entering Yaquina Bay. Specifically, Oregon DFW recommends that Oregon's Aquatic Invasive Species Control rules (Oregon Admin. R. 635-059-0000 et. seq.) be applied to project vessels, WECs, and construction activities. Oregon DFW notes that state regulations and OSU's proposed measure 12 require that if aquatic invasive species are found on or inside a watercraft, the owner or operator must provide Oregon DFW with an accurate history as to where the watercraft has been during the last 6 months. Information shall include: (1) all waterbody(s) in which the watercraft has been moored or operated; (2) the length of time that the watercraft has been out of water; (3) all locations where the watercraft has been stored; and (4) if previously inspected, the agency and individual which conducted the inspection.

Our Analysis

OSU proposes to charter or contract with a number of vessels, including tugs, installation vessels, and other workboats for the construction, operation, and maintenance of the project. The Port of Newport, within Yaquina Bay, moors many of these types of vessels. Some of these vessels that would be under contract or charted by OSU to work on the project would likely transit from other areas along the West Coast and potentially from areas outside of the U.S. to Yaquina Bay, creating opportunities to inadvertently introduce or spread aquatic invasive species. Informing contracted or chartered vessel owners and WEC clients about current federal and state laws and regulations regarding aquatic invasive species management, as proposed by OSU, in addition to practices to reduce the spread of invasive species, such as detection monitoring, incidental observations, and reporting would help minimize the risk of transporting invasive species from other areas and waterbodies.

Effects of Pinniped Haulout and Seabird Perching on Project Structures

Project structures can provide opportunities for pinnipeds to haul out and for seabirds to perch and nest that could potentially damage project structures and interfere with project operations. For example, seabird guano is known to corrode some materials which may be used in project structures, accumulated guano deposits could prevent safe access, and nests could impede access to project components.

OSU proposes to make opportunistic visual observations of pinnipeds in the portions of the WEC test site being visited while conducting operations, maintenance, and environmental monitoring activities at least once per quarter. If pinnipeds are identified on WECs or project structures, OSU would follow NMFS haulout protocols (APEA, Appendix I, measure 8) during any attempt to access the device or structure and implement deterrent measures, as appropriate.

FWS and Oregon DFW recommends (10(j) recommendations 1 and 2, respectively) OSU implement its proposed BBCS Plan that includes measures to conduct opportunistic observations of seabirds to identify potential issues related to seabird perching and nesting on project structures. Further, if issues are identified, OSU and the WEC testing client would develop a plan in coordination with FWS to prevent or discourage future seabird perching or nesting using non-lethal measures. OSU states that active nests would not be disturbed after egg-laying or before fledging of young, unless critical maintenance is required or in the event of an emergency.

Our Analysis

Pinnipeds may attempt to use WECs as haulouts. They are known to haulout on manmade structures, especially those with underwater components that attract fish and increase foraging opportunities, such as navigation buoys.

Haulout opportunities, combined with possible fish attraction to the project's underwater structures, could increase pinniped predation on fish associated with those structures. Pinnipeds that are hauled out on WECs could detrimentally affect operation of those devices or preclude access for maintenance activities. Possible deterrence measures include special coatings and physical barriers (i.e., fencing). However, for many WECs, such measures may not be feasible if they preclude access for maintenance or if the design of the WEC does not lend itself to implementation of deterrence measures. For example, an attenuator or point absorber WEC submerges below the surface periodically, and fencing could result in capturing of marine life when the WEC surfaces. The need for deterrence measures is lessened, however, because the creation of artificial haulout opportunities is not expected to negatively affect pinnipeds; in fact, it could be beneficiary if it provides areas to rest. As a WEC test center, experience gained at PacWave South would inform appropriate design measures to minimize opportunities for pinniped haulout.

Increased foraging is not expected to occur with pinniped haulout or seabird perching since attraction of forage fish to underwater project structures is not expected to be significant (see above discussion on potential community changes). Perching on buoys and other manmade structures is a common behavior for seabirds like gulls and cormorants and is not generally considered to adversely affect these birds. Nesting seabirds could foul and interfere with access to project structures. In addition, project activities could result in disturbance to seabirds that may nest on project structures, potentially causing nest failure. However, significant adverse effects on seabirds as a result of perching on project structures or feeding on fish are not expected to occur.

OSU's proposed measures to document pinniped and seabird use of facilities and develop any necessary plans in consultation with FWS and the WEC client would serve to discourage future use of project facilities and minimize potential impacts to pinnipeds and seabirds including seabird nests.

Effects of Seabird Avoidance/Displacement of Project Area

The presence of proposed project facilities has the potential to affect seabird and sea duck behavior including displacement of individuals or avoidance of the marine portion of the project area.

Our Analysis

Some species of seabirds or sea ducks could exhibit avoidance behavior around the WECs. In Europe, common eiders and pink-footed geese have been shown to avoid offshore wind farms during their migration between wintering and breeding grounds, by adjusting their flight trajectories and flying around the farms (Desholm and Kahlert 2005, Masden et al. 2009, Plonczkier and Simms 2012), and several species of loons, sea ducks, and seabirds have been estimated to have a moderate to high risk of displacement by offshore wind farms (Bradbury et al. 2014). Avoidance behavior could have the positive effect of reducing their risk of collision with turbines, but it could also result in increased energetic costs associated with migration (Masden et al. 2009).

Although avoidance behavior has been reported for some species of sea ducks at offshore wind farms, this behavior is unlikely to occur in response to WECs at PacWave South. Wind turbines are considerably taller than the WECs at PacWave South (>100 meters versus < approximately 15 meters in height) presenting a greater barrier to migratory flight. In the study on wave and tidal energy converters in Scottish waters, the vulnerability of seabird populations to adverse effects from WECs was ranked as low or very low (with the exception of divers/loons, which were ranked as moderate), and one of the seven vulnerability factors used for this ranking was the potential for exclusion from foraging habitat (Furness et al. 2012). Therefore, there is a low likelihood of avoidance or displacement of seabirds as a result of the project.

Effects of Artificial Lighting

Artificial lighting on marine project facilities and support vessels could attract phototactic[37] species of seabirds (e.g., shearwaters, petrels, auklets, and murrelets) potentially causing seabirds to become disoriented, collide with or perch on project structures, that could result injury to seabirds and damage to project equipment (Montevecchi 2006).

To minimize the effects of project lighting on seabirds, OSU proposes to include the following measures in its BBCS Plan:

---

[37] Phototactic species are those that are attracted to light.

- Install low-intensity flashing lights and bird-friendly wavelengths on project structures to minimize seabird attraction and follow lighting specifications developed in consultation with FWS and USCG.

- Minimize lighting (e.g., shielded lighting not providing upward-pointing light or light directed at the sea surface) used at night by service and support vessels to reduce the potential for seabird attraction.

- Conduct service and maintenance operations during daylight when practical.

Our Analysis

Phototactic seabirds have been shown to be highly attracted to artificial light in the marine environment; typical sources of light include boats, lighthouses, oil and gas platforms, coastal resorts, and commercial fishery operations. Continuous high-intensity, white lighting has a higher likelihood of attracting phototactic seabirds than lower-intensity, colored lights and those that flash at intervals (Montevecchi 2006, Poot et al. 2008). Phototactic seabirds are most susceptible to light attraction in cloudy, foggy, or hazy conditions, in light rain, and when the moon is absent or obscured. Immature and nonbreeding phototactic seabirds tend to be more attracted to light than breeding adults (Montevecchi 2006, Miles et al. 2010).

For the Reedsport Project, FWS recommended that navigation lights should be shielded to direct light only towards approaching watercraft (and not directly upwards) and that the flash-timing interval should be equal to or greater than 4 seconds for each individual light to minimize the potential for seabird attraction (Reedsport OPT Wave Park, LLC 2010). OSU's proposed lighting would be similarly installed and should minimize the effects of seabird attraction to project lighting on WECs and other project structures, as determined in coordination with the USCG and FWS.

Potential effects on seabirds from vessel lighting are expected to be short-term and intermittent as it would be limited to WEC installation and during periodic maintenance and repair activities. Because monitoring of seabird activity is unlikely to occur at night, OSU proposes to perform service and maintenance operations during daylight when possible, which would limit the need for nighttime light use and further reduce the risk of potential impacts to seabirds in the project vicinity.

Effects of Changes in Wave Energy to Habitat

Operation of the proposed WEC arrays would extract and scatter wave energy from the WEC test site, which in turn has the potential to reduce the height of waves experienced on the beaches. This loss of wave energy could reduce surf energy, alter sediment transport and sediment deposition of the nearby shoreline, and change habitats for a variety of shoreline and shallow bottom dwelling organisms.

Our Analysis

Wave energy on the Oregon coast varies considerably by season, such that the wave energy flux is approximately eight times greater during winter than summer (Bedard 2005). Episodic winter storms bring large waves from the west and southwest. As waves encounter the floating WECs, the wave energy would be absorbed or reflected (i.e., radiated) to another direction, causing localized eddies or gyres as currents pass by the WECs. However, attenuation of wave energy by WECs would be indistinguishable outside of the test site, as any changes to the hydrodynamics at the WEC arrays would be subject to the far stronger influences of the circulations of the California Current. Because of the dominance of medium to coarse sandy habitat in the project area and the lack of finer grained sediment (percent fines in the PacWave South area are very low, less than 1 percent; Henkel 2016), it is not expected that scour around project structures would result in significant changes to the seafloor.

Changes to the littoral zone and shoreline habitat would be unlikely due to the distance between the WEC test site and the shoreline (i.e., about 6 nautical miles) and the permeability of the test site (as the WECs would be spaced about 50 to 200 meters or more apart). Wave patterns closer to shore are influenced by land features, bathymetry, tidal currents, and estuarine-induced currents (USACE and EPA 2012); none of these factors would be affected by the project. At full build-out, the arrays of WECs at the project are not anticipated to significantly impact wave energy and related habitat-forming processes. Likewise, the absorption of wave energy at the project would not affect species or habitats listed in the Oregon Nearshore Strategy.

Effects of Underwater Sound/Vibration on Marine Mammals, Fish, and Seabirds

The primary sources of project-related underwater sound would be from vessels operating offshore at the project and transiting between Newport and the WEC test 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., not impulsive) sounds.

Underwater sounds generated by the project may be similar to, or masked by, ambient underwater sounds in the project area, which are reported to be higher than the typical deep ocean sound found in the northeast Pacific Ocean (Haxel et al. 2011), likely due to wave activity and existing vessel traffic. Ambient sound in the marine environment originates from both natural and anthropogenic sources, such as commercial and recreational vessel traffic, wave action, marine life (e.g., marine mammal vocalizations), atmospheric sound, and others (Haxel et al. 2013). Baseline underwater sound monitoring at the PacWave North Project recorded sound pressure levels (SPL) between 95 decibels (dB) root mean square (RMS) re: 1 μPa (micro Pascal)[38] and 136 dB, with a time-averaged SPL for the monitoring period of 113 dB (Haxel et al. 2011). 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. SPL RMS from 7 Hz-13 kHz was used to generate a cumulative distribution function (CDF) of noise levels where the 50th percentile (101 dB) was representative of a "typical" background sound level at the WEC test site. Baseline monitoring recorded minimum SPL RMS levels for this time period of 83 dB, while local vessels generated the maximum RMS sound pressure level (138 dB) 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).

Vessel Sound

Vessels used during initial project construction and WEC installation, maintenance, environmental monitoring, and decommissioning (e.g., anchor handling and towing tugs, material transport barges, research vessels, and crew vessels) would regularly transit between Newport and the WEC test site. 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 ships, and ships underway with a full load (or towing or pushing a load) produce more sound than unladen vessels (Hildebrand 2009). For vessels used at PacWave North, NMFS (2012a) assumed that "[underwater] sound intensity generated by tugs, barges, and diesel-powered vessels (i.e., the types that would be used for project installation and maintenance) when fully underway (traveling to and from the test site) or due to cavitation during starts and stops, would be no greater than 130 to 160 dB over a frequency range of 20 Hz to 10 kHz" (also see Richardson et al. 1995, DOE 2012). This assumption would also be applicable to PacWave South. These levels would occur when vessels are fully underway, coming to or leaving the site, which for most trips between the WEC test site and Newport would last 1 to 1.5 hours. The underwater sound intensity would be lower when the vessels are operating at very slow or idle speed, which is likely to occur at the test site when conducting monitoring or maintenance activities.

A vessel with dynamic positioning thrusters could be used during cable lay operations at the beginning of the project and potentially during installation of individual

---

[38] The magnitude of sound pressure levels in water is normally described by sound pressure on a dB scale relative to a reference RMS pressure of 1 μPa. Unless noted, this scale is used throughout the document.

WECs. In the EA for the Virginia Offshore Wind Technology Advancement Project on the Atlantic Outer Continental Shelf Offshore Virginia, BOEM (2014) estimated that the sound source-level for the dynamic positioning cable laying vessel would be 177 dB at 1 meter, and Deepwater Wind LLC's Block Island Wind Farm estimated the sound source-level for the dynamic positioning cable laying vessel would be 180 dB at 1 meter (NMFS 2015).

Yaquina Bay is a large commercial harbor with many recreational, charter, and commercial boats, and vessel traffic is often concentrated near the mouth of the bay, so it is assumed that project-related vessel sounds would not be significantly greater or different than existing conditions. Although vessel sound could be expected to result in avoidance by marine mammals, fish, and seabirds (DOE 2012), these effects would be temporary and short term, and exposure to the stressor would be limited to locations and times where a vessel and marine life are in close proximity.

The estimated annual number of days during which vessels would be transiting between Newport and the WEC test site for the initial development scenario and full build-out scenario are shown in Table 3-12. During some days, only one vessel may be on site (e.g., environmental monitoring or O&M activities), while during deployment or removal activities, a number of vessels may be on site.

Table 0-12. Estimated number of days during which vessels would be transiting between Newport and PacWave South for the initial development and full build-out scenarios.*

Build-Out Scenario	Estimated Annual Vessel Round Trips Between Newport and PacWave South		
	Deployment, O&M, and Retrieval	Monitoring	Total
Initial Development (6 WECs)	36	45	81
Full Build-Out (20 WECs)	69	36	105

* Note, during days when deployment activities are occurring, multiple vessels would be at PacWave South and transiting between the Port of Newport and PacWave South. During other days, only one vessel may be on site (e.g., environmental monitoring or O&M activities).

Anchor Deployment Sound

Anchor installation is a short-term activity (hours), with anchoring occurring in soft substrates that would likely produce less sound than the sounds from the vessels deploying the anchors. However, suction anchors require hydraulic pumps for installation. Suction anchors were proposed for installation for the Neptune LNG Deepwater Port, and noise modelling indicated that installation of the suction pile anchors at the Port would produce only low levels of underwater sound with no levels above the 120-dB criterion for continuous sound (Neptune LNG LLC 2007). Modeling for installation of the suction pile anchors was conducted by Jasco, indicating that the 120-dB threshold would not be exceeded and the 90-dB contour would occur only out to 300 to 1,000 feet from the source of the sound. The method for installation was using a submerged pump attached to an ROV (Engineering-Environmental Management Inc. 2006).

<u>HDD Sound</u>

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).

<u>WEC Operation Sound</u>

During operation, sound may be generated by water flowing past the mooring lines, waves splashing against the WECs and other structures, or by the moving components of the WECs and moorings. Due to the variety and complexity of differing sound sources within an array, it is difficult to model or predict the sound signature (Wilson et al. 2014). Based on underwater sound monitoring, the operational sounds of the test WET-NZ device at PacWave North were within the range of ambient conditions and did not exceed NMFS's 120 dB marine mammal harassment threshold (as discussed below). The maximum SPL attributed to Columbia Power Technologies' 1/7-scale WEC was measured from 116 to 126 dB in the integrated bands from 60 Hz to 20 kHz at distances from 10 to 1,500 meters from the SeaRay (Bassett et al. 2011). From this, the SPL was estimated to be 145 dB at 1 meter, and 126 dB at 10 meters (Thomson et al. 2012, as cited in NAVFAC 2014); in the EA 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 was between 148 and 151 dB at 1 meter (NAVFAC 2014). The maximum SPL generated by WECs off the west coast of Sweden was reported at 133 dB at 20 meters with an average of 129 dB (Haikonen et al. 2013). 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 and Sea 2002 *cited in* Navy 2003). Per NMFS's request, to be conservative a source term of 151 dB at 1 meter was used in this analysis.

Sounds emitted by the WECs, implementing NMFS's practical spreading model with the highest WEC sound source term, would attenuate to 120 dB at 125 meters.

Because of the uncertainty of the WEC type and size that would be deployed at PacWave South, as well as the exact sound signatures, OSU would implement the Acoustic Monitoring Plan under the Adaptive Management Framework to detect and, if needed, mitigate unanticipated adverse effects of WEC-related sound (APEA, Appendix I).

Effects of Underwater Sound/Vibration on Marine Mammals

Human-caused underwater noise and vibration have the potential to adversely affect cetaceans and other marine mammals by interfering with communication, prey and predator detection, and navigation and by causing temporary or permanent hearing loss. Noise has the potential to alter migration patterns, if cetaceans respond to noise by avoiding it, or to increase the potential for collision or entanglement, if cetaceans respond to it by investigating.

To minimize the potential effects of noise and vibrations on behavior of marine mammals, OSU proposes to implement an Acoustics Monitoring Plan, as may be modified in accordance with the proposed Adaptive Management Framework (APEA, Appendix I, measure 5), required by NMFS terms and conditions 1 and 2.

To minimize and mitigate for potential impacts for WEC operation and mooring systems (APEA, Appendix I, measure 7, required by NMFS term and condition 1), OSU proposes to implement measures to ensure sound levels do not exceed NMFS's harassment threshold of 120 dB, including necessary repair or modifications to facilities to abate noise levels. OSU would contact NMFS within 48 hours if acoustic monitoring detects sounds levels associated with WEC operation or mooring system greater than 150 dB, as required by NMFS Term and Condition 4.

To help ensure that the sound levels produced by DPVs (APEA, Appendix I, measure 6) do not injure marine mammals, OSU proposes to avoid use of DPVs to the maximum extent practicable during Phase B gray whale migration (April 1 - June 15). If use of DPVs are used during this migration period, the licensee would consult with Oregon DFW regarding the timing of such activities. OSU also proposes to implement actions and protocols necessary to maintain an appropriate acoustic zone of influence in accordance with NMFS's published harassment threshold (120 dB re: 1μPa) during DPV operations, including posting marine mammal observers during daylight hours, conducting start-up during daylight hours, and implementing ramp-up procedures.

Oregon DFW comments that DPV activity during installation of the five separate cables should be avoided during Phase B, the sensitive mother-calf migration period for gray whales.

Our Analysis

Marine mammals would be exposed to underwater sounds during construction, operation, and maintenance of the project.

The OSU study involving theodolite monitoring for whales from Yaquina Head in Newport from mid-December 2007 through May 2008 (Ortega-Ortiz and Mate 2008, personal communication with Barbara Lagerquist, Martha Winsor, and Bruce Mate, OSU Marine Mammal Institute, December 1, 2016) reported gray whales were observed offshore of Yaquina Head transiting the area during both southward and northward migrations, and predominantly occurring in parts of the ocean where water depths are between 10 and 70 meters. Two minke whales, observed during the end of May 2008, were the only other cetaceans seen during the study (Ortega-Ortiz and Mate 2008). The average distance offshore for gray whales was 3.9 nautical miles during the southbound migration (December 1-February 15; n=58), 2.9 nautical miles during the northbound, Phase A migration (February 16-March 31; n=74), and 1.7 nautical miles during the northbound, Phase B migration (April 1-June 15; n=38; personal communication between OSU and Barbara Lagerquist, Martha Winsor, and Bruce Mate, OSU Marine Mammal Institute, December 1, 2016). Ortega-Ortiz and Mate (2008) noted that gray whales appeared to follow a constant depth (isobath) rather than the shoreline. The project would be located about 7 nautical miles offshore, which is about 3 nautical miles farther offshore than the average distances detected during the whale observation studies. However, during the 2008 study, gray whales, an Oregon Nearshore Strategy and Stated-listed species, were detected as far offshore as 10.7 nautical miles (shore-based observations from Yaquina Head were limited to 11 nautical miles; Ortega-Ortiz and Mate 2008), so gray whales could still be expected to pass through the project area.

The intensity and duration of exposure to underwater noise would vary by project activity (i.e., installation versus operation), and development stage (i.e., initial build-out and full build-out scenarios). Sensitivity to sound can vary between marine mammals and responses to sound can be highly variable, depending on the individual hearing sensitivity of the animal, the behavioral or motivational state at the time of exposure, past exposure to the sound which may have caused habituation or sensitization, habitat characteristics, environmental factors that affect sound transmission, and non-acoustic characteristics of the sound source, such as whether it is stationary or moving (National Research Council 2003). Whales migrating past PacWave South may be able to detect sounds at considerable distances and may change course to avoid the project area. To some degree, whales migrating over the OCS are occasionally exposed to elevated sound levels near Newport, and other larger ports along their migration route, as well as passing ships; therefore, it is difficult to predict their response to project-related sound (Southall 2005), but serious adverse effects are not anticipated. Likewise, seals and sea lions that are habituated to vessel sound from commercial and recreation vessels that frequent the area could be undisturbed by project vessels because these animals already encounter similar sounds in harbors and nearshore environments.

NMFS has developed revised guidance on sound levels likely to cause injury for marine mammals (NMFS 2016). The NMFS (2016) guidance provides thresholds for injury levels using cumulative sound over a 24-hour period: temporary (TTS) and permanent threshold shift (PTS) onset threshold levels for injury have been identified for low (baleen whales) to mid-frequency (delphinids, beaked whales, sperm whales) cetaceans for non-impulse noise (178 and 179 dB re 1 micro Pascal squared second (μPa^2s)[39] for TTS and 198 & 199 dB re 1 μPa^2s for PTS) for phocid (true or earless seals) and otariid (eared seals) pinnipeds (181 dB & 199 dB re 1 μPa^2s for TTS and 201 dB & 219 dB re 1 μPa^2s for PTS). NMFS uses conservative exposure thresholds from broadband sounds that have been shown to cause behavioral disturbance (an adverse effect)--160 dB for impulsive sound and 120 dB for non-impulsive sound. None of the project components or activities are expected to generate sound at levels that could cause injury to marine mammals. However, the sound levels from vessels during installation and operation, from cable laying using DPVs, and from continuous sounds produced by the various WECs over the operation of the test site may exceed the 120-dB behavioral disturbance threshold and cause behavioral disruption of marine mammals (NMFS 2012c).

Vessel sound could affect feeding patterns and socialization for marine mammals, but these effects would be short term and temporary (i.e., hours or less as the vessels pass), though periodic over the license term, and are anticipated to be negligible and similar to what marine mammals already experience along the Oregon Coast. Also, ambient sound levels are also expected to approach 120 dB; baseline underwater sound monitoring at PacWave South recorded SPLs of between 83 and 116 dB (Haxel 2019).[40] For example, gray whales, an Oregon Nearshore Strategy and state listed species, are regularly exposed to vessel sound from commercial and recreational fishing and research vessels calling on the Port of Newport. Additionally, sound from project vessels would likely be partially masked by ambient sound.

Underwater sound that may be generated as the HDD drill head approaches the exit point underwater is qualitative and 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). Cetaceans and pinnipeds are highly mobile and would be expected

[39] dB re 1 μPa^2s is a measure of sound level that takes into account the duration of the signal.

[40] A maximum value of 138 dB was measured, but less than 1 percent of the measurements surpassed the 116-dB level (i.e., 99th percentile) (Haxel 2019).

to avoid the effective range of cable laying operations, thus further reducing potential for exposure to sound generated by the dynamic positioning thrusters. Considering the temporary nature of cable laying activities at PacWave South (occurring only during construction), and the low likelihood that most whales would be near the cable route, coupled with the proposed mitigation to further reduce the potential for marine mammals to experience sound exceeding 120 dB, any effects of sound generated during cable installation would be negligible.

Use of DPVs to install the buried subsea transmission cables would take about 30 days and could produce sound levels of 180 dB, exceeding harassment levels for marine mammals. Although OSU proposes to avoid use of DPVs during the phase B gray whale migration period (northward migration including primarily females with calves) to the extent practicable, there still is a chance that installation would occur during that sensitive period. Although the gray whale migration corridor is generally more than 3 nautical miles from the area where DPVs would be used, some gray whales would be expected to pass through the area and be exposed to high noise levels. Given the short timeframe for cable installation, the ability of gray whales to avoid the area, and limited numbers of gray whales expected to occur in vicinity of the DPVs, impacts are not expected to result in take or harassment of gray whales.

Sound generated by operating WECs is expected to be lower than the injury level for cetaceans or pinnipeds (NAVFAC 2014) and is not expected to result in harassment of marine mammals (letter from NMFS, APEA, Appendix N). According to the analysis conducted in the WETS EA, sound source levels for the WECs range from 126 dB re: 1 µPa at 10 meters (Thomson et al. 2012, as cited in NAVFAC 2014). Using the NMFS practical spreading method with this 10-meter source term, or the same approach used in the WETS EA, the potential harassment area would range from 26 meters (81 feet) to 50 meters (163 feet). For the WETS EA the harassment area was determined to be roughly the mean of these two distances, or 35 meters (115 feet). The higher range of these sound levels would occur during higher sea states, though these conditions would also occur during periods of higher ambient sound, likely resulting in partial or potentially total masking of the WEC-generated sound. Because of uncertainty associated with this new industry and in order to determine the actual sound levels emitted by WECs at the project, OSU would implement the Acoustic Monitoring Plan under the Adaptive Management Framework to detect and, if needed, mitigate any effects of WEC-related sound (APEA, Appendix I). Implementation of the proposed measures would minimize impacts to marine mammals from increased sound levels.

Toothed whales (e.g., porpoises, dolphins, sperm whales, killer whales, and beaked whales), have mostly mid-frequency hearing capabilities (with the exception of harbor porpoises which are high-frequency cetaceans) and possible behavior response to non-impulse sound could include moderate changes in speed of travel, direction, or dive profile; cessation or modification of vocal behavior for moderate to extended periods;

avoidance of the sound source, and change in group distribution (Southall et al. 2007). The minor increase in travel time for toothed whales to avoid the project is unlikely to significantly increase an individual's energy budget (NMFS 2013a), plus avoidance would reduce the chance of collision or entanglement with project structures (discussed below). If displaced from the project area due to noise, alternative forging and migrating routes are available near the project. Recent research by Holt et al. (2015) found that increased vocalization efforts by marine mammals in noisy habitats, such as areas exposed to regular vessel traffic, can result in a measurable increase in metabolic rate and consequently an energetic cost at the individual level.

Baleen whales (e.g., fin, sei, gray, minke, and right whales), like humpback and blue whales, are considered to have low-frequency hearing. If exposed, a baleen whale is likely to deflect around the sound instead of continuing in the same direction. The distance moved is expected to depend on the sound level at the time of interaction. Similar to toothed whales, baleen whales could be displaced and precluded from foraging in the project area or from using it to move between foraging sites.

Pinnipeds have low- to mid-frequency hearing (Southall et al. 2007). Potential responses to non-impulse sound could include avoidance behavior, and they could be displaced and precluded from foraging in the project area or from using it to move between foraging sites.

Conversely, the noise levels created by the WECs may not affect marine mammals at all. As noted, baseline underwater sound monitoring at PacWave South recorded SPLs from 83 dB to 116 dB (Haxel 2019). If marine mammals choose to avoid the WEC test site, alternative foraging sites and routes are available and the additional distance traveled is unlikely to cause a significant increase in an individual's energy budget. It is likely that continuous, non-impact sound emissions from WEC testing would result in behavioral avoidance and corresponding minor energy cost at the individual level.

Based on the existing information, the likely behavioral responses, even considering potential for repeat exposures of individual whales and pinnipeds to sound from various periodic WEC tests and vessel traffic associated with the project, both at the site, and between PacWave South and Newport, over the license term, would not be expected to adversely affect baleen or toothed whales, or pinnipeds.

Effects of Underwater Sound/Vibration on Fish

Human-caused underwater noise and vibration have the potential to adversely affect marine fish behavior. Depending on the fish species, and the frequency and sound power level (loudness or amplitude) of the source, sound and vibration can cause stress, behavioral effects such as a startle response or movements away from the source, displacement from preferred feeding or reproduction sites, masking of acoustic communication and ability to find prey or detect predators, reduced growth, altered migration patterns, injury, or even mortality (Slotte et al. 2004, Popper and Hastings 2009, Popper et al. 2014).

Proposed measures to minimize the effects of noise on marine fish are described in section 2.2.5. OSU proposes to implement an Acoustics Monitoring Plan. The objective of the Acoustic Monitoring Plan is to quantify sound levels using field measurements and validated sound propagation models and evaluate the level and signature of sound produced from various project components at the WEC test site and compare that information to established sound thresholds for marine mammals, fish, and seabirds. If results of modeling or field surveys indicate that the operating WECs or other project facilities exceed an acoustic management or mitigation threshold, adaptive management (APEA Appendix J) and mitigation measures (APEA Appendix I) to address the unanticipated adverse effects would be implemented by OSU. For as long as WEC or mooring systems remains deployed, OSU would continue in-situ monitoring and notify NMFS when noise levels are detected that exceed the threshold for behavioral effects attributable to the WEC/mooring system.

Oregon DFW and FWS recommend (10(j) recommendation 1 and 2, respectively) that OSU implement the Acoustics Monitoring Plan. NMFS term and condition 1 and EFH recommendation 2 requires OSU to implement the Acoustics Monitoring Plan.

Our Analysis

Underwater sound radiates outward from its origin until the sound pressure waves encounter land mass or attenuate to background levels. Rate of sound attenuation can vary based on sediment type, bottom topography, structures in the water, slope of bottom, temperature gradients, currents, and wave height (WSDOT 2014).

Most fish species can sense and may react to one or two components of sound waves, sound pressure, and/or particle motion. Species that are capable of detecting both sound pressure and particle motion can detect a wider range of frequencies and sounds of lower intensity, while those that can only detect particle motion (e.g., those lacking a swim bladder or those having a swim bladder and hearing structures that are far apart) are less sensitive. Sound and vibration may attract, repel, or otherwise affect fish behaviors (e.g., predator avoidance), depending on the species and the frequency and sound power level (loudness or amplitude) of the sound source.

At very high intensities, the potential effects of sound on fish can include mortality, injury in the form of temporary and permanent hearing damage and tissue damage, and temporary reductions in hearing sensitivity (known as a "temporary threshold shift", or TTS) (Hastings and Popper 2005, Popper and Hastings 2009, Popper et al. 2014). These types of effects are generally related to impulsive sounds, such as the high-level, short-duration sounds of impact pile-driving, explosions, or seismic airguns (Popper et al. 2014). The thresholds for injury resulting from percussive pile driving have been defined as a peak SPL of 206 dB and cumulative sound exposure level (SEL_{cum}) of 187 dB re 1 μPa^2·s, by the U.S. Fisheries Hydroacoustic Working Group (FHWG 2009). Fish near the project would not be exposed to sound levels that would cause mortality, injury, or TTS, because project activities would not generate impulsive sounds and the sound levels are expected to remain well below these thresholds for injury.

Sound associated with vessels, cable laying, and continuous sounds from the WECs and other project infrastructure, could approach or occasionally exceed the threshold for behavioral effects (described below). Potential effects of moderate (e.g., non-injury) anthropogenic noises on fish can include disturbance and deterrence, reduced growth and reproduction, interference with predator-prey interactions, and masking of communication (Slabbekoorn et al. 2010). A reduced ability to avoid predators was shown to occur in Ambon damselfish in response to motorboat noise (Simpson et al. 2015), and reduced forage efficiency was shown to occur by threespine sticklebacks in response to white noise similar to the noise environment in a shoreline area with recreational speedboat activity (Purser and Radford 2011). The threshold for causing temporary behavioral changes (startle and stress) on threatened and endangered fish species, as defined by NMFS and FWS, is 150 dB (FHWG 2009). There are a number of studies that suggest that project-related sounds may elicit some behavioral responses by ESA-listed fish, but adverse effects are unlikely; these studies are described below.

Sound levels less than approximately 160 dB are reported to not adversely affect adult fish, including species such as rockfish and rainbow trout (Hastings and Popper 2005; Popper et al. 2014). Based on the measured sound levels of drilling for cable laying in the U.K., avoidance of the sound source by fish was likely but auditory injury was unlikely (Nedwell and Edwards 2004). Rainbow trout exposed to continuous sound (up to 150 dB re: 1 μPa rms) in an aquaculture facility for nine months showed no hearing loss or adverse effects on fish health (Wysocki et al. 2007). A study that exposed juvenile Chinook salmon to simulated tidal turbine sounds at levels of 159 dB for 24 hours found low levels of temporary tissue damage that had low physiological costs to the fish, and no effects on hearing sensitivity (Halvorsen et al. 2011). This represented a worst-case scenario for temporal exposure, the more likely scenario would be that salmonids, due to their migratory nature, would pass by the turbine and very quickly back into waters with much lower and rapidly declining sound levels, and the risk of tissue damage would be much lower (Halvorsen et al. 2011). A study conducted by Wahlberg and Westerberg (2005) estimated that Atlantic salmon could detect sound emitted from a wind farm at a distance of 400-500 meters and speculated that they may change their swimming pattern to avoid the source. However, fish could habituate to the continuous sounds of the WECs; in one study comparing effects of intermittent versus continuous sounds, European seabass returned to pre-exposure behaviors more quickly in response to continuous sounds as compared to intermittent sounds of the same intensity (Neo et al. 2014). The migratory nature of many pelagic fish would lower their potential temporal exposure to the continuous sounds of WECs and it is unlikely that the sounds would interrupt their migration path; in one study, the installation of wind farms within the migratory pathway of European silver eel in coastal northern Europe elicited no apparent change in their migration patterns (Andersson et al. 2012). Haikonen et al. (2013) reported that noise generated by WECs off the west coast of Sweden (maximum 133 dB at 20 meters, average 129 dB) was detectable by fish, but not sufficient to alter fish behavior.

Based on the existing information, the temporary sounds from vessels transiting to or from the WEC test site and within the WEC test site (i.e., hours or less as the vessels pass), and from cable laying during installation and deployment of WECs, as well as from continuous sounds from the WECs, even though they would occur over the license term, are not likely to adversely affect fish for several reasons: the area affected (e.g., up to 125 meters around the WECs) would be insignificant compared to the range of most fish species that would pass through the project area, and, there is similar and abundant habitat available in the surrounding area that they could move to if they are exposed or disturbed by the sounds. In addition, sounds emitted from the WECs or from vessel traffic are unlikely to be significantly greater than existing conditions, given the high level of vessel traffic already present in the vicinity of the project area in association with the Port of Newport.

The WEC test site is located between two rocky reef areas and approximately 6 nautical miles off the coast of Newport/the entrance to Yaquina Bay. Fish may swim around a WEC or avoid a vessel transiting between the Port of Newport and the WEC test site, but there is no basis to expect that noise associated with the project, including deployment, operation and maintenance, retrieval, and environmental monitoring, would affect aggregating fish such as rockfish or green sturgeon, or the migratory path for pelagic fish, such as salmon leaving or returning to natal streams because of the remote offshore location of the project, the spacing of the WECs, and relatively low levels of noise associated with the project. Therefore, underwater sound from the project would not be expected to adversely affect any fish.

Because of uncertainty associated with underwater sounds created by this new technology and in order to determine the actual sound levels emitted by WECs and other facilities at the project, OSU would implement the Acoustic Monitoring Plan under the Adaptive Management Framework to detect and, if needed, mitigate any effects of WEC-related sound (APEA, Appendix I, measure 5). Implementation of the proposed mitigation measures would minimize potential effects of sound levels to fish in the marine environment.

Effects of Underwater Sound/Vibration on Seabirds

Underwater sounds emitted by the proposed project could alter the behavior of seabirds and their primary prey (fish).

Oregon DFW and FWS recommend (10(j) recommendations 1 and 2, respectively) OSU implement its proposed Acoustics Monitoring Plan under the Adaptive Management Framework to detect and, if needed, mitigate any effects of WEC-related sound that exceed regulatory thresholds set by NMFS.

Our Analysis

Although intense underwater sound, such as impulses produced by underwater explosions, seismic pulses, sonar, and pile-driving, has the potential to cause injury or mortality to seabirds, sounds emitted by WECs during ordinary operation is expected to be within the range of ambient sound levels. Furthermore, the proposed project is not expected to produce intense sounds at amplitudes capable of causing auditory harm to seabirds (Wilson et al. 2014).

Sounds associated with vessels accessing the proposed project could temporarily disturb seabirds, but these effects are anticipated to be negligible since they would not rise to such a level as to cause harm and would be of short duration (i.e., hours). The Acoustics Monitoring Plan proposed by OSU would monitor noise levels and outlines steps to implement protective measures (APEA, Appendix I, measure 7) should potentially harmful noise thresholds occur that could affect marine vertebrates, including seabirds.

Effects or Risk of Collision/Entanglement with Project Structures, Entangled Gear, or Service Vessels to Marine Species

Effects or Risk of Collision/Entanglement to Marine Mammals

Project structures, including WECs, mooring lines, subsea floats, marker buoys, and umbilical cables, could pose a risk to whales if they collide with these submerged components or become entangled with debris (e.g., lost fishing gear) if it accumulates at the surface or on submerged structures. The estimated number of mooring lines and umbilical cables for each scenario is provided in Table 3-13.

Table 0-13. Estimated number of mooring lines and umbilical cables for Initial Development and Full Build-Out Scenarios.

Build -Out Scenario	No. WECs	No. Anchors/ Mooring Lines Total*	No. Umbilical Cables Total
Initial Development	6	21	6
Full Build-Out	20	100	20

* One anchor per mooring line.

In addition, whales could potentially collide with vessels visiting the site or transiting between the Port of Newport and PacWave South. The estimated annual number of days during which vessels would be transiting between Newport and PacWave South for the initial development scenario and full build-out scenario are shown in Table 3-12. During days when deployment or retrieval activities are occurring, multiple vessels (e.g., up to four vessels) would be at PacWave South and transiting between the Port of Newport and the WEC test site, while for other activities (e.g., environmental monitoring or O&M activities), only one vessel may be on site. Therefore, on an annual basis, it is expected that vessels would be transiting between the Port of Newport and the WEC test site, and working for 81 days and 105 days for the initial and full build-out scenarios, respectively (Table 3-12). Approximately 33-56 percent of vessel activity would be for required environmental monitoring purposes.

As described in section 2.2.5, OSU proposes the following measures to minimize the risk of collision and/or entanglement to marine mammals: minimize vessel strike risk by requiring project-related vessels to avoid close contact with marine mammals and adhere to NMFS "Be Whale Wise" guidelines, while in transit. OSU also proposes steps to monitor for and remove entangled fishing gear, which would minimize the potential for marine mammals to encounter lost fishing gear at the WEC test site and become entangled. OSU would also comply with current regulations that require marine mammal observers for certain vessel-based activity (e.g., sub-bottom profiling and DP vessel activities). To the extent practicable, OSU would direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement and follow the reporting and haulout protocols (APEA, Appendix I, measure 3).

Oregon DFW notes that gray whale bottom-feeding foraging activity may increase an individual's risk of entanglement in project equipment exposed on the seafloor and comments that the analysis of effects should consider the entanglement hazards of exposed seafloor equipment, such as unburied cable segments. Oregon DFW also requested additional information from OSU to justify the need for 300 meters of unburied cable.[41]

Our Analysis

Marine mammals offshore of Oregon are exposed to a variety of anthropogenic structures that present collision risk, including moored navigation aids and NOAA oceanographic buoys, as well as moored and moving ships. Marine mammals have evolved to avoid colliding with natural features and to avoid predators, but whale collisions with moored or drifting vessels have been recorded (Nielson et al. 2012). It is possible that sound generated by WECs could result in behavioral avoidance of the WECs, which could reduce the risk of collision (NMFS 2012b and 2012c). There are no data documenting whale collisions with stationary structure (e.g., piers, oil platforms) along the west coast.

Many toothed whales have a well-developed ability to echolocate and avoid structures in the water (Akamatsu et al. 2005), and moorings for WECs would consist of large cables, which are likely to be detected at distances of tens of meters by echolocating toothed whales (Nielsen et al. 2012 *cited in* Benjamins et al. 2014). In a study of finless porpoise, Akamatsu et al. (2005) found that this species inspected a distance of up to 250 feet forward of the animal and swam less than 65 feet without using sonar. The inspection distance was sufficient to provide for a wide safety margin before meeting any risk (Akamatsu et al. 2005). NMFS (2012b) noted that southern resident killer whales, which use sonar for hunting and communication, would likely be able to detect and avoid an array of WECs even when they were not making sound. It is expected that this would be true for other toothed whales. Therefore, the risk of collision with project structures, for toothed whales in the project area during the license term would likely be very low.

While toothed whales use echolocation for active detection, most other species rely on hearing or pressure wave detection to detect their surroundings. There is uncertainty regarding the ability of baleen whales (e.g., gray whales), which do not use sonar, to detect or avoid objects in the water column or on the seafloor. Mooring noise would be relative to current flow, and marine mammals, sea turtles, and other species may be able to detect these cues (Bartol and Ketten 2006, Kot et al. 2012, *both cited in* Benjamins et al. 2014). Therefore, the risk of collision with project structures, for any baleen that occur in the project area, may be higher than for odontocetes. In addition, gray whales are bottom-feeders, and roll on their sides swimming slowly along the

---

[41] OSU responded that the 300 meters is consistent with industry standards. Three times the water depth (approximately 80 meters) results in 240 meters of additional, unburied cable. OSU has added an additional 25% (~60 meters) to provide a safety factor and allow for any repairs that might be needed to the end of the cables.

seafloor sucking sediment and benthic amphipods through coarse baleen plates. This feeding behavior puts them is the proximity of structures on the ocean floor associated with the project.

Pinnipeds have well-adapted underwater vision (Schusterman and Ballet 1970) and can detect changes in pressure or vibrations in the water through the use of their vibrissae (Dehnhardt et al. 2001, Mills and Renouf 1986). Because of the specialized sensory capabilities of toothed whales (echolocation) and the small size and maneuverability of pinnipeds, it is expected that these species also would be able to detect and avoid underwater structures, such as moorings.

In 2016, there were reports of 71 entangled whales off the coasts of Washington, Oregon, and California (NOAA 2017). Sixty-six of these were off California, though this does not necessarily reflect the location of entanglement but could instead be the result of higher reporting rates (i.e., more people to report entanglements off the California coast). Sources of entanglement, identified for 29 of the entanglements were as follows: Dungeness crab commercial trap fishery (22), set gillnet and tribal gillnet fishery (2), spot prawn trap fishery (3), and sablefish trap fishery (2) (NOAA 2017).

Similarly, an examination of entanglement records from 1990 through 2007 maintained by NMFS Northeast Regional Office showed that, for the 46 confirmed right whale entanglements that occurred during that time period, the whales were entangled in weirs, gillnets, and trailing lines and buoys (NMFS 2009b). In an evaluation of the potential for entanglement of large marine life with marine renewable energy development, Benjamins et al. (2014) report that "the vast majority of reported instances of entanglement ... are associated with ropes forming part of fishing gear. To date, there are few reported cases of marine megafauna becoming entangled in moorings or cables of any kind." Umbilical cables are thought to be less of a concern than mooring lines because power cables have a lower minimum breaking load than mooring lines, as they are not designed to maintain a WEC on station (Harnois et al. 2015).

The project mooring lines (up to 21 and 100 for the initial development and full build-out, respectively; Table 3-13) and the umbilical cables (up to 6 and 20 for the initial development and full build-out, respectively) are more substantial than those used for fishing or crab pot lines within which whales have become entangled. Also, the WECs are expected to create substantial tension on the mooring lines. Heavy mooring gear combined with relatively taut mooring lines has been shown to render the potential for entanglement negligible (Wursig and Gailey 2002). Entanglement is unlikely due to the moorings' size and mass regardless of the mooring configuration, though taut mooring systems represented lower relative risk than catenary mooring systems, particularly those using nylon (Benjamins et al. 2014, Harnois et al. 2015). The umbilical cables descending from the WECs to the seafloor would also be substantially taut and relatively rigid. Therefore, it is likely the umbilical cables and mooring lines would act more as structures than as lines and entanglement would be unlikely to occur. In addition, the spacing of the WECs, approximately 50 to 200 meters or more apart, would further minimize the potential for collision by providing ample space for marine mammals to pass between the WECs and associated mooring lines and umbilical cables. Tighter WEC spacing would result in a smaller array footprint, yet still allow spacing for larger cetaceans to maneuver between mooring lines; greater WEC spacing would result in a larger array footprint with more room for cetaceans to maneuver between moorings.

The expectation that it would be very unlikely for whales and other marine species to become entangled in the mooring lines or cables is consistent with the "... apparent absence of entanglement records in similar moorings associated with other offshore industries (e.g., oil and gas)", which is the closest parallel to moorings used for marine renewable energy converters (Benjamins et al. 2014). This has also been confirmed at a NOAA-funded open ocean aquaculture facility located 6 nautical miles off of New Hampshire (Atlantic Marine Aquaculture Center 2008). The facility, which was installed in 1997, covered about 30 acres at depths of 164 feet and had a mooring system comparable to those that would be used at PacWave South (Figure 3-9). Celikkol (1999) evaluated the risk of entanglement and concluded that "the chance of whale entanglement should be considered unlikely to very unlikely" because of the absence of structures that are known to cause entanglement such as slack lines and netting. Monitoring of whales and sea turtles occurred in the project vicinity following deployment of the facility, and fin and humpback whales were observed in the vicinity, but not in the immediate area. Researchers reported in 2006 that "…no incidents related to marine mammals or turtles have occurred at the open ocean aquaculture field site and no impacts have occurred since the beginning of aquaculture activities in 1997" (Atlantic Marine Aquaculture Center 2006).[42] The findings from the Atlantic Marine Aquaculture Center are relevant to PacWave South because the New Hampshire site occurred at comparable depths (164 ft), comparable distance offshore (6 nautical miles), had a mooring system comparable to those that would be used at PacWave South, and similar species of interest were present (baleen whales [fin and humpback] and sea turtles). However, the netting of the large net pens would likely be harder for a large whale to detect than the more substantial steel of

[42] Prior to 2002, sightings data were obtained from fisherman and personnel associated with the Atlantic Marine Aquaculture Center. In 2001, the database of mammal and sea turtle sightings recorded by onboard naturalists from a local sight-seeing and whale watching commercial operation was obtained and analyzed for species of interest in the project area (Atlantic Marine Aquaculture Center 2002). From 2002 to 2006, marine mammals and sea turtles in the vicinity of the site were monitored by the University of New Hampshire and the Blue Ocean Society for Marine Conservation. From May through late October or November, trained naturalists and interns on whale watch cruises identified and recorded locations and other data on the species sighted (Atlantic Marine Aquaculture Center 2008).

WECs; thus, the fact that no impacts were observed during 10 years of monitoring is relevant to evaluating the potential risks of PacWave South.

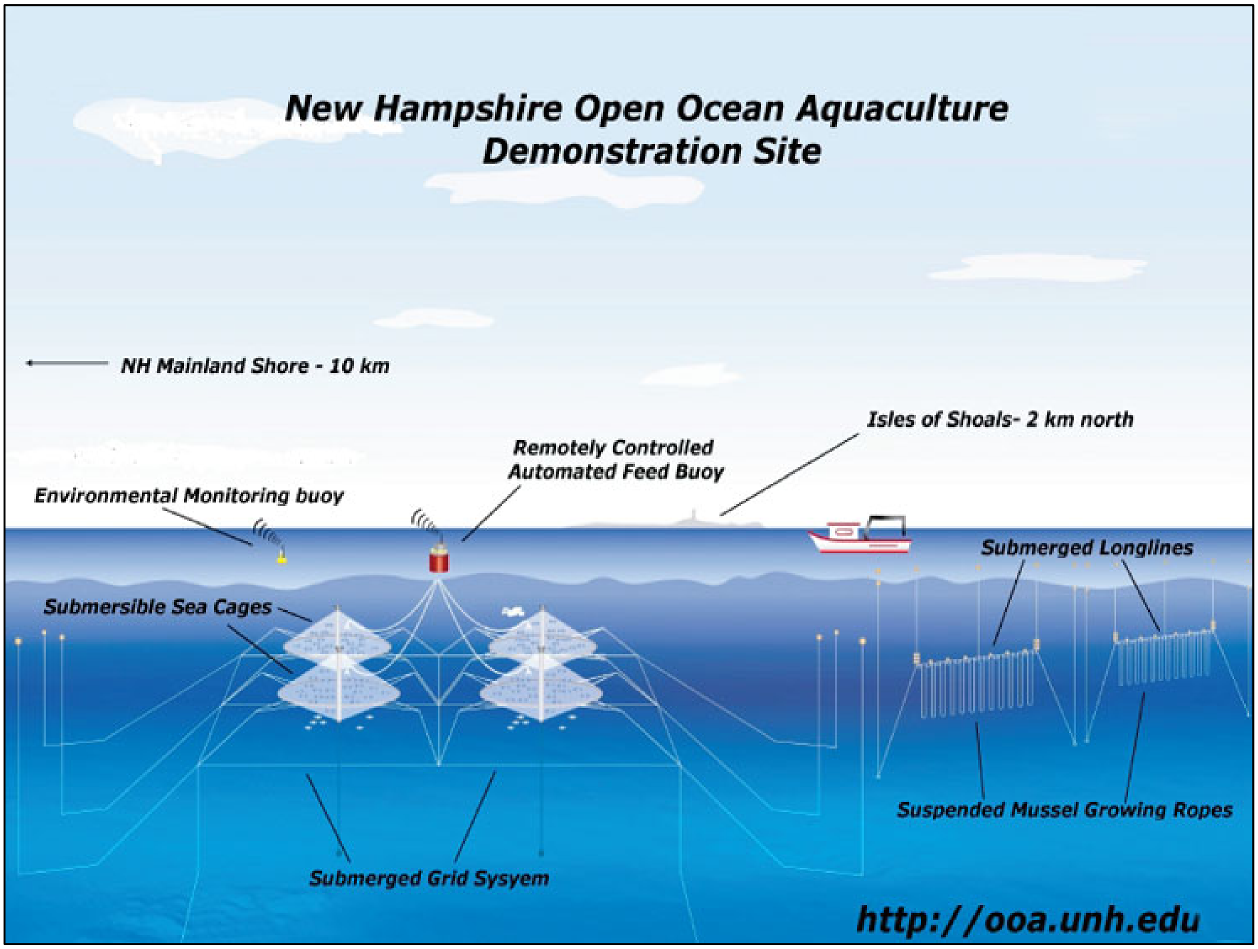

Figure 0-9. NOAA-funded New Hampshire open ocean aquaculture demonstration site (Source: Atlantic Marine Aquaculture Center 2014).

Observations of whale interactions with moored offshore net pens in Hawaii found a similar lack of effect to marine mammals (Sims 2013). This site is located a half-mile offshore in waters over 200 feet deep, with a sandy bottom and strong currents. Eight submersible net pens, each with a capacity of around 4,000 cubic yards, are centered in the 90-acre lease (e.g., approximately 0.33 nautical mile per side if square). The net pens are tied into a submerged grid anchored by 14 steel embedment anchors and chains, with 14 mooring lines at a 5:1 scope. A series of weights and buoys are attached to the chains to keep them taut, and bridles extend from the mooring grid corners to the net pen rims to hold the net pens in place. Regarding interactions of humpback whales with the farm, which are monitored as part of the project's Marine Mammal Monitoring Plan, Sims (2013) noted: "There is no definitive pattern of whales avoiding, or being attracted to the cages. Whales are occasionally seen within the lease area. On one instance, the farm workers witnessed a humpback on the surface inside the mooring grid array; the animal appeared to negotiate its path between the net pens and mooring lines with ease." Sims (2013) also reported that bottlenose dolphins frequent the site, and adverse effects have not been observed.

At the Hawaii Wave Energy Test Site (Marine Corps Base Hawaii), researchers evaluated the effects on marine mammals from the shallow-water (water depth of about 30 m) WEC test berth from 2001 to 2003, and in 2011, before and after the first WEC was installed. No marine mammals were seen or heard within 1,640 feet of the anchor or power cable (NAVFAC 2014). It should be noted that Hawaii WETS occurs in shallow water, and is nearer to shore than PacWave South.

Another potential impact that was considered is that lost fishing gear could "travel" with currents, and thus become entangled or fouled on project structures and infrastructure. Lost fishing gear could include crab pots with float lines, or trawl or other nets, some with flotation devices that could make them more likely to foul or become entangled on project structures. Marine mammals could become entangled in lost fishing gear if it accumulates at surface or underwater structures (Henkel et al. 2013). OSU would implement the Mitigation for Marine Species Entanglement or Collision (APEA, Appendix I, measure 3), to detect and remove marine debris caught on project infrastructure to minimize the potential for marine mammals to become entangled.

Toothed whales use sonar for hunting and communication, and thus would likely be able to detect and avoid an array of WECs over the license term. The large size of the WECs is expected to be readily perceived by an approaching baleen whale. Even though gray whales may be common in the project area, the risk of a gray whale colliding with a WEC, anchor, or mooring structure is expected to be low, as corroborated by baleen whale interactions with similar projects (Atlantic Marine Aquaculture Center 2008, NAVFAC 2014, Sims 2013). In addition, whales are not known to collide or entangle with taut moorings, which would be used at PacWave South; whale entanglement appears to be associated with fishing gear such as crab pots (especially buoy lines) and lost nets. OSU would implement the Mitigation for Marine Species Entanglement or Collision, to detect and remove marine debris caught on project infrastructure to minimize the potential for marine mammals to encounter lost fishing gear at the WEC test site and become entangled. OSU would require vessels in transit to/from the project site to avoid close contact with marine mammals and adhere to NMFS "Be Whale Wise" guidelines to minimize potential vessel impacts to minimize the risk of project-related vessels colliding with these species. Potential non-strike encounters (e.g., a whale approaching a service vessel that is on site) are expected to be sporadic with transitory behavioral effects and therefore would be insignificant. The small footprint of the project relative to the surrounding open ocean along the coastline also reduces the likelihood of a collision occurring. OSU would also record sightings of pinniped haul out during vessel-based monitoring and maintenance activities.

Based on the existing information, the potential for collision or entanglement with project structures or with vessels associated with the project, both at the site, and between PacWave South and Newport, over the license term, would not be expected to adversely affect cetaceans.

Effects or Risk of Collision/Entanglement to Seabirds

Seabirds could collide with proposed marine project facilities including underwater structures while swimming and foraging and potentially become entangled with marine debris (e.g., fish nets) that become attached to underwater project structures.

To minimize the risk of seabird entanglement, FWS and Oregon DFW recommend (10(j) recommendation 1 and 2, respectively) OSU implement its proposed BBCS Plan that includes measures to conduct opportunistic visual observations from the water surface in the portions of the WEC test site, that are being visited to conduct operations, maintenance, or environmental monitoring work, and review any underwater visual monitoring conducted for other purposes to detect derelict gear that has the potential to increase the risk of marine species entanglement. Documented derelict gear and its potential risk for causing entanglement would be assessed. If it poses a potential threat to navigational safety or marine species, OSU would notify the USCG, NMFS, FWS, and Oregon DFW within 7 days of detection, and would remove the derelict gear as soon as is practicable while avoiding jeopardizing human safety, property or the environment.

Our Analysis

Seabirds are unlikely to collide with above-surface project structures during periods of high visibility and low winds (Camphuysen et al. 2004, Boehlert et al. 2008, Suryan et al. 2012, Henkel et al. 2013). Avoidance rates at wind farms (e.g., avoidance by seabirds of an entire wind farm and of individual wind turbines, used to predict potential collision risk) by many species of seabirds, including terns, loons, cormorants, alcids, gulls, fulmars, and shearwaters, have been estimated at greater than 98 percent (Cook et al. 2012). The avoidance rate estimates were based on surveys conducted when sea conditions and visibility were considered good (Camphuysen et al. 2004), as such seabirds may be more susceptible to collisions with above-surface structures during periods of high winds or poor visibility (e.g., storm conditions, fog, and darkness; Boehlert et al. 2008, Suryan et al. 2012, Henkel et al. 2013). In addition, artificial lighting on WECs may increase the risk of collisions for some light-attracted seabirds (e.g., shearwaters, petrels, auklets, and murrelets) (Montevecchi 2006, Miles et al. 2010).

The presence of seabirds in the project area and opportunities to encounter project structures and WECs would likely be highly variable and dependent on factors such as prey availability (Ainley et al. 2009), seasonal migrations, and constraints by distance to breeding colonies. The seabird species likely to occur in the project area that are most susceptible to colliding with WECs include those known to fly at altitudes of less than 30 meters at least some of the time, including alcids (common murres, auklets, puffins), cormorants, storm-petrels, shearwaters, gulls, brown pelicans, and phalaropes (Geo-Marine, Inc. 2011, Suryan et al. 2012, Henkel et al. 2013). Of these species, alcids, gulls, phalaropes, storm-petrels, and cormorants may be most likely to collide with above-surface structures during high winds because they tend to fly at lower altitudes (<10 m), especially during high winds, whereas fulmars, and shearwaters would be less likely to collide with above-surface structures because they fly at higher altitudes when wind speeds increase (Ainley et al. 2015). Scoters and loons also fly at low altitudes, but they are unlikely to occur as far offshore as the project site (Strong 2009, Adams et al. 2014).

Even during times of low visibility or high winds, seabirds are unlikely to collide with above-surface structures of the project because the likelihood of encountering WECs would be low. Proposed above-surface structures would consist of a maximum of 20 WECs, extending less than 15 meters above the water surface occupying a relatively small area of marine seabird habitat. Moreover, WECs would be located at least 50 to 200 meters or more apart, which would provide ample space for seabirds to maneuver and avoid WECs.

Pursuit-diving seabirds such as alcids and cormorants, and plunge-diving seabirds such as brown pelicans, gulls, and shearwaters could collide with underwater WEC components or become in entangled in marine debris (e.g., lost fishing gear, plastic trash) if it attaches to and accumulates onto underwater components (Henkel et al. 2013) or be crushed or entrapped by moving parts. The species likely to occur in the project area are unlikely to collide with submerged WEC structures, because they are agile swimmers and have high underwater visual acuity (Henkel et al. 2013). Diving seabirds have to capture highly mobile prey in very low visibility temperate waters along the Pacific Coast with a turbidity range on a large scale of 5 to 30 meters (Secchi depth, Ainley 1977) and on a much smaller scale (i.e., in Monterey Bay) of 3 to 9 meters (Secchi depth, Laird 2006). For example, alcids (e.g., common murres, tufted puffins, and murrelets) are wing-propelled pursuit divers that swim rapidly (approximately 1 meter per second) to pursue and capture mobile prey such as schooling fish, and can veer, turn, and glide underwater (Johnsgard 1987); thus, it is expected that their vision and agility is adequate for navigating around submerged structures.

As discussed in the section above, OSU's proposed measures regarding project lighting would minimize the risk of nighttime collisions (e.g., using low-intensity flashing lights). OSU's proposed plan to monitor and remove potentially harmful marine debris would minimize the risk of entanglement by marine species.

EMF Emissions on Species Sensitive to Electric and Magnetic Fields

Concern about the potential effects of anthropogenic electromagnetic fields (EMF) on marine organism is widespread but knowledge of such effects is very limited (Polagye, 2010; DOE, 2009). A variety of fish and other organisms have been found to be sensitive to EMF fields, and it is known that some fish use them for navigation or feeding. In some circumstances this sensitivity to EMF could affect fish movement and feeding.

OSU proposes to implement an EMF Monitoring Plan (APEA Appendix H) respectively) to detect and, if needed, mitigate any unanticipated adverse effects of EMF emissions from WECs (APEA, Appendix I, measure 1). The objective of the EMF Monitoring Plan is to evaluate the EMF levels produced by the WECs, by using existing models to estimate the expected EMF output of the WECs and validating the model estimates using field measurements. If results of modeling and/or field surveys indicate that EMF attributable to the WECs has the potential to elicit a behavioral response from green sturgeon, salmonids or other species of concern (i.e., 3 millitesla, based on Woodruff et al. 2012, Normandeau Associates et al. 2011, Gill 2016, and newer information), and exceeds the mitigation threshold, adaptive management and mitigation measures to address the unanticipated adverse effects would be implemented by OSU (APEA, Appendix I).

During the pre-filing application process, NMFS and Oregon DFW recommended that OSU monitor EMF levels produced by the WECs and, if levels exceed those that would elicit a behavioral response from fish species of concern (i.e., 3 millitesla, based on Woodruff et al. 2012, Normandeau Associates et al. 2011, Gill 2016, and newer information), implement mitigation measures (APEA, Appendix I, measure 1) to address the unanticipated adverse effects. Oregon DFW and FWS (10(j) recommendation 1 and 2, respectively) and NMFS EFH recommendation 3, recommend and NMFS term and condition 2 requires that OSU implement the EMF Monitoring Plan.

Our Analysis

Ambient, natural EMF emissions in the ocean come from three sources: the geomagnetic field of the earth, electric fields induced by the movement of charged objects (e.g., currents/waves, organisms) through a magnetic field (i.e., induced electric field, iE), and bioelectric fields produced by organisms (Slater et al. 2010a, Normandeau et al. 2011, Gill et al. 2014, Bedore and Kajiura 2013). EMF includes both the electric field (E-field, measured as the voltage gradient in V/m) and the magnetic field (B-field, measured in tesla [T] or gauss [G]; 10,000G=1T; Slater et al. 2010a).

Wave, tidal, and current motion of seawater, an electrolyte, through the Earth's magnetic field induces electric fields (Slater et al. 2010a). The earth's magnetic fields off Reedsport, Oregon is estimated at 52.2 microteslas (µT) [~52,000 nanoteslas (nT)] and is largely vertical (Slater et al. 2010a). EMF in the ocean at the Reedsport site was modelled by incorporating the influence of ocean conditions (e.g., currents, waves) on the earth's magnetic field. Based on the wave climate at the Reedsport site, at surface (where effects are likely the strongest), electric fields are expected to range from 6 to 216 µV/m, and would be observed between 0.04 and 0.3 Hertz (Hz), with maximum induced magnetic fields due to wave motion ranging from 0.02 to 0.54 nT. The maximum electric fields generated by tidal motion are expected to be 33 µV/m, and the maximum magnetic fields because of tidal sources are expected to be 0.08 nT (Slater et al. 2010a). Coastal currents are expected to generate electric fields up to 22 µV/m, although higher values may be observed, with potential values in extreme current flows of up to 44 µV/m and corresponding estimated magnetic field values would be 0.06 nT (Slater et al. 2010a). Because of the similar levels of the earth's magnetic field, wave climate, tidal motion, and coastal currents at Reedsport and the project area, it is expected that EMF modeled at Reedsport would be similar to that in the project area; however, there is uncertainty about the underlying geology at PacWave South that may affect ambient conditions.

EMF transmissions would be generated by the WECs, the umbilical cables (connecting the WECs to the subsea connectors), the hubs and subsea connectors, and the subsea cables to the shore. Each test berth could accommodate a WEC or array of WECs with a maximum capacity, based on cable specifications, of 8 MW (although not all 4 berths could be at capacity at any one time); the capacity of the umbilical cables would correspond with the WECs. The subsea cables would be three-conductor (3C), AC cables, with approximately 70 mm^2 copper conductors bundled together into a typical 3C submarine power cable configuration with a total diameter of approximately 10 cm. Each of these cables is estimated to have a rated capacity of up to 35 kV. Because the power cables would be shielded and armored, they would not emit any electric fields directly; however, electric fields could be induced by the movement of fish and currents through the magnetic fields produced by the cable.

Observations at energized transmission cables indicate rapid dissipation of EMF with distance from the cables. In studies of the Las Flores Canyon submarine power cables (6- 7-inch diameter, 36-kV, unburied) that cross the Santa Barbara Channel to oil platforms, EMF (as recorded in µT– a measure of the magnetic field) is reported to dissipate to background levels at a distance of about 1 meter from the cable (Love et al. 2015, 2016). Studies of a 33-kV three-conductor buried power cable crossing the River Clwyd in Scotland indicate measureable (nT – 1,000 times smaller than the µT measured by BOEM for the Las Flores Canyon cables) magnetic fields up to 10 metrers away from the cable (CMACS 2003). Field magnetic profiles of 10 subsea cables, many of which transmit considerably higher voltage than the 36-kV cables at PacWave South, indicate very rapid decay of magnetic field strength moving away from the cable (Normandeau Associates et al. 2011).

As a general rule, the higher the power output from a WEC, the higher the electrical current transmitted through AC cables and hence the stronger the emitted magnetic field and iE-field (Gill 2016). It is notable, however, that there is 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, Bull 2015, Gill 2015). These cables likely carried much larger currents than the proposed project cables at full build-out, all of them were unburied cables, and they all still showed an exponential decline that reached near ambient levels by around 2 meters 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 meters from the cable, and it is expected this to be similar at the project site (Normandeau et al. 2011, Bull 2015, Gill 2015). From the offshore WEC test site, the majority of the cables would be buried 1-2 meters (3-6 feet) below the seafloor, except within the footprint of the test site. Burial of the cable at a depth of 1-2 meters would reduce the magnetic field at the seafloor by around 80 percent (Normandeau et al. 2011). Therefore, it is likely that EMF generated by the project cables would be similar or less than other cables that have been measured, and that EMF generated by power cables above ambient levels would not extend much beyond 1-2 meters. Physical burial of most of the project cables would additionally minimize any likelihood of exposure.

Models based on fundamental physics have been used to estimate the strength of localized EMF generated by a point source (i.e., an energized WEC; Slater et al. 2010b). Model results indicate that the EMF in the nearshore marine environment decrease rapidly with distance from the source, decreasing to minimum levels of instrumentation detection meters of the WEC (Slater et al. 2010b). Models have also developed to estimate the EMF generated by subsea transmission cables (Slater et al. 2010c, Normandeau et al. 2011). Three-conductor cables can either be individually shielded or have an outer shield encompassing all three conductors (Slater et al. 2010c); the three-conductor with a common shield has the lowest electric and magnetic field strengths compared to individually shielded three-conductor cables (Slater et al. 2010c); this is the type of cable planned for the project. Modeling results indicate that EMF of the strength that could be detected by species is limited to a distance of much less than 10 meters 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, Gill 2016). Because the majority of the subsea cables would be buried, there is little uncertainty related to EMF transmission given our understanding of existing cables and the capability to model EMF. However, there is some uncertainty in applying these results to WECs at PacWave South because specific EMF characteristics of WEC types and subsea connectors are not known. These uncertainties would be addressed in part by the EMF Monitoring Plan.

Electric field detection occurs by fish with specialized electroreceptors that include electroreceptive elasmobranchs (e.g., sharks, skates, and rays) and holocephalans (e.g., ratfish), and electrosensitive agnatha (e.g., lamprey), acipenseriformes (e.g., sturgeon), and some teleost fish (Normandeau Associates et al. 2011, Gill et al. 2014). Electroreception is used to detect bioelectric fields emitted by prey, detection of mates, and potentially to detect predators, as well as for short- and long-term movements or migration (Normandeau Associates et al. 2011, Gill et al. 2014). Elasmobranchs and holocephalans are the most electroreceptive marine animals because of specialized electroreceptive organs, the Ampullae of Lorenzini, which can detect very weak electric fields as low as <5-20 nanovolt per meter (Fisher and Slater 2010, Normandeau Associates et al. 2011, Gill et al. 2014). Elasmobranchs are repelled by strong anthropogenic electric fields (Gill et al. 2014). Electroreceptive teleost fish have a minimum sensitivity level of about 0.01 mV/meter (Normandeau Associates et al. 2011) and may respond to strong electric fields 6-15 V/meter (Gill et al. 2014).

Some animals use geomagnetic fields to orient during migration; animals that are considered to be capable of this include cetaceans, sea turtles, certain fish and crustaceans, and mollusks (Gill et al. 2014). Species in the project area that may be capable of detecting magnetic fields include Dungeness crab, salmonids, sturgeon, and leatherback sea turtles (Normandeau Associates et al. 2011). Fish, in particular salmonids and scombrids (e.g., tuna), have a magnetite receptor system and respond to magnetic fields in the 10-12 μT range (Normandeau Associates et al. 2011). In the laboratory, juvenile salmon, when subjected to the magnetic field intensity and inclination angles similar to those found at the latitudinal extremes of their ocean distribution (northern and southern intensity used in laboratory experiments of 555.5 μT and 444.6 μT), change their orientation (e.g., direction of swimming) and subjecting fish to unnatural pairings of field intensity and inclination resulted in more random orientation (Putman et al. 2014). Dungeness crab have also been examined in the laboratory, and only subtle changes in behavior were observed for relatively high thresholds of B-field (from ~0.05 mT background to 1.0-1.2 mT direct current (DC), considered an upper bound of an anthropogenic source that might be encountered based on reviewed literature; Woodruff et al. 2012).

Multiple projects on the U.S. West Coast have evaluated or are evaluating EMF at subsea cables and biotic interactions, indicating very minor, limited interactions. In particular, BOEM has evaluated effects of EMF from power cables by conducting in-situ studies of powered and unpowered cables using SCUBA and ROV surveys (Love et al. 2015, 2016). Results from three years of surveys included:

- "Researchers did not observe any significant differences in the fish communities living around energized and unenergized cables and natural habitats;

- They found no compelling evidence that the EMF produced by the energized power cables in this study were either attracting or repelling fish or macro invertebrates;
- EMF strength dissipated relatively quickly with distance from the cable and approached background levels at about one meter from the cable;[43] and
- Cable burial would not appear necessary strictly for biological reasons" (BOEM 2016).

These study results are applicable to the project area because the transmission cables are approximately the same rated voltage; however, the effects at PacWave South would be even less because the subsea cables would be largely buried creating a physical separation from the EMF produced by cables.

The MARS cable, which carries 10,000 volts of electricity directly to a science node for the cabled ocean observing system, is a 52-km (32-mile) DC power and data cable that was plowed in until reaching the shelf break, where it continues unburied to the science node at a depth of 891 m. Evaluations in 2007-2008 and 2010 (37 months post cable installation, Kuhnz et al. 2011) of the cable and biota indicated that abundance of most animals observed did not differ between the area over the cable route and 50 meters away. However, in 2008, before the cable was powered, longnose skates were significantly more abundant along a short section at ~300 meter depth, near minor (<10 cm) suspensions of the cable above the seafloor (Kuhnz et al. 2011). Longnose skates may have responded to mild electromagnetic fields generated by components of the cable; however, in 2010, when the cable was powered, no significant difference in the abundance of skates was observed near the cable compared to 50 meters away (Kuhnz et al. 2011). Field measurements of EMF were not taken (Kuhnz et al. 2011).

The OOI Site-Specific EA (TEC Inc. 2011) provided an assessment of the effects of the power and data cables, buoys, deployment platforms, moorings, junction boxes, and mobile assets (i.e., autonomous underwater vehicles and gliders) on the environment. The approximately 900-km-long, 10-kV power and data cable initiates on land at Pacific City, north of Yaquina Bay, to support the offshore OOI project components; the assessment indicated negligible effects of EMF on marine biota, which were attributed to armoring, burial, and lower than background levels of magnetic fields (TEC Inc. 2011).

EMF emissions from the project are expected to be minor and limited to the immediate vicinity of the WECs and cables. As described above, previous studies on EMF from subsea cables observed little or no behavior change in invertebrates or fish, and similar lack of responses are expected at PacWave South. However, there is a higher

---

[43] EMF readings from a 35- kV unburied AC power cable measured ~110-120 µT at cable surface (Love et al. 2016).

uncertainty about EMF emissions from WECs, which has not been measured. While there is uncertainty about whether electro- and magneto-sensitive species would be capable of detecting EMF emissions from the WECs, as well as the type and degree of these species' responses to EMF from WECs, the proportion of a given population that might be exposed to site-specific EMF generated by the project is expected to be low for most of these species due to factors such as migratory range and available habitat, and low likelihood of exceeding biologically relevant EMF transmissions from WECs.

Even if individuals encounter and are exposed to magnetic fields, any potential effects are expected to be short term and minor, because of the very localized fields relative to the earth's geomagnetic field potentially being used for navigation; therefore, these species are not expected to be affected by EMF. Bottom-oriented fish could be more exposed to EMF from the subsea cables than pelagic fish; however, the cables would be shielded, armored, and buried for the most part, limiting exposure to EMF. Based on the low levels of EMF expected, and spatially limited exposure to fish, it is anticipated that relatively minor, short-term potential effects, if any, could occur, and that the EMF Monitoring Plan within the Adaptive Management Framework (Appendix J) and implementation of the mitigation measures, if necessary, (APEA, Appendix I, measure 1) should minimize any potential effects.

Effects on Bats in the Marine Environment

No bats are expected to be affected by the proposed project at the WEC test site. Although hoary bats are known to occur offshore during fall migration and could encounter WECs, they would not be expected to collide with the structures given their ability to echolocate and detect structures. Hoary bats will use artificial structures for roosting during migratory periods (D. Johnston, unpublished data). Because the project provides artificial structures in a marine environment that has almost no other options for temporary roost sites, hoary bats could roost on the WECs or marker buoys. Potential attraction of migrating bats to project structures could potentially increase their risk of predation if they were flying during the day. However, any bats migrating during the day would already be susceptible to predation and such predation risk is unrelated to the proposed project. Therefore, no impacts on bats are expected in the marine environment.

Effects on Fish in Surface Streams

Ground-disturbing activities and the presence of heavy machinery during construction have the potential to result in erosion and sedimentation or runoff of toxic materials into nearby streams adversely affecting fish habitat.

To minimize effects of project construction on fish habitat in the project area, OSU proposes to follow best management practices to avoid or minimize potential effects of soil erosion by minimizing the time that ground is disturbed and by using HDD to install the transmission line. OSU would avoid construction activities near Friday Creek at the entrance to the Driftwood (no streams are located at the UCMF site). OSU also proposes to develop and implement an erosion and sediment control plan to minimize effects of ground-disturbing activities associated with installation of the terrestrial transmission lines and/or other construction on the UCMF site.

Oregon DFW and FWS recommend (10(j) recommendation 8 and 4, respectively) that OSU use HDD to install the terrestrial transmission lines to avoid ground-disturbing activities associated with traditional construction methods.

Our Analysis

Adverse effects on fish habitat has the potential to occur during ground-disturbing activities at Driftwood and at the UCMF site if sediment-laden runoff from construction work areas enters nearby streams and results in increased turbidity. Three small fish-bearing streams have the potential to be affected by construction activities at Driftwood and along the transmission line route. OSU would avoid ground-disturbing activities along the terrestrial transmission line route by using HDD for installation and by avoiding ground-disturbing activity near Friday Creek at the entrance to the Driftwood There are no streams located at the UCMF site. Implementing OSU's proposed erosion and sediment control plan and appropriate BMPs would minimize effects of ground-disturbing activities on fish habitat.

Releases of diesel fuel, lubricants, hydraulic fluid, and other contaminants contained in construction equipment potentially could result in adverse effects on fish, invertebrates, and instream habitat. Implementation of a stormwater management plan to minimize runoff of hazardous substances and sediment during onshore construction would minimize adverse effects on fish habitat.

As discussed in section 3.3.2.2, installation of the terrestrial transmission line using HDD could result in inadvertent returns of drilling fluids to a nearby streams. HDD uses a slurry, composed of a fine clay material such as bentonite, as a drilling fluid. The drilling fluids are non-toxic but aquatic habitats can be temporarily impacted and affect benthic invertebrates, aquatic plants, fish, and fish eggs can be smothered by the fine particles if drilling fluids are discharged to waterways. The depth of the HDD boring operations would be designed so that there is a low risk of inadvertent return of drilling fluids. Inadvertent return during HDD is considered highly unlikely. Implementing an HDD plan with contingencies would minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor. Through implementation of construction BMPs, no detrimental effects to freshwater fish are expected from hazardous materials releases.

Fish or Wildlife Emergency

OSU proposes to notify agencies with regulatory authority as soon as possible in the event of a fish and wildlife emergency where fish or wildlife are being killed, harmed, or endangered by project facilities or operations in a manner that was not anticipated (APEA measure 20). OSU proposes to promptly take action to minimize the impacts of the emergency, including implementing any guidance pursuant to agency legal authorities. Within 48 hours after the emergency, OSU would notify the agencies regarding the results of actions taken to minimize impacts to fish or wildlife and consult with the agencies regarding whether additional actions are necessary to comply with federal, state or local law.

FWS recommends (10(j) recommendation 2) that any occasion of a WEC having moved outside of its operational boundary (as described in the FLA Emergency Response Plan, Appendix H to the APEA) constitutes a fish or wildlife emergency under measure 20. In response, OSU points out that a WEC moving outside the operational boundaries of the deployment site does not necessarily constitute a fish and wildlife emergency. For example, OSU states that if a WEC moves a short distance and then stops, it may be the result of an anchor shifting or an issue with a mooring line, and such a situation would not necessarily kill, harm, or endanger wildlife.

Our Analysis

Although not anticipated, an emergency situation could occur at the facility and cause harm to fish or wildlife. For example, if a WEC were to break away from its mooring and move well beyond its operational boundary, the free-floating device and trailing mooring lines would pose a serious threat to marine mammals (collision and entanglement) and to other fish and wildlife (substrate disturbance and toxic fluid exposure) if the WEC grounds into the nearshore bottom substrate or on the beach.

Notifying the agencies within 48 hours of any emergency situation associated with the project that causes fish or wildlife to be killed, harmed, or endangered, would give the agencies the opportunity to visit the site within a reasonable amount of time to assess the effects and the effectiveness of the implemented mitigation measures during any of these events. Such an assessment would be beneficial because the agencies could provide OSU and the Commission with recommendations for ways to prevent future emergencies from occurring.

Decommissioning Plan

OSU proposes to develop a decommissioning plan to remove project facilities and restore the site in the future as the license term nears its end.

FWS recommends (10(j) recommendation 5) a license article requiring OSU to consult with the FWS and other resources agencies at least three years prior to the expiration of the license term regarding removal and decommissioning, and to submit a draft plan for review and comment no later than two years before the expiration of any license term. In the event the project is proposed to be decommissioned for any reason, Oregon DFW recommends (10(j) recommendation 10) that OSU develop a decommissioning plan in consultation with and subject to approval by Oregon DFW, to include the following elements:

- A decommissioning schedule;
- A description of removal and containment methods;
- Description of site clearance activities;
- Plans for transporting and recycling, reusing, or disposing of the removed project components, including removal of all anchors and equipment from the water at the time of decommissioning and destination location of appropriate land-based permitted disposal or storage facility;
- A description of those resources or conditions, and activities that could be affected by or could affect the proposed decommissioning activities;
- Results of any recent habitat or biological surveys conducted in the vicinity of the structures;
- Mitigation measures to protect sensitive biological features during removal activities or subsequently restore habitat features;
- Description of methods that will be used to survey the area after removal to determine any effects on marine life or habitat;
- Description of how the licensee will restore the site to the natural condition that existed prior to the development of the project area;
- Plans to conduct post decommissioning underwater visual surveys to demonstrate that all equipment has been removed and habitat has been returned to its pre-installation state; and
- Plans to provide a report of post-decommissioning survey results.

Our Analysis

The proposed action under review is to authorize the construction, operation, and maintenance of the project. Therefore, this EA does not assess the environmental effects of decommissioning the project.

3.3.3.3 Cumulative Impacts

The marine ecosystem in the vicinity of PacWave South is exposed to past and ongoing disturbances, such as such as bottom trawling and other types of fishing, deposition of dredged material at the Yaquina Ocean Dredged Materials Disposal Site, and frequent vessel traffic. The project would vary from these ongoing disturbances because OSU would construct and operate in-water structures. Specifically, effects related to changes in the local marine community resulting from the presence of project components in an area generally devoid of vertical habitat features; increased opportunity for pinniped haulout and seabird perching; long-term lighting associated with offshore development; and changes to wave energy due to presence of in-water structures would only contribute to cumulative impacts in conjunction with the limited number of small scale off-shore renewable energy projects, such as PacWave North or Camp Rilea.

There is low potential for low-flying seabird species (e.g., common murres, Cassin's auklets, rhinoceros auklets, gulls, phalaropes, and cormorants) to collide with above-surface structures or for baleen whales to collide with mooring lines or cables in the water column, especially during periods of higher abundance (e.g., summer and/or fall for seabirds) and during periods of low visibility or high winds. project design components may reduce the potential for collisions; in particular, the spacing of the WECs would likely be 50 to 200 meters or more apart, which should provide ample space for seabirds and marine life to maneuver between them. In addition, the likelihood of seabirds or baleen whales encountering project structures is low because of the relatively small area of the submerged and above-surface structures (maximum of 20 WECs) compared to the available at-sea habitat.

Of the other past, present, and reasonably foreseeable activities in the area, PacWave North and Camp Rilea could also pose a collision risk to seabirds from above-surface structures or to baleen whales from below-surface structures of WECs. However, PacWave North is 9 nautical miles from the proposed project and limited to a maximum of two WECs at a time. The potential cumulative impacts of seabird and whale collisions from these two projects are expected to be negligible because of the distance between the projects, the overall low likelihood of collisions at each project, and the small area occupied by the WEC test site relative to the expansive ocean area.

Potential habitat changes (i.e., biofouling) at PacWave South would occur during the same timeframe as PacWave North, and the proposed Camp Rilea Ocean Renewable Energy Project, but would be geographically separated, given that PacWave North is about 9 nautical miles from the proposed project, and Camp Rilea Project would be about 125 nautical miles away, and project build-out would be phased over the course of several years. Thus, potential cumulative habitat changes are expected to be negligible. The distance between these projects diminishes cumulative impacts due to changes in marine community composition, increased pinniped haulout and seabird perching, artificial lighting, and changes to wave energy.

As discussed above, sound generated by operating WECs is expected to be less than the injury level for cetaceans or pinnipeds, but WEC operation might generate underwater sound exceeding the 120-dB threshold for marine mammal behavioral disturbance within 125 meters of a WEC (NAVFAC 2014). Sound from vessels would be localized and would be similar to existing vessel traffic surrounding Yaquina Bay. Sound generated by the OOI is not expected to have any significant impacts on fish and marine mammals because most active acoustics sensors used for monitoring (e.g., acoustic Doppler current profilers) would operate at higher frequencies than those considered audible by fish and marine mammals (e.g., >180 kHz), and for those that operate at lower frequencies (e.g., 2-170 kHz for sensors on autonomous underwater vehicles), fish and marine mammals would not be disturbed due to the low duty cycles of the WECs, the brief period when an individual animal would potentially be within the very narrow beam of the source, and the relatively low source levels (OOI 2011). The distance between the three reasonably foreseeable offshore marine and hydrokinetic energy projects diminishes cumulative impacts due to sound. Thus, potential cumulative impacts from sound are expected to be negligible.

EMF emissions from the project are expected to be minor and localized, limited to the immediate vicinity of the cables, although EMF emissions from WECs have a greater degree of uncertainty and has not been measured. Previous studies on EMF from subsea cables observed little or no behavior change in fish, and similar lack of responses are expected at PacWave South. PacWave North does not have a cable to shore, so the EMF emissions are limited to the WECs associated with the project. The Camp Rilea project is 125 nautical miles away from PacWave South, and the EMF emissions from this project would also be very minor and localized, with likely no significant impact on fish. EMF from the OOI Project would also not be expected to have any significant impact on fish due to the low voltage transmitted from the cable, the smaller cable size, and the armoring and burying of the cables (OOI 2011). Thus, potential cumulative impacts from EMF emissions are expected to be negligible.

Significant effects on bats at the WEC test site are not expected to occur, nor would they be expected at Camp Rilea because the SurgeWEC™ does not penetrate above the water's surface, nor the OOI project because of the very small size of the buoys.

When considered together with other relevant past, present, and reasonably foreseeable actions, project impacts are not expected to contribute to cumulative adverse effects on the marine or freshwater environment, including marine protected species and sensitive habitats.

3.3.4 Terrestrial Resources

3.3.4.1 Affected Environment

Upland Vegetation

The terrestrial environment in the vicinity of the land-based project components includes the sandy beach area that would be crossed by the cable, developed recreational area (i.e., Driftwood) where the HDD conduits would exit via a manhole, the terrestrial habitat under which the cables would extend via HDD from the Driftwood to the UCMF and potentially from the UCMF to the grid connection point, and a vegetated area where the UCMF would be built.

The upland vegetation communities surrounding these project components are maritime forest, grass-shrub-sapling/regenerating young forest, coastal dunes, and mixed conifer/deciduous forest (Kagan et al. 1999). HDR (2016, 2017, 2019) conducted field surveys in May 2016, June 2017, and February 2019 of the project area to characterize terrestrial habitat. Forest stands are typically dominated by western hemlock, Sitka spruce, and shore pine with some western red cedar and red alder interspersed. Understories are typically dense with shade-tolerant plants, including evergreen shrubs (e.g., salal, evergreen huckleberry), forbs (e.g., twinflower and false lily-of-the-valley) and ferns (e.g., western sword fern, wood fern, deer fern). The surrounding forest is fairly fragmented due to housing developments and timber harvesting. In general, large tracts of land in Lincoln County are second and third generation woodland, having been logged and replanted over the years (3U Technologies 2013). Intermixed with these habitats are residential housing and associated roads.

Wetlands, Riparian, and Littoral Habitat

Wetlands provide a multitude of ecological benefits, providing habitat for fish, wildlife, and a variety of plants. Based on available wetland data from Oregon Wetlands Explorer (ORNHIC and The Wetlands Conservancy 2009), marine tidal wetlands are present on the beach near the terrestrial project components. The littoral habitat was comprised mainly of broad sandy beach that varies from unvegetated intertidal area to partially vegetated back dunes. Oregon DFW considers coastal dunes a strategy habitat in the Oregon Conservation Strategy (Krutzikowsky et al. 2016). Oregon DFW notes that threats to coastal dunes include beachgrass invasion, increased development, and recreation impacts (Krutzikowsky et al. 2016).

A total of four freshwater wetlands (Wetland C, D, H, and I) were delineated in the terrestrial project area (i.e., Driftwood and UCMF) during wetland and waterway surveys conducted in May 2016 and June 2017 (Figure 3-5; HDR 2017). Wetland C is a 0.11-acre forested wetland, Wetland D is a 0.31-acre scrub-shrub/emergent wetland,

Wetland H is a 0.27-acre scrub-shrub/emergent wetland, and Wetland I is a 0.15-acre emergent wetland (HDR 2017, 2019).

In 2019, a wetland and waterway survey was also conducted along the terrestrial HDD corridor, which included an extension of Wetland D as well as three stream features (Buckley Creek, Friday Creek, and "Stream 4). Wetland D, along with the 0.31 acre identified in the previous survey, collectively consisted of 2.93 acres of a forested/scrub-shrub wetland (Figure 3-5) (HDR 2019). Dominant species include shore pine, salal, salmon raspberry, and spirea. Streams are discussed in Section 3.3.2, and a detailed description of each wetland and stream is provided in the Wetland Delineation Report (HDR 2017, 2019).

Special-status Plant Species

The following special-status plant species, which are known to occur in Lincoln County (HDR, 2017): pink sand-verbena (FWS federal species of concern), Point Reyes bird's beak (federal species of concern and Oregon endangered species), and coast range fawn lily (federal species of concern and Oregon threatened species).

Pink sand-verbena (*Abronia umbellate var. breviflora*) is a federal species of concern and an Oregon endangered species. Pink sand-verbena can be either an annual or occasionally a short-lived perennial. In the northern portion of its range, from Oregon north to Vancouver Island, populations occur on broad beaches and/or near the mouths of creeks and rivers. The species usually occurs on beaches in fine sand between the high-tide line and the driftwood zone, in areas of active sand movement below the foredune. No populations or individuals of pink sand-verbena were observed during rare plant surveys conducted between May 31 and June 3, 2016, or June 21-22, 2017.

Point Reyes bird's beak (*Cordylanthus maritimus ssp. palustris*) is a federal species of concern and an Oregon endangered species. In Oregon, the species is restricted to Netarts Bay, Yaquina Bay, and Coos Bay, with the majority of known occurrences located in Coos Bay. Point Reye bird's beak inhabits the upper end of maritime salt marshes at approximately 2.3-2.6 meters (7.5-8.5 feet) above mean lower low water, the mean height of water at the lowest of the daily low tides), in sandy substrates with soil salinity 34-55 parts per trillion (ppt), and less than 30 percent bare soil in summer. No populations or individuals of Point Reyes bird's beak were observed during the rare plant surveys. No maritime salt marshes were documented within the terrestrial study area, and suitable habitat for Point Reyes bird's beak was not observed during the rare plant surveys conducted between May 31 and June 3, 2016, or June 21-22, 2017.

Coast Range fawn lily (*Erythronium elegans*) is a federal species of concern and an Oregon threatened species. Coast Range fawn lily is restricted to the Coast Range of northern Oregon. It is known to occur at six primary sites, each occurring on prominent peaks and ridges separated by up to 48 km (30 miles), resulting in a fragmented distribution among high-elevation islands of habitat separated by lower elevation coniferous forests. This species is found in a variety of Coast Range habitats, including meadows, rocky cliffs, brushland, open and closed coniferous forest, and the edges of sphagnum bogs at elevations above 790 meters (2,600 feet). No populations or individuals of coast range fawn lily were observed during rare plant surveys conducted between May 31 and June 3, 2016, or June 21-22, 2017. The terrestrial study area did not extend to elevations above 790 meters, and therefore, suitable habitat for coast range fawn lily was not documented.

Kinnikinnick (*Arctostaphylos uva-ursi*) is a host plant for seaside hoary elfin, a butterfly that is known to occur in the project area. Kinnikinnick is native on the west coast from Northern California to Alaska, and grows on sandy slopes, exposed rocky banks, dry subalpine meadows, and coniferous forests. It spreads slowly but can grow into a mat as big as 15 feet (OSU 2016). HDR documented kinnikinnick in several locations throughout the study area. All kinnikinnick was found in disturbed areas adjacent to paved areas, on the west side of Highway 101, or adjacent to a dirt road (NW Wenger Lane), on the east side of Highway 101. The majority of kinnikinnick was found within Driftwood and was likely previously documented by Oregon State Parks and Recreation studies.

Terrestrial Wildlife

The moderately open multi-story forest and wetlands in the project area and at the UCMF location may support a number of wildlife species depending on season, species behavior, and specific habitat availability.

Mammal species that could occur in the project area includes Baird’s shrew, black bear, black-tailed deer, bushy-tailed woodrat, California ground squirrel, coast mole, common porcupine, common raccoon, coyote, creeping vole, deer mouse, Douglas' squirrel, fog shrew, house mouse, long-tailed weasel, Pacific shrew, Pacific water shrew, and white-footed vole (OSU and INR 2014). Based on capture records for Lincoln County from Ormsbee et al. (2010) and unpublished acoustic data (ODFW 2015) bat species potentially occurring in the project area include big brown bat, California myotis, fringed myotis, long-legged myotis, Yuma myotis, little brown bat, long-eared myotis, hoary bat, Townsend’s big-eared, and silver-haired bat.

More than 200 bird species could occur along the proposed inland cable route as residents, migrants, or transients including several species of heron, egret, hawk, gull, woodpecker, dove, and songbird (Marshall et al. 2006). Several special-status species could also occur including harlequin duck, bald eagle, peregrine falcon, rufous hummingbird, olive-sided flycatcher, willow flycatcher, purple martin, and purple finch.

Amphibians that could occur in the project area include clouded salamander, ensatina (a salamander), northwestern salamander, Pacific chorus frog, Pacific giant salamander, red-legged frog, rough-skinned newt, and southern torrent salamander. Reptiles that could occur in the project area include common garter snake and northern alligator lizard (OSU and INR 2014).

Bird species associated with nearshore waters where the cable landing site would be located, include harlequin duck, surf scoter, white-winged scoter, black scoter, long-tailed duck, red-throated loon, Pacific loon, common loon, red-necked grebe, eared grebe, western grebe, Brandt's cormorant, double-crested cormorant, pelagic cormorant, brown pelican, red-necked phalarope, red phalarope, common murre, pigeon guillemot, Cassin's auklet, rhinoceros auklet, tufted puffin, and gulls (e.g., western, herring, Thayer's, California, glaucous-winged, Bonaparte's, Mew, and Heermann's gulls) (Marshall et al. 2006). Shorebird species likely to occur on wide sandy beaches at the cable landing site include black oystercatcher, semipalmated plover, killdeer, whimbrel, marbled godwit, ruddy turnstone, black turnstone, sanderling, dunlin, least sandpiper, and western sandpiper (Marshall et al. 2006). Other bird species that could occur on the sandy beaches at the cable landing site include brown pelican, great blue herons, snowy, and great egrets, turkey vulture, osprey, bald eagle, and gulls.

According to Oregon PRD, the seaside hoary elfin (*Callophrys polios maritima*), a rare species of butterfly, is found in Driftwood, with habitat found throughout the park in upland areas. Oregon PRD reported that recent taxonomic work revealed that the population at Driftwood may be the only remaining population of the butterfly, because it was found to be distinct from other populations (personal communication with K. Duzik, Oregon PRD, October 29, 2014). This species is ranked as Critically Imperiled in Oregon by the Oregon Biodiversity Center, and the genetically distinct population in Lincoln County is presently the only one of its kind known location in Oregon. Its habitat is relatively undisturbed coastal sand flats and associated shore pine forest edges and openings that support extensive stands of its larval host plant, kinnikinnick (bearberry). As discussed above, kinnikinnick was documented in several locations throughout the terrestrial project area.

3.3.4.2 Environmental Effects

Effects on Upland Habitat

Project construction activities have the potential to temporarily displace or disturb wildlife and botanical resources in the immediate vicinity of the project. Construction of above-ground onshore project structures, specifically the UCMF, would result in alteration and loss of habitat. Habitat disturbance could also result in the potential spread of invasive plant species.

To minimize potential impacts on terrestrial resources OSU proposes to:

- Use HDD to install proposed transmission cable conduits under beach and sand dune habitat and from the existing parking area at the Driftwood to the UCMF to minimize effects to terrestrial habitats.
- Develop a revegetation plan, in consultation with NMFS, Oregon DFW, and appropriate agencies, using native species to the extent practicable for areas disturbed during construction. This plan would include the minimization measures identified by NMFS and Oregon DFW as appropriate.
- Develop measures that would limit the introduction or spread of invasive species, to be included in a construction plan.

Oregon DFW recommends that OSU prepare its proposed revegetation and restoration plan (10(j) recommendations 4A and 7) in consultation with Oregon DFW. Oregon DFW outlines numerous components that should be included in the plan, including monitoring, success criteria, methods to address soil compaction, short-term stabilization methods, noxious weed control methods, mitigation goals to be met by revegetation, plans to seed and plant with native vegetation, and compliance with the Oregon Habitat Mitigation Policy. Oregon DFW also recommends (10(j) recommendation 4d) that acres of temporary and permanent impact for each habitat type within each habitat category shall be determined based on a definition provided by FERC (either FERC's own or those from the state) and all information shall be provided in the Habitat Mitigation Plan (HMP) and in the environmental analysis.

Our Analysis

Proposed construction would result in the temporary (about 1.5 acres) and permanent (about 2 acres) disturbance of vegetated and unvegetated upland habitats (impacts to kinnikinnick is described below under the *Effects to Seaside Hoary Elfin Butterfly Habitat* subsection) (table 3-16). The project could affect numerous habitat categories outlined in Oregon's Habitat Mitigation Policy (Oregon Administrative Rules 635-415-0025) (table 3-14).

Table 0-14. Potential temporary and permanent impacts in the onshore portion of the project area.[44]

Feature name	Feature characteristics	Potential for Temporary Impacts	Potential for Permanent Impacts
Habitat Category 2 (Essential habitat and limited on a physiographic province or site-specific basis)*			
Buckley and Friday Creeks	Perennial, fish-bearing streams	No	No
Wetland D	Riparian-forested depressional scrub-shrub emergent wetland, potential habitat for amphibians, supports hydrology of fish-bearing Friday and Buckley creeks	No	No
Roost habitat for bats	Maternity roosting habitat for bats. This habitat type (snags, fallen trees, etc.) is only Habitat Category 2 if there are bats roosting. If no bats are roosting, this area is Habitat Category 4 like surrounding forest type.	Yes	No
Beach habitat for western snowy plovers	Potential roosting, foraging, and nesting habitat for western snowy plover. The beach is only Habitat Category 2 if there are western snowy plovers that occur within 300 feet of construction activities. If no western snowy plovers are on the beach, this beach habitat is Habitat Category 4.	No	No
Habitat Category 3 (Essential habitat or important habitat that is limited on a physiographic province or site-specific basis			
Wetland H	Scrub-shrub emergent wetland on north side of NW Wenger Lane	No	No
Wetland I	Emergent wetland on north side of NW Wenger Lane	No	No
Dunes	Dunes adjacent to Driftwood parking lot	No	No
Habitat Category 4 (Important habitat)			
Disturbed/Shore Pine Forest	Disturbed forest with few or no large trees and shore pine forests within the UCMF site	Yes (<1.1 acres)	Yes (<1.4 acres)
Beach habitat	Foraging and stopover habitat for multiple species	No	No
Habitat Category 5 (Habitat having high potential to become essential or important habitat)			
Unpaved maintained and landscaped areas	Unpaved maintained and landscaped areas adjacent to Driftwood parking lot and restroom access, and area adjacent to CLPUD's utility pole on Hwy 101	Yes (<0.2 acres)	No
Habitat Category 6 (Habitat that has low potential to become essential or important habitat)			
Paved and dirt roads, rights-of-way, houses, other paved areas	Driftwood access road, parking lot and restroom area, existing NW Wenger Lane and old utility shed on UCMF site	Yes (<1.2 acres)	Yes (<0.04 acres)

* Habitat categories are based on Oregon's Habitat Mitigation Policy (Oregon Administrative Rules 635-415-0025).

[44] The assessment of potential impacts and acreages of impact are based on current construction footprints and is subject to change.

Table 0-15. Habitat categories and mitigation goals and strategies in the project area.

Habitat Category	Characteristics	Mitigation Goal	Mitigation Strategy	Habitat Type in Project Area
1	Irreplaceable, essential habitat and limited on a physiographic province or site-specific basis	No loss of habitat quantity or quality	Avoidance	None
2	Essential habitat and limited on a physiographic province or site-specific basis	No net loss of habitat quantity or quality, and provide a net benefit of habitat quality or quantity	Avoidance or in-kind, in-proximity habitat mitigation	Fish bearing streams, wetlands, and habitat important for rare species
3	Essential habitat or important habitat that is limited on a physiographic province or site-specific basis	No net loss of habitat quantity or quality	Avoidance or in-kind, in-proximity habitat mitigation	Older forested areas, wetlands, and dune habitat
4	Important habitat	No net loss in habitat quantity or quality	Avoidance or in-kind or out-of-kind in-proximity or off-proximity habitat mitigation	Beaches, degraded wetlands, and recently disturbed forests.
5	Habitat having high potential to become essential or important habitat	Net benefit in habitat quantity or quality	Avoidance or mitigation that contributes to essential or important habitat	Landscaped or maintained areas
6	Habitat that has low potential to become essential or important habitat	Minimize impacts	Actions that minimize direct habitat loss and avoidance of impacts to off-site habitat	Roads and existing rights-of-way, houses, and other paved areas.

The anticipated temporary impacts of construction would last approximately 6 to 8 months, and may temporarily impact forested areas, unpaved maintained and landscaped areas, and paved and dirt roads, rights-of-way, houses, other paved areas. There are a number of areas that would require repairs or improvements, such as the Driftwood parking lot, which would be largely removed during construction, but would be replaced with a new, identical parking lot. Impacts would be avoided or minimized whenever possible, and mitigation would be implemented immediately after construction is complete.

The project would include permanent removal or modification of approximately 1.4 acres of Habitat Category 4 Disturbed/Shore Pine Forest for the UCMF compound and improved access road, but impacts would be mitigated, as discussed below. In addition, a small area (less than 0.04 acre) of Habitat Category 6 Roads and Existing Rights-of-way would be permanently impacted in the vicinity of the CLPUD utility pole on Highway 101 and along the edges of NW Wenger Lane. The anticipated impacts of habitat removal or modification would last for the term of the project’s license and while the UCMF and improved access road exist. This characterization of temporary and permanent impacts is generally consistent with Oregon DFW 10(j) recommendation 4D.

To mitigate the loss of shore pine forest, OSU proposes planting native vegetation in adjacent areas along the north side of NW Wenger Lane. Unpaved and maintained and landscaped area would be revegetated using native species. These measures would offset project impacts in the long term.

The spread of invasive plant species as a result of soil disturbance or vehicle use has the potential to displace native plant species and alter composition of the native plant community and degrade wildlife habitat. Implementation of measures to limit the introduction or spread of invasive species, as proposed by OSU, would protect wildlife habitat.

Effects on Freshwater Wetlands

Poposed project construction activities have the potential to affect existing wetland habitat.

OSU proposes to minimize or avoid project activities in sensitive ecological areas (e.g., jurisdictional wetlands). OSU would use HDD to install the terrestrial transmission line conduits, minimizing effects to wetlands and streams. The proposed terrestrial transmission line route, UCMF, and other associated structures would be sited to avoid impacts to wetlands and streams. The terrestrial transmission lines are proposed to be installed directly from the Driftwood to the UCMF, and from the UCMF to the Highway 101 grid connection point by boring underground (the HDD bore path would have a maximum depth of over 200 feet) to avoid direct impacts to sensitive habitats such as wetlands and streams.

OSU also proposes to maintain buffers around wetlands to the degree practicable, avoid to the extent practicable disturbance of forested wetlands, maintain natural surface drainage patterns, and develop a stormwater management plan at terrestrial facilities to maintain existing drainage patterns, protect project-adjacent habitat, and prevent contamination of streams. Further OSU proposes to avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Natural hydrology would be restored after construction is complete and may require a restoration plan with monitoring until successful restoration can be determined.

Oregon DFW, Oregon PRD, and FWS believe that limiting the number of bores would reduce the risk of a frac-out and recommend OSU use fewer than the five proposed. Oregon DFW (10(j) condition 4C and 8) and Oregon PRD recommend that OSU limit the number of bores under the Buckley Creek wetland and stream habitat to one, while FWS recommends no more than three bores, to minimize the risk of frac-out that could impact aquatic and terrestrial habitats.

OSU has committed to the minimum number to safely and effectively construct the project and states that it can commit to a maximum of three bores.

Our Analysis

A total of four freshwater wetlands and three freshwater streams were delineated within the proposed terrestrial project area during wetland and waterway surveys (HDR 2017, 2019). OSU would avoid direct effects to these habitats and proposed measures would minimize any indirect effects from changes in drainage patterns or release of sediment. Development of a restoration plan and monitoring may be necessary to ensure long-term protection of wetland habitat.

Installing terrestrial transmission lines underground using HDD would avoid direct effects to freshwater wetland and streams. The inadvertent return of drilling fluids, however, could potentially enter wetland or aquatic habitats and impacts plant and animal species and their habitat.

As discussed above, one 48-inch-diameter bore may not necessarily be better than three or more smaller bores. Ensuring that the bores occur in stable geologic materials and developing an HDD contingency plan, including monitoring pressure within the bores to detect problems, etc., would minimize potential impacts to wetland habitats from the boring operation.

Effects on Wildlife

Noise, human and equipment activity, and artificial lighting associated with construction of the proposed project has the potential to displace and disturb wildlife species. Construction activities could also result in poorly contained refuse or debris introducing anthropogenic food sources potentially attracting predators and increasing predation risk for nesting birds. As discussed above in *Effects on Upland Habitat* subsection, proposed construction would also result in disturbance and removal wildlife habitat.

Construction activities (e.g., strong lights used for nighttime construction or construction activities that generate high frequency sound) could potentially disturb bat maternity roost habitat to the point that adult female bats at a maternity roost (i.e., females that are pregnant or are raising young) could abandon the roost and possibly their young. If bats abandon a roost during daylight hours, they are subject to predation by raptors, corvids, and other birds.

To assess and minimize or avoid potential impacts to birds in terrestrial habitats, FWS and Oregon DFW recommend (10(j) recommendations 1 and 2, respectively) OSU implement its proposed BBCS Plan, which includes BMPs and measures to:

- Conduct pre-construction surveys by a qualified biologist no more than 7 days prior to any vegetation clearing that would occur within the nesting season (February 1 to July 31) within designated buffers surrounding potential impact areas.
- Remove nest-starts[45] to discourage birds from nesting near proposed construction zones that could result in impacts to birds. Qualified biologists would remove nest-starts, excluding the nests of raptors and listed species, for any nests found within the proposed project footprint and within 100 feet of proposed construction zones. OSU would consult with Oregon DFW and FWS if raptors are observed building nests within 300 feet of a construction zone.
- Establish species-specific, protective buffers (typically 300 feet for raptors and 100 feet for other species) around active nests (i.e. nests with eggs and/or young). If necessary, adjust buffers to reflect existing conditions including ambient noise, topography, and disturbance with approval of Oregon DFW.
- Restrict project-related activities around identified nesting bald or golden eagles per National Bald Eagle Management Guidelines (FWS 2007b).
- Initiate any planned removal of potential nesting habitat in late winter, prior to the start of the nesting season.
- Provide guidance to construction crews and animal-proof litter receptacles and signage at Driftwood park on the importance of litter and food waste removal for wildlife.
- Install low-intensity, shielded lights directed to minimize light attraction by birds for any necessary lighting at UCMF.

To minimize impacts to bats, the proposed BBCS Plan includes measures to:

- Avoid disturbance of snags and legacy trees including live or dead trees that provide roost habitat for bats and benefits for other wildlife, when practical.
- Avoid construction during the maternity season if maternity roosts are detected within or adjacent to the construction area, if possible.
- Conduct preconstruction surveys for roosting bats.
- Minimize construction impacts from high frequency sound disturbance, night lighting, and air quality degradation near roosts by implementing protective bat roost buffers or excluding bats within bat roost buffers, or developing species and

[45] Nest-starts refer to nests being actively constructed by adult birds and do not contain any eggs or juvenile birds (i.e., nestlings or fledglings) using the nest.

equipment specific buffers, use noise controls, and monitor bat roost activity before, during and after construction.

FWS and Oregon DFW recommends (10(j) recommendation 1 and 2B, respectively) that the BBCS Plan include results from the most recent bat maternity roost surveys conducted in July 2019. Oregon DFW also recommends (10(j) recommendation 2B) that OSU modify the plan in accordance with Oregon DFW's recommendation to install terrestrial cables with a single HDD bore beneath the sensitive bog/fen wetland complex associated with Buckley Creek. OSU does not agree to a single HDD bore and because we analyze this recommendation in previous sections, we do not discuss it further below.

Our Analysis

To minimize impacts to wildlife and habitat in the terrestrial portion of the proposed project area, OSU would use HDD to install the transmission cable conduits (to depths of over 200 feet), thereby eliminating impacts typically associated with conventional above-ground transmission lines.

Proposed construction activities would occur along an existing, busy highway (Highway 101) where disturbance from vehicles, noise, and human activity is already present. Therefore, existing wildlife in the area would likely be habituated to such disturbances. Effects of construction noise, equipment and human activity on terrestrial wildlife would be temporary and use of the area would be expected to return to normal following completion of construction as well as site restoration activities through implementation of OSU's proposed revegetation plan (see *Effects on Upland Habitat* above). Although habitat loss (about 2 acres) would result in permanent displacement of some wildlife species from the area occupied by the UCMF, there is ample habitat around the proposed UCMF site for wildlife to relocate.

As discussed in previous sections, during project construction, erosion and sediment control measures would be implemented to minimize disturbance of soils and vegetation. Through efforts to avoid and minimize effects to wetlands and streams, OSU would also minimize effects to amphibian state special-status species (e.g., western toad and foothill yellow-legged frog).

The proposed BBCS Plan contains several measures that would minimize impacts to birds and bats. Effects to nesting birds would be minimized by proposed measures to remove vegetation in winter outside of the nesting period and pre-construction surveys to identify and protect active nests with protective, species-specific buffers. Because Driftwood is already used by visitors, food sources are already likely present, but construction at the parking lot could potentially introduce food sources. Proposed measures to provide animal-proof receptacles and guidance to construction workers would minimize attracting additional predators that could incidentally prey on bird eggs and young in the area. Construction would occur during daylight; however, should work occur at night, use of shielded lighting, as proposed by OSU, would limit effects associated with artificial lighting on birds.

OSU's proposed measures to limit disturbance to potential habitat used by bats (e.g., dead trees) and conduct construction activities outside of the bat maternity period, as practical, would avoid impacts to bats potentially occurring in the area. Additionally, the proposed BBCS Plan includes preconstruction surveys that would identify the location bat roosts and outlines species- and impact-specific protective buffers (e.g. from high-frequency noise) from nearby construction activities. OSU conducted a habitat roost and maternity roost surveys in the summer of 2019 (i.e., the anticipated year prior to proposed construction). Surveys documented no maternity colony roosts in or around the UCMF property and OSU states maternity roosts are not expected to occur within the UCMF buffer zones. Oregon DFW states that survey results for bat maternity roosts informed the selection of environmental measures and should be completely described in the BBCS Plan. However, Oregon DFW does not explain how adding this information to the BBCS Plan would inform any protective measures for bats or what other benefit it may provide. Additionally, on February 2, 2020, OSU filed the survey results to the public record for the licensing proceeding. Therefore, such a modification is unnecessary.

Effects of HDD

OSU proposes to set up the HDD drill rig in the Driftwood parking lot. Each HDD bore would take approximately a month to complete. The terrestrial portion of the cable would be installed from the beach manholes in Driftwood to the UCMF. The entire terrestrial transmission line route would be about 0.5 mile long. From the UCMF, the transmission lines would also be buried by HDD running west under Highway 101 to the grid connection point with the CLPUD overhead transmission line along the road; for this operation, the HDD rig would be set up on the UCMF site.

Sound and vibration from HDD and other construction activities could disturb birds and other wildlife species in the vicinity of the nearshore (sub-surface cable) and onshore cable interconnection points during the proposed construction phase. Such disturbance has the potential to affect breeding and foraging activities including general avoidance of the construction area.

Our Analysis

Effects on non-nesting birds as a result of HDD would be limited to disturbance in the immediate vicinity of the onshore staging area during the proposed construction period. Based on measured sounds emitted by other construction equipment (e.g., bulldozers, scrapers, generators, compressors, pumps), noise from the HDD is anticipated to be similar to, but not greater than, other project construction-produced noises (CH2M Hill 2008, GEI Consultants 2015). For example, noise emitted by HDD for the Deepwater Wind Project was estimated at 92 dBA at a distance of 15 meters (Tetra Tech 2012b). As discussed above, proposed construction including the use of HDD would occur along the existing highway where disturbances to wildlife are already present. Because the HDD would be operating in Driftwood parking lot, effects of sound and vibration from HDD would be lessened, and any effects would be temporary and localized, occurring only during construction. Therefore, HDD drilling is not likely to have significant or long-term adverse effects on birds.

Effects to Seaside Hoary Elfin Butterfly Habitat

The seaside hoary elfin butterfly could be affected by the unavoidable loss of kinnikinnick, its larval host plant species.

OSU proposes to avoid to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood. The current construction footprint is contained within the parking lot boundary of Driftwood, therefore, interaction with kinnikinnick would be unlikely. Where unavoidable, species-specific surveys may be necessary on properties outside of Driftwood but within the construction footprint to determine the extent of occupied habitat and associated mitigation.

Permanent impacts would be mitigated by developing a revegetation plan and using native species, including kinnikinnick where appropriate, to establish forest habitat in adjacent areas along the north side of NW Wenger Lane. The revegetation plan would consider mitigation, as appropriate, including transplanting or relocating kinnikinnick plants prior to construction, replanting with kinnikinnick after construction, and removal of encroaching disturbed/shore pine forest to enhance kinnikinnick growth and survival.

Oregon PRD recommends that impacts to kinnikinnick be completely avoided within Driftwood. Oregon DFW recommends (10(j) recommendation 4B) that OSU assess and possibly survey kinnikinnick patches delineated within the project area but outside of Driftwood to determine if habitat is suitable for, or occupied by, the seaside hoary elfin.

Our Analysis

The seaside hoary elfin butterfly is found in Driftwood, and its habitat is found throughout the park in upland areas. Its larval host plant, kinnikinnick, was documented in several locations throughout the study area during surveys conducted in May 2016 and June 2017. Kinnikinnick was found in a disturbed area adjacent to a gravel road (NW

Wenger Lane) at the UCMF site. The majority of kinnikinnick was found within Driftwood.

The project would avoid impacts to hoary elfin butterfly habitat within Driftwood by constructing upland facilities within previously disturbed areas. Likewise, installation of the cables from the Driftwood to the UCMF, and from the UCMF to the CLPUD grid connection, would likely not impact habitat because they would be installed underground using HDD, which would avoid vegetation clearing. Similarly, the cable from the UCMF to the CLPUD grid connection would be installed by HDD. Some loss of kinnikinnick shrubs, however, could occur as a result of construction activities within the UCMF site.

OSU's proposal to survey the construction site for the extent of occupied elfin butterfly habitat, if needed, and avoid removal of kinnikinnick where possible and mitigate for the loss of kinnikinnick by transplanting or replanting kinnikinnick or enhancing habitat would minimize any long-term effects to the elfin butterfly. Development of specific measures to minimize any long-term effects as part of the proposed revegetation plan, including control of invasive plant species, would help ensure implementation of appropriate mitigation measures.

Effects to Special-status Plant Species

Ground-disturbing activities could potentially affect special-status plants (pink sand-verbena, Point Reyes bird's beak, and coast range fawn lily, if any occur within the construction area.

Our Analysis

As discussed above, multiple pre-construction surveys in 2016 and 2017 have been conducted for these species during the appropriate season and no individuals have been identified. Plus, no suitable habitat was found at the proposed project site for the Point Reyes bird's beak and cost range fawn lily. Given the absence of these species during the surveys and limited habitat, no impacts to special-status plant species are anticipated.

Adaptive Management Framework

OSU proposes to use an Adaptive Management Framework (AMF) within its environmental monitoring plans to inform implementation of certain monitoring and mitigation measures at the projects' offshore facilities with emphasis on the WEC test site. To guide implementation of the monitoring plans and address any unforeseen effects of the project, OSU, NMFS, FWS, BOEM and Oregon DFW, would participate on an AMC in ongoing adaptive management. The AMC would evaluate monitoring results and recommend changes to monitoring plans based upon proposed mitigation measures 1, 2, 3, 4 and 5 (APEA Appendix J). In addition, the AMC would make decisions and recommendations whether to adopt additional or modify existing mitigation measures 1, 2 and 3 to bring effects within the criteria identified in those measures. The framework also defines meeting protocols and dispute resolution procedures.

Oregon DFW and FWS recommend (10(j) recommendation 1 and 2, respectively) that the AMF be included as a license condition to assist OSU in evaluating monitoring plan results and make recommended changes to the monitoring plans and implementation of mitigative measures. NMFS recommends in EFH recommendation 5 and requires in term and condition 4 that OSU provide an Annual Report to NMFS on the results of the benthic sediments, organism interactions, acoustics, and EMF monitoring plans, WEC installation and removal activities, and another report on project completion, which describes installation details of the subsea transmission cables and the terrestrial transmission lines.

Our Analysis

In section 3.0, we conclude that constructing and operating the project would be likely to have only minor adverse effects on environmental resources and we evaluate the specific monitoring plans proposed by OSU. This conclusion is based on the scale and location of the project, design features that have been incorporated to minimize adverse effects, and our review of the best available scientific information. However, because the project would be the first multi-unit deployment of WEC devices in the U.S., monitoring to confirm our effects analysis and learn more about how environmental resources interact with the equipment would be warranted.

The AMF defined in OSU's proposal would guide implementation of monitoring efforts, inform the need to modify these efforts, and identify mitigation measures to minimize or avoid any unanticipated adverse effects. The deliberations of the AMC would provide an opportunity for OSU to, in consultation with the AMC, prepare the annual reports and project completion report required by NMFS's incidental take statement. The feedback loop that the AMF provides is especially important given the very limited amount of information that is available from constructed MHK projects with WEC devices.

Five Year-Review and Report

OSU proposes to file a Five-Year Report that evaluates past and future project operations, beginning five years and six months after deployment of the first WEC at the project, and recurring every 5 years thereafter, as described in the APEA, Appendix I, measure 19, and would provide copies to BOEM, NMFS, USFWS, and Oregon DFW. The Five Year Report consist of: (1) a review of all WEC deployments and associated project activities from the prior 5 years (not including the most recent six months), including a description of the types and number of WEC devices deployed, frequency and duration of WEC deployments, monitoring activities and results, and any adaptive management criteria or response actions that were applied or modified; and (2) a description of WEC deployment activities that are planned or that are reasonably foreseeable in the next 5 years including, to the extent known, the types and number of WEC devices likely to be deployed, and the likely duration of such deployments.

Oregon DFW and FWS recommend (10(j) recommendation 1 and 2, respectively) that OSU prepare and distribute a report every 5 years to the resource agencies. The FWS further recommends that the reporting of monitoring activities and results, and any adaptive management criteria or response actions, include any and all activities relating to natural resources, including mitigation monitoring.

Our Analysis

The Five-Year review and report would allow OSU and the resource agencies to evaluate proposed project operations to confirm the project effects analysis conducted in this EA. This report would discuss any adaptive management criteria or response actions that were applied or modified in the previous 5 years in accordance with any authorizations issued for the project, and would provide an opportunity for OSU to consult with the resource agencies on the long-term outlook that is planned for the project. Such a 5-year report and review could incorporate information from the NMFS EFH recommendation 5 annual reports and required by NMFS's incidental take statement term and condition 4.

3.3.5 Threatened and Endangered Species and Essential Fish Habitat

3.3.5.1 Affected Environment

Section 7 of the ESA (19 U.S.C. § 1536(a)(2)), as amended, requires that any actions authorized, funded, or carried out by a federal agency are not likely to jeopardize the continued existence of a federally listed endangered or threatened species, or result in the destruction or adverse modification of federally listed designated critical habitat. OSU, on behalf of FERC, determined with input from FWS and NMFS that 40 species listed under the ESA may occur in the project area (Table 3-16). Of these species, critical habitat has been designated within the project area for Southern DPS North American green sturgeon, Oregon Coast coho salmon, and leatherback sea turtle, and proposed for southern resident killer whale and humpback whale. OSU prepared a draft BA in consultation with NMFS and FWS for FERC's use in consulting with those agencies pursuant to Section 7 of the ESA (APEA Appendix A). This section summarizes information in the draft BA.

Table 0-16. ESA listed species that may occur within the PacWave South Project area.

Common Name	Scientific Name	Federal Status	State Status	Critical Habitat Designated	Critical Habitat in Project Area
Fish					
Chinook salmon[1]	*Oncorhynchus tshawytscha*				
Lower Columbia River Evolutionarily Significant Unit (ESU)		T	NL	Y	N
Upper Columbia River spring-run ESU		E	NL	Y	N
Snake River spring/summer -run ESU		T	T	Y	N
Snake River fall-run ESU		T	T	Y	N
Upper Willamette River spring-run ESU		T	NL	Y	N
California Coastal spring-run ESU		T	NL	Y	N
Sacramento River winter-run ESU		E	NL	Y	N
Central Valley spring-run ESU		T	NL	Y	N
Coho salmon[2]	*O. kisutch*				
Lower Columbia River ESU		T	E	Y	N
Oregon Coast ESU		T	NL	Y	Y
Southern Oregon/ Northern California Coast ESU		T	NL	Y	N
Central California Coast ESU		E	NL	Y	N
Steelhead	*O. mykiss*				
Lower Columbia River Distinct Population Segment (DPS)		T	NL	Y	N
Middle Columbia River DPS		T	NL	Y	N
Upper Columbia River DPS		T	NL	Y	N
Snake River Basin DPS		T	NL	Y	N
Upper Willamette River DPS		T	NL	Y	N
Northern California DPS		T	NL	Y	N
Central California Coastal DPS		T	NL	Y	N
California Central Valley DPS		T	NL	Y	N

Common Name	Scientific Name	Federal Status	State Status	Critical Habitat Designated	Critical Habitat in Project Area
South-Central California Coast DPS		T	NL	Y	N
Sockeye salmon Snake River ESU	*O. nerka*	E	NL	Y	N
Chum salmon Columbia River ESU	*O. keta*	T	NL	Y	N
Green sturgeon Southern DPS	*Acipenser medirostris*	T	NL	Y	Y
Eulachon Southern DPS	*Thaleichthys pacificus*	T	NL	Y	N
Reptiles					
Leatherback sea turtle	*Dermochelys coriacea*	E	E	Y	Y
Green sea turtle	*Chelonia mydas*	T	E	Y	N
Loggerhead sea turtle	*Caretta*	T	T	Y	N
Olive (Pacific) Ridley sea turtle Pacific DPS	*Lepidochelys olivacea*	E	T	N	N
Mammals					
Killer whale southern resident DPS	*Orcinus orca*	E	NL	Y/P	P
Humpback whale, Central America DPS/Mexico DPS	*Megaptera novaeangliae*	E	E	P	P
Blue whale	*Balaenoptera musculus*	E	E	N	N
Fin whale	*Balaenoptera physalus*	E	E	N	N
Sei whale	*Balaenoptera borealis*	E	E	N	N
Sperm whale	*Physeter macrocephalus*	E	E	N	N
North Pacific right whale	*Eubalaena japonica*	E	E	Y	N
Western north Pacific gray whale DPS	*Eschrichtius robustus*	E	E	N	N
Birds					
Marbled murrelet	*Brachyramphus marmoratus*	T	T	Y	N
Short-tailed albatross	*Phoebastria albatrus*	E	E	N	N
Western snowy plover	*Charadrius alexandrinus nivosus*	T	T	Y	N
Northern spotted owl	*Strix occidentalis caurina*	T	T	Y	N

Source: Letter from FWS to FERC dated August 1, 2014, letter from NOAA to FERC dated August 4, 2014.

Notes: [1]Based on recoveries of coded wire tagged Chinook salmon (Weitkamp 2010). [2]Based on recoveries of coded wire tagged coho salmon (Weitkamp and Neely 2002). E = Endangered, T = Threatened, NL = not listed; Y = yes; N = no; P = Proposed

Fish

Federally listed fish in the project area include five species of anadromous salmonids (i.e., Chinook, coho, chum and sockeye salmon, and steelhead), green sturgeon, and eulachon.

Chinook Salmon

Chinook salmon are the largest of Pacific salmon and historically ranged from southern California (Ventura River) to northern Alaska (Point Hope). Given this widespread geographic distribution, Chinook salmon have developed diverse and complex life history strategies. Chinook salmon can be grouped into two generalized freshwater life history types; “stream-type” and “ocean-type.” Stream-type Chinook salmon reside in freshwater for a year or more following emergence, whereas “ocean-type” Chinook salmon migrate to the ocean predominantly within their first year. In addition to differences in freshwater life histories, there appears to be differing ocean use patterns between these stream-type and ocean-type Chinook salmon. Stream-type populations appear to undertake extensive offshore ocean migrations while ocean-type Chinook salmon undertake distinct, coastally oriented, ocean migrations (Good et al. 2005).

Juvenile Chinook salmon exhibit a patchy distribution in U.S. West Coast waters; in pelagic trawl surveys conducted in summer and fall along Oregon and Washington, half of all juvenile salmonids were collected in about 5 percent of the surveys and none were collected in about 40 percent of the surveys (Peterson et al. 2010). In general, salmonids are low in abundance in U.S. West Coast waters when compared to other fish, as evidenced by: (1) the low numbers of juvenile salmonids captured in directed pelagic surface/ subsurface research trawls relative to other nekton (Brodeur et al. 2004, Brodeur et al. 2005, Fisher et al. 2014, Peterson et al. 2010, Trudel et al. 2009), and (2) the low numbers of adult and subadult salmonids captured as bycatch in midwater trawls (e.g., commercial trawls for whiting, see Lomeli and Wakefield 2014).

Juvenile salmonids are pelagic and typically surface-oriented, most often found in the upper 20 meters of the water column (Emmett et al. 2004, Walker et al. 2007, Beamish et al. 2000). Adult coho salmon tend to occur at shallower depths (< 40 m) than adult Chinook salmon (Walker et al. 2007). Juvenile Chinook salmon tend to occur closer inshore than other juvenile salmonid species, generally within the 100-meter isobath (Brodeur et al. 2004, Peterson et al. 2010). In fact, subyearling Chinook salmon have been found in the surf zone (Marin Jarrin et al. 2009). Juvenile Chinook salmon tend to be more abundant off Washington in comparison to coastal waters of central and northern Oregon, likely reflecting more favorable habitat in Washington waters with a northwards migration after ocean entry (Bi et al. 2008, Peterson et al. 2010, Trudel et al. 2009). There are eight evolutionarily significant units (ESUs) of federally listed Chinook salmon that could occur in the project area: Lower Columbia River, Upper Columbia River, Snake River spring/summer, Snake River fall-run, Upper Willamette River, California Coastal, Sacramento River winter-run, and Central Valley spring-run (Table 3-16). Chinook salmon from these ESUs differ in their freshwater spawning and rearing locations and differ somewhat in their marine distributions (Weitkamp 2010). Oregon Coast Chinook salmon are not listed under the ESA.

Lower Columbia River ESU – NMFS listed Lower Columbia River Chinook salmon as threatened under the ESA in 1999 (70 FR 37160). This ESU includes naturally spawned Chinook salmon originating from the Columbia River and its tributaries downstream of the Hood and White Salmon Rivers, and fish originating from the Willamette River and its tributaries below Willamette Falls.

The predominant life history type for this ESU is the fall-run, which consists of an early component that returns to the Columbia River beginning in early to mid-August and spawns within a few weeks (Kostow 1995), and a later returning component, which returns to the Lewis and Sandy Rivers (Washington State Department of Fisheries et al. 1993, Kostow 1995). These later fish enter the Columbia River over an extended period of time and spawn from late October through November. Some runs of spring-run Chinook salmon also occur in this ESU on the lower Columbia River and enter freshwater in March and April, well in advance of spawning in August and September (Myers et al. 1998), entering the ocean from May through July (NMFS 2013b). Upon ocean entry, most Lower Columbia River fall Chinook salmon disperse slowly, remaining south of Vancouver Island through autumn (Fisher et al. 2014). The spring-run Chinook salmon become widespread along the coast from summer through autumn, indicating a diversity of dispersal rates (Fisher et al. 2014). Most of the spring-run and fall-run Chinook salmon appear to migrate northward after ocean entry, although a fraction of them migrate south of the Columbia River (Trudel et al. 2009). Designated critical habitat includes the mainstem Columbia River and its tributaries below Hood River (70 FR 52630). Critical habitat includes the mainstem Columbia River and its tributaries below Hood River (70 FR 52630).

Upper Columbia River ESU – In March 1999, NMFS listed upper Columbia River spring-run Chinook salmon as endangered under the ESA (64 FR 14308). The ESU includes stream-type Chinook salmon spawning above Rock Island Dam and downstream of Chief Joseph Dam, including the Wenatchee, Entiat, and Methow Rivers in Washington. Upon ocean entry in spring, most Upper Columbia River Chinook salmon migrate rapidly northward and by late summer are not found south of Vancouver Island (Fisher et al. 2014). This ESU also includes six artificial propagation programs in

Washington. Designated critical habitat includes the Columbia River mainstem and tributaries in Washington (70 FR 52630).

Snake River Spring/Summer-run ESU – NMFS listed Snake River spring/summer-run Chinook salmon as threatened in April 1992 and this status was reaffirmed in 2005 (70 FR 37160–37204). This ESU includes all naturally spawned populations of spring/summer-run Chinook salmon from the mainstem Snake River, Tucannon River, Grande Ronde River, Imnaha River, Salmon River sub-basins, and 15 artificial propagation programs. Upon ocean entry in spring, most Snake River spring/summer Chinook salmon migrate rapidly northward and by late summer are not found south of Vancouver Island (Fisher et al. 2014), and they do not appear to migrate south of the Columbia River (Trudel et al. 2009). Designated critical habitat includes the Columbia River mainstem and Snake River tributaries (64 FR 57399).

Snake River Fall-run ESU – NMFS listed Snake River fall-run Chinook salmon as threatened in April 1992 (57 FR 14653) and this status was reaffirmed in 2003 (70 FR 37160). This ESU includes all naturally spawned populations of fall-run Chinook salmon from the mainstem Snake River and below Hells Canyon Dam and in the Tucannon, Grande Ronde, Imnaha, Salmon, and Clearwater Rivers, as well as four artificial propagation programs. Upon ocean entry from the Columbia River, they migrate both north and south along the coast (Trudel et al. 2009). Designated critical habitat includes the Columbia River mainstem and Snake River tributaries (58 FR 68543).

Upper Willamette River ESU – NMFS listed the Upper Willamette River Chinook salmon as threatened in March 1999 (64 FR 14508), and the threatened status was reaffirmed in June 2005 (70 FR 37160). This ESU includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River, and its tributaries, above Willamette Falls. This ESU also includes seven artificial propagation programs (79 FR 20802). Upper Willamette River Chinook salmon typically exhibit an ocean-type life history and enter the Columbia River estuary at a younger age; they are smaller in size than other salmon that rear longer in streams (Bottom et al. 2005). Upon ocean entry, most Upper Willamette River Chinook salmon become widespread along the coast from summer through autumn, indicating a diversity of dispersal rates (Trudel et al. 2009, Fisher et al. 2014). Critical habitat includes the Columbia River mainstem, the Willamette River and its eastside tributaries above Willamette Falls (70 FR 52630).

California Coastal ESU – The California Coastal ESU, which includes all Chinook salmon naturally reproduced in streams between Redwood Creek in Humboldt County, California, south to the Russian River, Sonoma County, was federally listed as threatened in 1999 (64 FR 50394). Critical habitat was designated in 2005 and consists of river reaches from Redwood Creek to the Russian River (70 FR 52488). Critical habitat does not extend into the open ocean and does not include the project area. The California

Coastal ESU includes 15 independent populations of fall-run and 6 independent populations of spring-run Chinook salmon (NMFS 2011e).

Sacramento River Winter-run ESU – The Sacramento River winter-run ESU was federally listed as threatened in 1989 (54 FR 32085) and reclassified as endangered in 1994 (59 FR 440). It was also listed as endangered by the State of California in 1989. This ESU includes all naturally spawned populations of winter-run Chinook salmon in the Sacramento River and its tributaries in California. Critical habitat was designated in 1993 and includes the Sacramento River from Keswick Dam, Shasta County, to Chipps Island at the westward margin of the Sacramento-San Joaquin Delta; all waters from Chipps Island west to the Carquinez Bridge; San Pablo Bay west of the Carquinez Bridge; and San Francisco Bay from San Pablo Bay to the Golden Gate Bridge (58 FR 33212). Critical habitat does not extend into the open ocean and does not include the project area. Chinook salmon in this ESU enter the Sacramento River in the winter and spawn in the summer (Quinn 2005). No other Chinook salmon populations have a similar life history pattern, and DNA analysis indicates substantial genetic differences between winter-run and other Chinook salmon in the Sacramento River. Chinook salmon from this ESU are the ocean-type race, and they migrate to the ocean in winter or spring after 5 to 9 months of freshwater residence. Juvenile Chinook salmon from the Sacramento and San Joaquin rivers in the Central Valley were more abundant along the Oregon coast north of Cape Blanco than in northern California during surveys conducted in the summer, which indicates that they likely migrate north during their ocean phase (Brodeur et al. 2004). Thus, Sacramento River winter-run Chinook salmon could occur in the project area.

Central Valley Spring-run ESU – The Central Valley spring-run ESU was federally listed as threatened in 1999 and includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries in California, including the Feather River and the Feather River Hatchery spring-run Chinook program (64 FR 53094). Critical habitat was designated in 2005 and consists of the Sacramento River and its tributaries in California (70 FR 52488). Critical habitat does not extend into the open ocean and does not include the project area.

Chinook salmon from this ESU are the ocean-type race, returning to freshwater in spring or summer and spawn in the fall, and the juveniles migrate to the ocean in spring. Juvenile Chinook salmon from the Sacramento and San Joaquin rivers in the Central Valley were more abundant along the Oregon coast north of Cape Blanco than in northern California during surveys conducted in the summer, which indicates that they likely migrate north during their ocean phase (Brodeur et al. 2004). However, these salmon are likely stream-type Chinook salmon that undertake extensive offshore migrations and return to freshwater in the fall and would not include salmon from this ESU. Therefore, Chinook salmon from this ESU are unlikely to occur in the project area

Coho Salmon

Coho salmon are a widespread Pacific salmon species that inhabit most major river basins in western Oregon. Coho salmon typically exhibit a three-year life history, divided between 18 months in freshwater and 18 months in saltwater phases. In freshwater, coho salmon spawn and rear in small streams with stable gravels and complex habitat features, such as backwater pools, beaver dams, and side channels. Marine survival and growth of coho salmon are linked to food availability, environmental conditions, and stressors present in the nearshore environment.

Juvenile coho salmon disperse from their natal streams to coastal waters; their ocean distribution changes with time, with juveniles typically moving northward or farther offshore (Brodeur et al. 2004). Ocean dispersal rates for yearling Columbia River coho salmon averaged between 3.2 and 6.6 km/d (Fisher et al. 2014). Juvenile salmonids are pelagic and typically surface-oriented, most often found in the upper 20 meters of the water column (Emmett et al. 2004, Walker et al. 2007, Beamish et al. 2000). Adult coho salmon tend to occur at shallower depths (< 40 meters) than adult Chinook salmon (Walker et al. 2007).

In general, juvenile salmonids are low in abundance in U.S. West Coast waters when compared to other fish, as evidenced by the low numbers of juvenile salmonids captured in directed pelagic surface/subsurface research trawls relative to other nekton (Brodeur et al. 2004, Brodeur et al. 2005, Fisher et al. 2014, Peterson et al. 2010). Juvenile coho salmon exhibit a patchy distribution in U.S. West Coast waters; in pelagic trawl surveys conducted in summer and fall along Oregon and Washington, half of all juvenile salmonids were collected in about 5 percent of the surveys and none were collected in about 40 percent of the surveys (Peterson et al. 2010). Juvenile coho salmon occur in coastal waters, usually further offshore than juvenile Chinook salmon (Brodeur et al. 2004, Peterson et al. 2010). Juvenile coho salmon tend to be more abundant off Washington in comparison to coastal waters of central and northern Oregon, likely reflecting more favorable habitat in Washington waters (Bi et al. 2008, Peterson et al. 2010). Data from coded-wire tag recaptures suggest that juvenile coho salmon generally migrate northward from point of ocean entry (Morris et al. 2007).

There are four coho salmon ESUs that could occur in the project area: the Lower Columbia River, the Oregon Coast, the Southern Oregon/Northern California Coast, and the Central California Coast ESU.

<u>Lower Columbia River ESU</u> – NMFS listed the lower Columbia River coho salmon as threatened under the ESA in June 2005 (70 FR 37160). This ESU includes all naturally spawned populations of coho salmon from Columbia River tributaries below the Klickitat River on the Washington side and below the Deschutes River on the Oregon side (including the Willamette River as far upriver as Willamette Falls), as well as coastal

drainages in southwest Washington between the Columbia River and Point Grenville. Critical habitat has been proposed for lower Columbia River coho salmon and includes Columbia River tributaries between the Cowlitz and Hood rivers (78 FR 2726). Upon ocean entry, most Lower Columbia River coho salmon become widespread along the coast from summer through autumn, indicating a diversity of dispersal rates (Fisher et al. 2014).

Oregon Coast ESU – In February 2008 (73 FR 7816), NMFS listed the Oregon Coast coho salmon ESU as threatened. The ESU includes all naturally spawned populations of coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco, including the Cow Creek coho hatchery program. Critical habitat is designated for most coastal streams in Oregon that currently, or historically, support coho salmon (64 FR 24049). Near the project area, the Yaquina and Alsea Rivers, and Thiel, Beaver, and Hill creeks are designated as critical habitat (73 FR 7816).

Southern Oregon / Northern California Coast ESU – Coho salmon from the Southern Oregon/Northern California Coast ESU were listed as threated by NMFS in 1997 (62 FR 24588) and reconfirmed in 2005 (76 FR 35755). This ESU includes naturally spawned coho salmon originating from coastal streams and rivers between Cape Blanco, Oregon, and Punta Gorda, California, plus coho salmon from three artificial propagation programs. Southern Oregon/Northern California coast coho salmon can occur in ocean waters from California to British Columbia, but they primarily occur off the California coast (Weitkamp and Neely 2002). Critical habitat was designated in 1999 (64 FR 24049) and revised in 2008 (73 FR 7816), and the closest designated rivers to the project are the Chetco, Illinois, and Rogue rivers in Curry County, Oregon.

Central California Coast ESU – Coho salmon from the Central California Coast ESU were listed as threatened by NMFS in 1996 (61 FR 56138) and upgraded to endangered in 2005 (70 FR 37160). This ESU was also listed as endangered by California in 2002. This ESU includes all coho salmon naturally spawned coho salmon from rivers south of Punta Gorda in Humboldt County, California (70 FR 37160, 77 FR 19552). Coho salmon from this ESU can occur in ocean waters from California to British Columbia, but they primarily occur off the California coast (Weitkamp and Neely 2002). Critical habitat was designated in 1999 and consists of accessible reaches of all rivers (including estuarine areas and tributaries) between Punta Gorda and the San Lorenzo River (64 FR 24049). Critical habitat does not extend into the open ocean and does not include the project area.

Steelhead

Steelhead are rainbow trout that exhibit an anadromous life history pattern. By migrating to the ocean, steelhead grow to much larger sizes than their resident rainbow trout cohorts. Anadromous steelhead and resident rainbow trout can be considered to be from the same population, as “anadromous parents can produce resident offspring and resident parents can produce anadromous offspring” (LCFRB 2010). This adaptive life history makes steelhead flexible to changing habitat conditions. Also, unlike other Pacific salmonids, they can spawn more than one time.

After emergence, young steelhead rear in freshwater streams for 1 to 4 years before out migrating to the ocean. After reaching the ocean in the spring, juvenile steelhead tend to move offshore quickly rather than use nearshore waters like other salmon. For example, Daly et al. (2014) captured tagged juvenile steelhead that migrated greater than 55 km offshore of the Columbia River within 3 days. While as sea, steelhead are found in pelagic waters of the Gulf of Alaska principally within 10 meters from the surface, though they sometimes travel to greater depths (Light et al. 1989).

There are nine DPSs of steelhead that may occur in the project area.

Lower Columbia River DPS – Listed as threatened in 1998, the lower Columbia River DPS includes naturally spawned steelhead originating Columbia River tributaries between the Cowlitz and Wind Rivers in Washington and the Willamette and Hood Rivers in Oregon (76 FR 50448). Excluded are steelhead in the upper Willamette River basin above Willamette Falls (which are included in the upper Willamette River DPS) and steelhead from the Little White Salmon and Big White Salmon Rivers, Washington (which are part of the Middle Columbia River DPS). Critical habitat is designated for lower Columbia River DPS steelhead and includes the Columbia River and tributaries between Cowlitz and Hood Rivers (70 FR 52630).

Middle Columbia River DPS – Steelhead from the middle Columbia River ESU were first listed as threatened 1999 (64 FR 14517), and this listing status was later confirmed in 2005 (76 FR 50448). This inland steelhead DPS occupies the Columbia River basin and tributaries from above (and excluding) the Wind River in Washington and the Hood River in Oregon upstream to, and including, the Yakima River in Washington. Steelhead of the Snake River basin are excluded from this DPS. Critical habitat is designated in Columbia River tributaries (70 FR 52630).

Upper Columbia River DPS – NMFS listed upper Columbia River steelhead threatened in 2009 (62 FR 43937). This inland steelhead DPS occupies the Columbia River basin upstream from the Yakima River, Washington, to the U.S./Canadian border. The principal tributary rivers include the Wenatchee, Entiat, Okanogan, and Methow Rivers. Critical habitat is designated in Columbia River tributaries in Washington (70 FR 52630).

Snake River Basin DPS –NMFS listed steelhead trout from the Snake River Basin as threatened in 1997 (62 FR 43937) and reaffirmed this status in 2006 (71 FR 834). This inland steelhead DPS includes fish originating from the Snake River basin of southeast

Washington, northeast Oregon, and northwest Idaho. Sockeye are dependent on lakes for part of their life history. Critical habitat is designated in Snake River tributaries in northeast Oregon and central Idaho (70 FR 52630).

Upper Willamette River DPS – Listed as threatened by NMFS in 2006 (71 FR 834), this DPS includes naturally spawned anadromous winter-run steelhead originating below natural and manmade impassable barriers from the Willamette River and its tributaries upstream of Willamette Falls to and including the Calapooia River. Critical habitat includes Willamette River tributaries upstream of Willamette Falls (70 FR 52630).

Northern California Steelhead DPS – This DPS was federally listed as threatened in 2000 and includes all naturally spawned steelhead populations below natural and manmade impassable barriers in coastal rivers, from Redwood Creek in Humboldt County, California, south to, but not including, the Russian River (65 FR 36074). Critical habitat was designated in 2005 and consists of river reaches between Redwood Creek south to Point Arena on the Mendocino coast (70 FR 52488). Critical habitat does not extend out into the open ocean and does not include the project area. This DPS contains both winter and summer steelhead populations.

Central California Coastal Steelhead DPS – This DPS was federally listed as threatened in 1997 and includes all naturally spawned steelhead populations below natural and manmade impassable barriers in California streams from the Russian River south to Aptos Creek and in the drainages of San Francisco, San Pablo, and Suisun bays, excluding the Sacramento-San Joaquin River Basin (62 FR 43937). Critical habitat was designated in 2005 and consists of accessible river reaches of the Russian River south to Aptos Creek, and the drainages of San Francisco, San Pablo, and Suisun bays and their tributaries (70 FR 52488). Critical habitat does not extend out into the open ocean and does not include the project area.

California Central Valley Steelhead DPS – This DPS was federally listed as threatened in 1998 and reaffirmed in 2006 and includes all naturally spawned steelhead populations below natural and manmade impassable barriers in the Sacramento and San Joaquin rivers of California and their tributaries, excluding steelhead from San Francisco and San Pablo Bays and their tributaries (71 FR 834). Critical habitat was designated in 2005 and consists of accessible river reaches of the Sacramento River and San Joaquin Rivers and their tributaries (70 FR 52488). Critical habitat does not extend out into the open ocean and does not include the project area. This DPS contains winter and summer steelhead populations.

South-Central California Coast Steelhead DPS – This DPS was listed as threatened by NMFS in 1998 (63 FR 13347). This DPS includes all naturally spawned steelhead originating below natural and manmade impassable barriers from the Pajaro

River to (but not including) the Santa Maria River in California. Critical habitat for the South-Central California steelhead was designated in 2005 and includes accessible river reaches from the Pajaro River to (but not including) the Santa Maria River (70 FR 52488).

Sockeye Salmon

Sockeye salmon are a widely distributed and abundant Pacific salmon species; however, the number of sockeye originating from the Snake River has dramatically declined and NMFS listed Snake River sockeye salmon as endangered in 1991 (56 FR 58619), confirming the listing in 2005 (70 FR 37160). The ESU includes all anadromous and residual sockeye salmon from the Snake River basin, Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake captive propagation program. NMFS designated critical habitat for Snake River sockeye in 1993. Critical habitat includes the mainstem of the Columbia River and Snake River tributaries (58 FR 68543).

According to NMFS (2015b), “sockeye salmon enter the ocean and immediately begin migrating north, as no sockeye from the Columbia River have been caught south of the river’s mouth in 16 years of sampling in the Northern California Current.” Therefore, it is unlikely that sockeye salmon would occur in the ocean habitat near the project area.

Chum Salmon

Historically, over one million chum salmon returned to the Columbia River each year. Today, Columbia River chum salmon returns are limited to a few thousand fish in a few lower Columbia River tributaries (e.g., Grays River, Washington; NMFS 2011). NMFS listed the Columbia River chum salmon as threatened 1999 (64 FR 14508) and reaffirmed this status in June 2005 (70 FR 37160). Chum salmon are rare in Columbia River tributaries in Oregon. NMFS designated critical habitat for chum salmon in 2005. The critical habitat includes the Columbia River (in Clatsop, Columbia, Multnomah, and Hood River counties) and a few other lower Columbia River tributaries (70 FR 52630).

Chum salmon have a short freshwater residence time and rear in estuaries prior to entering the ocean. Chum salmon are present in the Columbia River estuary following emergence as early as mid-January through mid-July, with the peak in abundance between mid-April and mid-May as they migrate seaward. Chum salmon juveniles may remain in the coastal area longer than other salmon before moving offshore to feed in pelagic ocean environments (Beamish et al. 2005). However, adult chum salmon are unlikely to occur in the project area, because it is at the southern end of their range. Juveniles could occur in the project area based on surveys along the Oregon coast (Brodeur et al. 2007, Fisher et al. 2007), but they generally migrate northward after ocean entry from the Columbia River (Beamish et al. 2005).

Green Sturgeon

NMFS listed the southern DPS of North American green sturgeon as threatened in 2006 (71 FR 17757). This DPS is defined as green sturgeon originating from the Sacramento River basin and from coastal rivers south of the Eel River in California.

Green sturgeon is a long-lived (up to 70 years), anadromous fish species that occurs along the Eastern Pacific Coast from the Bering Sea south to Ensenada, Mexico, although their consistently inhabited range is much smaller, primarily concentrating in the coastal waters of Washington, Oregon, and Vancouver Island (Huff et al. 2012). They spend most of their lives in coastal marine waters, coastal bays, and estuaries along the Pacific coast. Juveniles inhabit bays and estuaries for 1 to 4 years before traveling to the ocean. They spend about 15 years at sea before returning to spawn in their natal freshwater habitat and spawn every 2 to 4 years thereafter (Moyle 2002). They spend summers in coastal waters typically <100 meters deep along California, Oregon, and Washington, migrate north in the fall to as far as southeast Alaska, and then return in the spring (Erickson and Hightower 2007, Lindley et al. 2008). They occur on the bottom, although they can forage throughout the water column, feeding on benthic invertebrates and small fish (Radtke 1966, Israel and Klimley 2006).

Green sturgeon occur in the vicinity of and in the project area based on trawl bycatch (Erickson and Hightower 2007, Al-Humaidhi et al. 2012) and coastal tracking of tagged fish (Erickson and Hightower 2007, Lindley et al. 2008, Huff et al. 2011, Lindley et al. 2011, Huff et al. 2012, Henkel 2017). They migrate and forage in coastal waters and in estuaries along the coast as well as in the project area (Lindley et al. 2011, Huff et al. 2011). Models predict green sturgeon to have a high probability of presence in the project area during all seasons (Huff et al. 2012) and occur at the same depths as the project (Erickson and Hightower 2007, Huff et al. 2011). Close to the project area, tagged green sturgeon spend longer durations in highly complex seafloor habitats (e.g., boulders) and tend to occur at depths of 20-60 meters (Huff et al. 2011). Based on a telemetry study near Reedsport, Oregon, green sturgeon most commonly occurred at depths of 50-70 meters and were associated with flat, soft bottom habitat lacking high-relief habitat (Payne et al. 2015), which is similar to the depth and habitat type of the project site. In addition, some sturgeon used the coastal waters near the mouth of the Umpqua River for extended periods of time (e.g., months), while others moved through the area quickly. It was thought that the coastal waters may represent an important feeding area for green sturgeon, likely because the river plume contributes to food resource availability in the adjacent coastal waters (Payne et al. 2015). 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). Most sturgeon moved through quickly (days) whereas others remained for longer periods (weeks or months) (Henkel 2017). When comparing the first set (Year 1) and the second set (Year

2), there were fewer unique green sturgeon in Year 2 (n=85 versus n=115 in Year 1) with fewer detections (pings) per sturgeon (n=245.8 versus n=1535.9 in Year 1), and shorter durations (half the time, average 19 days versus 38 days in Year 1) of each sturgeon's presence in the array, despite the longer duration of receiver deployment in Year 2 (Henkel 2017). However, despite differences in the number of sturgeon detected between the years, within each deployment period similar numbers of green sturgeon were seen at both PacWave North and PacWave South (Henkel 2017).

In October 2009, NMFS designated all nearshore waters to a depth of 60 fathoms (360 feet or 110 meters) offshore Oregon as critical habitat for the southern DPS of the green sturgeon (74 FR 52300; Figure 3-10). This critical habitat includes the project area.

Figure 0-10. Southern DPS green sturgeon critical habitat (74 FR 52300).

The applicable[46] physical and biological features (PBF) for the conservation of the Southern DPS of green sturgeon are (74 FR 52300):

- For estuarine habitats
    - Food resources - Abundant prey items within estuarine habitats and substrates for juvenile, subadult, and adult life stages.
    - Water flow - Within bays and estuaries adjacent to the Sacramento River (i.e., the Sacramento-San Joaquin Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds.
    - Water quality - Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.
    - Migratory corridor - A migratory pathway necessary for the safe and timely passage of Southern DPS fish within estuarine habitats and between estuarine and riverine or marine habitats.
    - Depth - A diversity of depths necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages.
    - Sediment quality - Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages.

- For nearshore coastal marine areas
    - Migratory corridor - A migratory pathway necessary for the safe and timely passage of Southern DPS fish within marine and between estuarine and marine habitats.
    - Water quality - Nearshore marine waters with adequate dissolved oxygen levels and acceptably low levels of contaminants (e.g., pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon.
    - Food resources - Abundant prey items for subadults and adults, which may include benthic invertebrates and fish.

A draft recovery plan was developed for green sturgeon (NMFS 2018) indicating that ocean energy projects are a "potential" risk factor for which future research was recommended. Specific concerns include potential exposure to EMF which could cause direct mortality, habitat loss, or migration, feeding, or habitat impacts.

[46] Not including PBFs for freshwater riverine systems.

Eulachon

Eulachon (commonly called smelt, candlefish, or hooligan) are a small, anadromous fish endemic to the eastern Pacific Ocean, ranging from northern California to southwest Alaska and into the southeastern Bering Sea. Eulachon leave saltwater to spawn in their natal streams late winter through early summer. During spawning, they release eggs over sandy river bottoms. Shortly after hatching, the larvae are carried downstream and dispersed by estuarine and ocean currents (WDFW and ODFW 2001). Winchuck, Chetco, Pistol, Rogue, Elk, Sixes, Coquille, Coos, Siuslaw, Umpqua, and Yaquina Rivers; and Hunter, Euchre, Tenmile (draining Tenmile Lake), and Tenmile (near Yachats, Oregon) creeks are Oregon drainages that are reported to support eulachon spawning (Gustafson et al. 2010), as well as several tributaries to the Columbia River (ODFW and WDFW 2014).

Juveniles are reported to rear in nearshore marine waters. Eulachon spend most of their life in the ocean and grow up to 12 inches in length and return to spawn at age 3 to 5 years (WDFW and ODFW 2001).

NMFS listed eulachon as federally threatened in 2010 (75 FR 13012). NMFS designated freshwater rivers and associated estuaries in California, Oregon, and Washington as critical habitat for eulachon in 2011. In Oregon, critical habitat includes the Columbia River, Tenmile Creek, and Umpqua River (76 FR 65324). Eulachon are also an Oregon Conservation Strategy species and a candidate for listing in the State of Washington.

Essential Fish Habitat

For Pacific Coast species, EFH is described by the Pacific Fisheries Management Council (PFMC) under four Fisheries Management Plans (FMP) covering: (1) groundfish, (2) salmon, (3) highly migratory species, and (4) coastal pelagic species. The groundfish FMP includes more than 80 species of fish, and the salmon FMP includes all species of salmon occurring along the west coast of the United States that are commercially fished, including Chinook, coho, and pink salmon. The highly migratory species FMP includes the tunas, some shark species, and billfish. The coastal pelagic FMP includes five taxa: northern anchovy, market squid, Pacific sardine, Pacific (chub) mackerel, and jack mackerel.

Pursuant to the Magnuson-Stevens Act, EFH has been designated for each of these groups, and all waters within and adjoining the project area constitute EFH for these groups. Specifically, EFH has been designated as follows (PMFC 2013):

- *Groundfish* - Water depths less than or equal to 3,500 meters (11,483 feet) to the mean higher high water level or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean-derived salts measure less than 0.5 parts per thousand during the period of average annual low flow; seamounts in depths greater than 3,500 meters (11,483 feet) as mapped in the EFH assessment GIS data; and areas designated as HAPC not already identified by the above criteria.

- *Salmon* - All waters of the United States between the Canadian border and the Mexican border and out 200 nautical miles (370 km) to the western extent of the Exclusive Economic Zone.
- *Pelagic* - All waters of the United States from the Canadian border to the Mexican border and out 200 nautical miles (370 kilometers) to the western extent of the Exclusive Economic Zone.
- *Highly migratory species* - Varies by species.

The PFMC has designated rocky reef habitats as HAPCs, which are distinct subsets of EFH. As noted previously, OSU proposes to avoid rocky substrate, to the extent practicable, along the South Reef near the project area during installation of the subsea transmission cable because the reef supports sensitive environmental resources and could pose risks to cable survivability.

Marine Turtles

Four sea turtle species may occur in the project area. OSU commenced initial site characterization studies in 2013, which included recording opportunistic sightings of sea turtles in the project area during sampling cruises. To date, OSU has not observed any sea turtles in the project area.

Leatherback Sea Turtle

The leatherback sea turtle was listed as endangered in 1979 (35 FR 8491). It has the widest distribution of all sea turtles, nesting on beaches in the tropics and sub-tropics and foraging in sub-polar waters. Following nesting, leatherbacks migrate along the west coast of North America from Mexico to Alaska. The leatherback is the most frequently observed sea turtle along the West Coast. However, sightings are still infrequent, and this species is typically seen miles off the coast (FERC 2010).

Leatherbacks have been seen near Oregon from commercial seiners in pelagic areas, miles offshore, and along the continental slope (NMFS and FWS 1998). During the Oregon and Washington Marine Mammal and Seabird Survey, observers documented 16 leatherback turtles: five were located offshore of northern Oregon along the continental slope and 11 were off the coast of Washington (Bruggeman et al. 1992). Tagged leatherback turtles have been observed offshore of the Oregon coast (TOPP 2010).

The number of leatherback sea turtles in the Pacific Ocean is sizeable but declining, according to the latest status review (NMFS and FWS 2013). In the eastern Pacific, major nesting beaches are found in Costa Rica, Mexico, and Nicaragua. Based on nest counts in these areas, there are about 1,000 breeding females (NMFS 2013c). Although, population estimates from index surveys (e.g., nest counts) are somewhat unreliable because females may breed at different beaches each year.

On January 26, 2012, NMFS designated critical habitat for leatherback sea turtles in the Pacific Ocean in areas off the coast of Washington, Oregon, and California (77 FR 4170; Figure 3-11). The offshore portion of the project boundary and surrounding area is located within critical habitat for this species. The area designated includes the offshore waters between Cape Flattery, Washington, and the Umpqua River (Winchester Bay), Oregon, out to the 2,000-meter depth contour, and a similar area offshore California (44 FR 17710). The primary prey for this species consists of jellyfish, particularly those belonging to the genera *Chrysaora, Aurelia, Phacellophora* and *Cyanea*. NMFS identified the occurrence, and sufficient condition, distribution, diversity, abundance, and density of jellyfish to support this species's population as a PBFs essential for its conservation. These PBFs was established to ensure that ample prey species are available for leatherback sea turtles during their long migrations.

NMFS and FWS (2013) state in their Five-Year Review for the leatherback that "climate change is likely to increase abundance and change the distribution of jellyfish, a major food source for leatherbacks." More specifically, during El Niño events the redistribution of primary prey (the jellyfish *Chrysaora fuscescens*) show a "poleward and offshore re-distribution" (NMFS 2010a). In discussing *C. fuscescens* distribution off of central California, Lenarz et al. (1995) states, "the distribution of the medusae towards the north is consistent with northward advection, but it should be noted that concentrations did not increase off Point Reyes during Niño years." Compared to other leatherback turtle populations, leatherbacks found along the west coast embark on trans-ocean migrations to forage on jellyfish at fixed or recurrent productive areas. Presumably, leatherbacks are still able to exploit prey-concentrating hydrographic features during Niño periods, as otherwise, leatherbacks would not have developed a migratory life history strategy.

Currently, no field data exist to demonstrate that leatherback turtle occurrence in the project area would be significantly altered due to changes in the distribution or abundance of primary prey resulting from any unusual climate events.

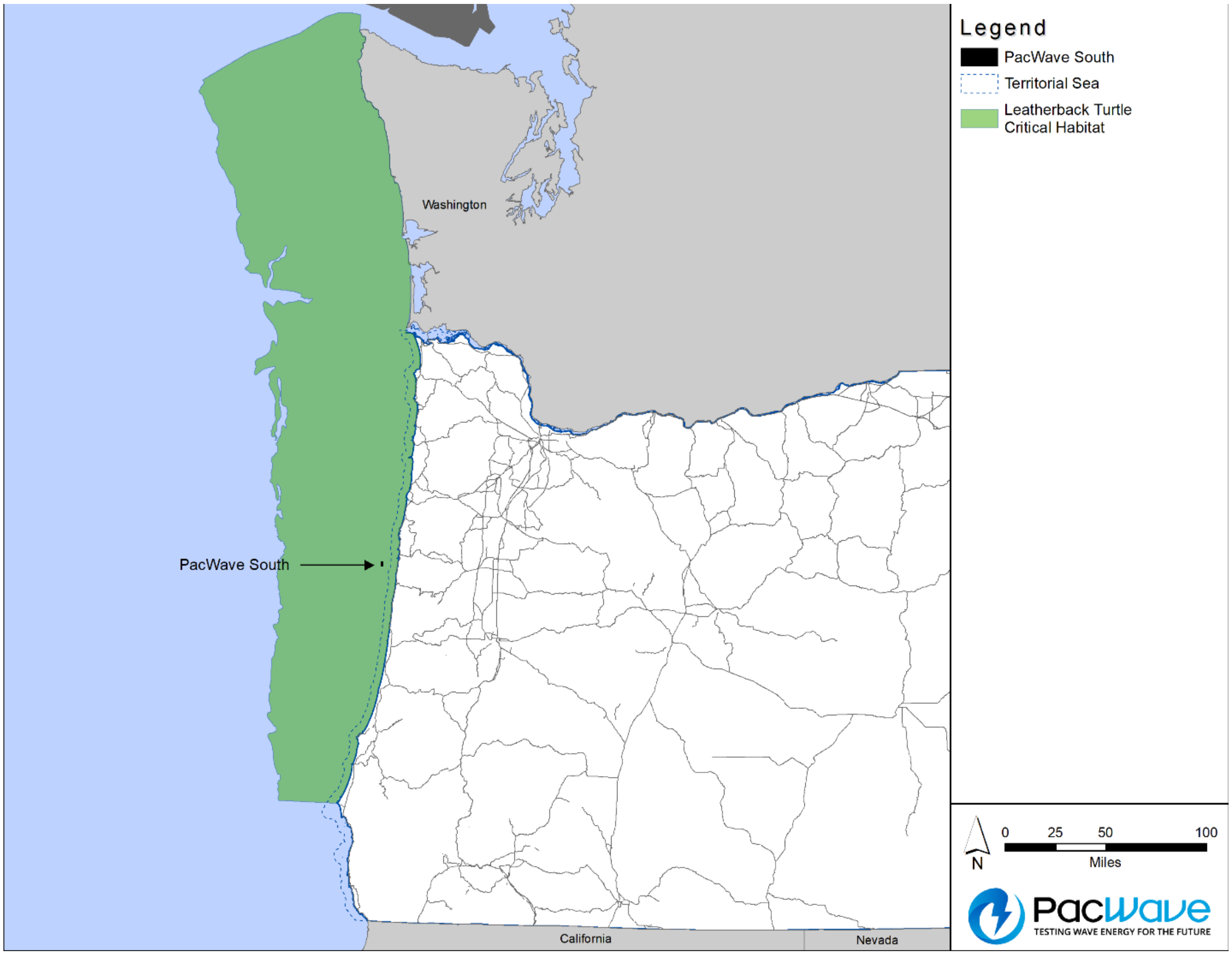

Figure 0-11. Leatherback sea turtle designated critical habitat (44 FR 17710).

Green Sea Turtle

The green sea turtle was listed as endangered in 1978 (43 FR 32800). This species inhabits warm coastal waters and is rarely observed off the coastline of Washington, Oregon, or California (NMFS 2012c). It is not known to nest on the West Coast, and the primary area of observations is in marine waters south of San Diego, California (FERC 2010). Critical habitat for the green sea turtle has only been designated only in the Atlantic Ocean (63 FR 46693).

Loggerhead Sea Turtle

The loggerhead sea turtle is listed as threatened both federally (43 FR 32800) and by the state of Oregon. Loggerhead nesting primarily occurs in the western Atlantic and Indian Oceans, and this species is not known to nest on the U.S. West Coast. Loggerheads have been documented off the U.S. West Coast and southeastern Alaska. In the Eastern Pacific, this species is primarily found south of Point Conception, which is the northern boundary of the Southern California Bight. In Oregon and Washington, loggerhead records have been kept since 1958, with nine strandings recorded over approximately 54 years, which equates to less than one stranding every 6 years (NMFS 2013c). NMFS has designated critical habitat for this species, but only in the Atlantic Ocean (79 FR 39855).

Olive Ridley Sea Turtle

The olive ridley sea turtle is thought to once have been the most abundant sea turtle, worldwide, but it was listed endangered in 1979 (43 FR 328200). This species nests in Central America, and individuals have been documented as far north as southern Oregon (FERC 2010). However, olive ridley sea turtles are rarely observed in the West Coast Exclusive Economic Zone (NMFS 2012c). This species is primarily pelagic, feeding on mid-water organisms, though it has been found in coastal areas. There are no apparent migration corridors for olive ridley sea turtles (FERC 2010). NMFS has not designated critical habitat for this species.

Marine Mammals

Three federally listed marine mammals (humpback, southern resident killer, and blue whales) are known or likely to occur within the project area. Three other marine mammals (fin, sei, sperm, north Pacific Right, and Western North Pacific gray whales) could occur as transients but are primarily associated with deeper water, farther from the coast.

Southern Resident Killer Whale

The southern resident killer whale was listed as endangered in 2005 (70 FR 69903). The current population for southern resident killer whales is 75 animals (census count occurs every year), divided between three pods (J, K, and L pods) that mainly reside in waters around the Puget Sound (Center for Whale Research 2019). As such, NMFS designated intercoastal waters of Puget Sound as critical habitat in 2006 (71 FR 69054), but a 12-month finding in 2015 determined it was necessary to revise designated critical habitat and expand this designation to include inhabited marine waters along the U.S. West Coast that constitute essential foraging and winter areas (80 FR 9632). They mainly occur in the coastal waters of southern Vancouver Island and Washington, but two pods (K and L pods) have been sighted as far south as Monterey Bay, California (Carretta et al. 2009, 2015). On September 9, 2019 (84 FR 182), NMFS proposed to designate six new areas along the U.S. West Coast, including about 15,626 square miles of marine waters between the 6.1-meter depth contour and 200-meter depth contour. Coastal Area 3, Central/Southern Oregon Coast Area includes 4,962 square miles of marine habitat

In describing the likelihood of southern resident killer whale to occur at PacWave North, NMFS (2012a) states "we have limited fine-scale information about Southern Resident foraging habits and space use along the Oregon coast, and do not have information specific to the project area [but] Southern Residents are likely to occur…given their general tendency to occupy nearshore coastal waters when foraging, which is consistent with nearshore sightings off the Oregon coast (i.e., near Depoe Bay, Yaquina Bay, and the mouth of the Columbia River)." Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 detected few killer whales (total of 12 individuals), and these were reported at deeper depths (100-2,000-meter depth) than the project area (Adams et al. 2014). However, killer whale vocalizations were detected on 7 days in April, May, and June 2014 by an acoustic lander deployed inshore of the WEC test site and on 3 days in July and August 2015 by the acoustic mooring at PacWave South (Haxel 2019), which indicates their presence in the project area.

During vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the project area, a total of 4 killer whales was observed (Henkel et al. 2019). These surveys indicate that small numbers of killer whales could occur at the WEC test site. Autonomous monitoring with passive acoustic recorders from Cape Flattery, Washington to Pt. Reyes, California (including off Newport, Oregon) indicated the greatest frequency of detections off the Columbia River and Westport, which was likely related to the presence of their most commonly consumed prey, Chinook salmon (Hanson et al. 2013). Based on recent findings, southern resident killer whale fecundity is highly correlated with the abundance of Chinook salmon, in particular the stocks from Fraser River, Puget Sound, and the Columbia River (Ward et al. 2009, Ford et al. 2016, Hansen et al. 2010, NOAA and WDFW 2018). Climate change is projected to cause a decline in Chinook abundance (Munoz et al. 2014, Lacy et al. 2017). Viability models suggest that prey limitation is the most important factor affecting population growth for southern resident killer whale, and that in order to meet recovery targets through prey management, Chinook salmon abundance would have to be sustained near the highest levels since the 1970s (Lacy et al. 2017). Southern resident killer whales may occur in the project area, but likely in small numbers and at low frequency.

Humpback Whale

Humpback whales were listed as endangered in 1970 (35 FR 18319); the Mexico distinct population segment is listed as threatened and the Central America DPS as endangered (effective October 11, 2016; 81 FR 62259). The humpback whale is a highly migratory marine mammal that ranges along the West Coast and worldwide. In the North Pacific, humpback whales migrate between feeding areas in the Bering Sea and wintering designations off Mexico, Central America, Hawaii, southern Japan, and the Philippines (Carretta et al. 2009). Humpback whales are commonly observed off the California, Oregon, and Washington coasts during the spring, summer, and fall months (NMFS 2012c). Past (Green et al. 1992) and recent (Tynan et al. 2005) studies noted summer concentrations of humpback whales in upwelled waters over Heceta Bank (about 15-30 nautical miles off the Oregon Coast in Lincoln and Lane Counties), where whales presumably gathered for feeding opportunities and preferred sea surface salinity.

Critical habitat for the Central America and Mexico DPSs of humpback whale was proposed by NMFS on October 9, 2019 (84 FR 54354). For both DPSs, the nearshore boundary is the 50-meter isobath, and the offshore boundary is defined by the 1,200-meter isobath relative to the mean lower low water. Unit 13, Coastal Oregon, includes 5,750 square nautical miles of marine habitat.

Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 frequently detected humpback whales (114 sightings of 264 total individuals), although most were reported in waters having deeper depths (100-2,000 meter depth) than the project area, with the exception of higher densities reported inshore at focal areas located both south and north of the project area (Adams et al. 2014). During surveys conducted offshore of Oregon from 1991 to 2008, humpback whales were observed near the Oregon coast (Carretta et al. 2015), and are expected to occur at PacWave South. OSU detected humpback whale vocalizations during underwater noise monitoring at the “nearshore” sampling site east of the project site (Haxel 2019), and a total of 20 humpback whales were observed during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the project area (Henkel et al. 2019).

Blue Whale

Blue whales were designated as endangered in 1970 (35 FR 62919), but critical habitat has not been designated for the species. Blue whales are the largest whale with worldwide distribution, but they are rarely sighted Oregon’s coastal waters. Blue whales are often concentrated near continental shelf breaks downstream of upwelling centers where krill are concentrated, but overall their distribution is more offshore than coastal (NMFS 2014). The offshore waters of Washington, Oregon, and California are thought to be important feeding areas for blue whales in the summer and fall (Carretta et al. 2009). Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 detected a few blue whales (10 sightings of 16 total individuals), most of which were in inner shelf waters (0-100 meter depth) offshore of Oregon (Adams et al. 2014). OSU did not detect blue whales during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the project area (Henkel et al. 2019). NMFS (2012a) concluded that the occurrence of blue whales in the PacWave North project area would be rare. It should be noted that PacWave South is located 4 nautical miles further offshore than PacWave North. However, given that whale surveys from 1991-2008 were conducted out to 300 nautical miles offshore (Carretta et al. 2015), PacWave South is only 1 percent further offshore than PacWave North (Figure 1-1) within that survey corridor, and it is expected that whale observations and conclusions at PacWave North would be relevant to PacWave South. It is expected that blue whales could occur in the project area, though rarely.

Fin Whale

Fin whales are listed as endangered (35 FR 8491), but critical habitat has not been designated for the species. Fin whales occur in the major oceans of the world and tend to be more abundant in temperate and polar waters. NMFS recognizes three populations in the United States, including one that is found in waters off California, Oregon, and Washington. In its Biological Assessment of dredged materials disposal near Yaquina Bay, EPA (2011) cites historical whaling records that note fin whales were harvested off the Oregon coast. However, fin whales are thought to prefer deeper waters than occur in the project area. For example, Tyan et al. (2005) sighted fin whales in >2,000 meters of water off the coast of Coos Bay during their linear transect surveys out to 150 km offshore from Newport, Oregon, to Crescent City, California. Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 only detected fin whales (6 sightings of 13 total individuals) at depths of >200 meters (Adams et al. 2014). In shipboard surveys conducted off Oregon from 1991-2008, all but one fin whale were found much further offshore than PacWave South (Carretta et al. 2015). OSU only detected one fin whale during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the project area (Henkel et al. 2019). It is expected that fin whales could occur in the project area, though rarely (Henkel et al. 2019, Carretta et al. 2015).

Sei Whale

Sei whales are large baleen whales that occur in subtropical and tropical waters to subpolar waters around the world and into the higher latitudes. Sei whales were listed as endangered in 1970 (35 FR 18319). Critical habitat has not been designated for the species. Sei whales in the eastern North Pacific (east of 180°W longitude) are considered a separate stock. They are predominately distributed over continental slopes, shelf breaks, and deep ocean basins situated between banks (NMFS 2011). They are rarely found off the Washington, Oregon, and California coasts; when observed, individuals are in oceanic waters, much further offshore than where PacWave South is located (Carretta et al. 2015). Surveys out to a distance of 300 nautical miles in 2005 and 2008 resulted in an abundance estimate of 126 sei whales off of Washington, Oregon, and California (Carretta et al. 2015). Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 did not detect any sei whales (Adams et al. 2014). OSU did not detect any sei whales during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the project area (Henkel et al. 2019). Therefore, sei whales are not expected to be encountered in the project area because the species occurs in much deeper waters farther offshore.

Sperm Whale

Sperm whales are the largest of the toothed whales and are found in deep waters throughout the world's oceans. Sperm whales were listed as endangered in 1970 (35 FR 18319). Critical habitat has not been designated for the species. Sperm whales primarily prey on other deep-water species, like squid, and are rarely found in waters less than 300 meters deep (NMFS 2013c). Sperm whales are present in the Pacific Ocean off of Oregon and Washington most of the year, except mid-winter, when they migrate farther south (NMFS 2010b). Based on surveys out to a distance of 300 nautical miles from 1991 to 2008, sperm whales are found in oceanic waters offshore of Oregon, much further offshore than where PacWave South would be located, and their abundance ranged between 2,000 and 3,000 individuals (Carretta et al. 2015). Surveys from aircraft conducted offshore of northern California, Oregon, and southern Washington in 2011 and 2012 only detected sperm whales (2 sightings of 3 total individuals) at depths of >200 meters (Adams et al. 2014). OSU did not detect any sperm whales during vessel-based, standard-line transect surveys conducted from October 2013 to September 2015 (a total of 37 cruises) in the project area (Henkel et al. 2019). Sperm whales are therefore not expected to occur in the project area (NMFS 2012c).

North Pacific Right Whale

Eastern North Pacific right whales have historically occurred along the West Coast and have been reported as far south as central Baja California in the eastern North Pacific, as far south as Hawaii in the central North Pacific, and as far north as the sub-Arctic waters of the Bering Sea and sea of Okhotsk (NMFS 2017). Migration patterns of the North Pacific right whale are unknown, although it is assumed the whales spend the summer in far northern feeding grounds and migrate south to warmer waters, such as southern California, during the winter. However, Shelden (2006, as cited in NMFS 2017) suggests that records of right whales in southern California and Hawaii likely represent vagrant individuals. Since 1950, there have been at least 3 sightings from Washington coast, fourteen from California coast, two from Baja California, Mexico, and three from Hawaii (Brownell et al. 2001); sightings are extremely rare (NMFS 2017). The western Gulf of Alaska and the southeastern Bering Sea are both frequently used areas primarily in the 50-100 meter isobaths (NMFS 2017). There are no reliable estimates of current abundance however, the Eastern Pacific population is likely to be very small, and has been estimated to consist of approximately 30 individuals (Wade et al. 2011).

Western North Pacific Gray Whale DPS

The western north Pacific gray whale is found from Russian foraging areas along the Aleutian Island, through the Gulf of Alaska, and south to the Washington and Oregon coasts, and to the southern tip of Baja California and back to Sakhalin Island. 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 shows 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. 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 (letter from NMFS, December 20, 2019).

Birds

Marbled Murrelet

The marbled murrelet was listed as threatened in 1992 (57 FR 45328). Marbled murrelets occur in Alaska, British Columbia, Washington, Oregon, and California. Although only a small percentage of the population (2 percent) occurs in Washington, Oregon, and California, this area represents 18 percent of the species' linear coastal range and likely supported far greater murrelet numbers historically (McShane et al. 2004). Population declines have been attributed to forest fragmentation and loss of nesting habitat from the harvest of old-growth coniferous forests, and from mortality associated with gillnet fisheries and oil pollution. Critical habitat has been revised several times since the first designation in 1996, with the most recent designation in 2011 (76 FR 61599). There is no critical habitat in the project area, because critical habitat was designated to protect inland nesting habitat (Figure 3-7). The species is also listed as threatened by the State of Oregon.

Marbled murrelets nest on naturally occurring branch platforms high in old-growth coniferous trees (Nelson 1997). They fly between coastal/ocean habitat where they feed and inland nesting habitat (Miller et al. 2002). At-sea abundance has been strongly correlated with inland areas containing contiguous old-growth forest (Miller et al. 2002). In Oregon, the at-sea density of marbled murrelets during the breeding season is highest in the nearshore waters of central Oregon between Reedsport and Newport (e.g., 9-50 murrelets/km^2; Strong 2009, Suryan et al. 2012), which is directly offshore from large tracts of inland nesting habitat. At sea, they forage on small schooling fish and large pelagic crustaceans (euphausiids, mysids, amphipods), and occur primarily in very nearshore waters (<1.5 kilometers from shore; Sealy 1974, Strachan et al. 1995, Strong 2009). Peak densities of murrelets in Oregon occur between 300 and 1,000 meters from shore, and they are rare but consistently present beyond 4 km from shore (Strong 2009). They most often feed as singles or in pairs, although they do occur in loose aggregations (tens to hundreds of birds) where prey is concentrated (Sealy 1975, Carter and Sealy 1990, Strachan et al. 1995). There is some evidence that they occur farther offshore over the continental shelf during the non-breeding season (Suryan et al. 2012), thus they are more likely to occur in the project area from fall through spring. Adult murrelets molt two times per year, and they are flightless for one to two months during the fall (October-November), during which time they remain on the water and do not fly to inland nesting areas (Carter and Stein 1995).

During vessel-based, strip transect surveys conducted from May 2013 to October 2015 (a total of 44 cruises) in the project area, a total of 35 marbled murrelets were observed, primarily concentrated shoreward of the WEC test site and adjacent nearshore waters near the mouth of the Yaquina Bay, with the exception of a couple of murrelet observations just north and west of the test site (Porquez 2016, Suryan and Porquez 2016). These surveys indicate that occurrences would likely be limited to occasional occurrences of 1 to 2 murrelets at the WEC test site, but that they would be expected to occur along the subsea cable route and vessel route between Yaquina Bay and the test site.

The mixed conifer/deciduous forest in the terrestrial project area does not contain suitable nesting habitat for marbled murrelets. However, murrelets could fly over or through the mixed conifer/deciduous forest in the terrestrial project area as they fly between at-sea and inland nesting habitats.

Short-tailed Albatross

The short-tailed albatross was federally listed as endangered in 2000 (65 FR 46643). Critical habitat has not been designated for the species. The species is also listed as endangered by the State of Oregon. The short-tailed albatross was once an abundant species, numbering more than a million birds. The species was decimated by feather hunting and egg exploitation at the turn of the 20th century and by the late 1940s was thought to be extinct. Through intense management efforts, the population has now reached an estimated 4,354 individuals and is currently undergoing very high population growth (5 to 9 percent per year), mainly due to high survivorship, translocation of chicks and use of social attraction to establish a new colony, and reduction of bycatch in commercial fishing (FWS 2014a). This species is now showing up in the northwest Hawaiian Islands in double-digit numbers during the breeding season and has bred on Midway Atoll (American Bird Conservancy 2012, FWS 2014a). Current potential threats to the short-tailed albatross include breeding colony habitat degradation due to volcanic activity, typhoons, flash floods, erosion, and invasive species; contaminants; plastics ingestion; and bycatch in commercial fisheries; and offshore wind energy development (FWS 2014a).

Except for Hawaii, the short-tailed albatross nests exclusively on small volcanic islands in Japan. The breeding season lasts about eight months and occurs in October to June (FWS 2008). During the non-breeding season (summer), they range along the

Pacific Rim from southern Japan to northern California, primarily along the continental shelf margins. Based on satellite tracking of 99 individuals between 2002 and 2012, juveniles generally range in shallower, nearer-to-shore waters than adults (e.g., <200-meter depth), and are more likely than adults to occur off the west coast of U.S. and Canada (Suryan et al. 2006, 2007, and 2008, Suryan and Fischer 2010, Deguchi et al. 2012, Yamashina Institute for Ornithology and Oregon State University, unpublished data, as cited in FWS 2014a).

The short-tailed albatross is still quite rare off the U.S. West Coast, with 14 records in Oregon waters (most of them <10 years old) accepted by the Oregon Bird Records Committee (OBRC; Marshall et al. 2006, OBRC 2016). During vessel-based, strip transect surveys conducted from May 2013 to October 2015 (a total of 44 cruises) in the project area, a total of 41 black-footed albatrosses (used as a proxy for short-tailed albatross due to similar habitat use) was observed, primarily concentrated beyond 20 kilometers from shore, with the exception of one sighting near the WEC test site about 16 kilometers from shore (Porquez 2016, Suryan and Porquez 2016). In addition to the extreme rarity of this species off the Oregon coast, these surveys indicate that occurrence of the short-tailed albatross at the test site is highly unlikely and would likely be limited to rare occasional occurrences, if at all, even as the population continues to grow.

Western Snowy Plover

The western snowy plover was federally listed as threatened in 1993 due to loss of nesting habitat and declines in breeding populations (58 FR 12864). Designated critical habitat units occur in California, Oregon, and Washington (77 FR 36728); however, no designated critical habitat units are found within, or near, the proposed project boundary. The main threats to the species include habitat loss and degradation from human disturbance, urban development, introduced beachgrass (*Ammophilia* spp.), and expanding predator populations (FWS 2007a). The species is also listed as threatened by the State of Oregon.

The western snowy plover nests on sand spits, dune-backed beaches, beaches at creek and river mouths, and salt pans at lagoons and estuaries from southern Washington to Baja California (FWS 2007a). They feed on invertebrates in wet sand within the intertidal zone, and dry sand above high tide, on salt pans, spoil sites, and along the edges of salt marshes, salt ponds, and lagoons. The breeding season occurs from March through September. The FWS (2007a) Recovery Plan for the Pacific Coast Population of the Western Snowy Plover, states that on the Oregon coast nesting may begin as early as mid-March, but most nests are initiated from mid-April through mid-July (Wilson-Jacobs and Meslow 1984) with peak nest initiation occurring mid-May to early July (Stern et al. 1990). In Oregon, hatching occurs from mid-April through mid-August, with chicks reaching fledging age as early as mid- to late May. Peak hatching occurs from May through July, and most fledging occurs from June through August.

Nests were documented along the beach between the mouth of the Alsea Bay to Seal Rock, which includes the cable landing site at Driftwood. Five nests were observed near Driftwood in 2017 (Lauten et al. 2017), and four nests were observed in 2018 (Taylor 2018).

Plovers use the same shoreline habitat during the non-breeding season and could be found at any beach with suitable habitat along the Oregon coast, including the shore cable landing area. Some plovers remain in their coastal breeding areas year-round while others are migratory, and most inland-nesting snowy plovers migrate to the coast for the winter (FWS 2007a). Winter surveys conducted at South Beach State Park in Newport (approximately 9.5 miles north of the Driftwood) observed plovers in 2015, 2016, 2017, and 2018 (FWS 2018).

A Habitat Conservation Plan prepared by the Oregon PRD covering incidental take of western snowy plover included Lincoln County in its covered lands, allowing recreation and beach management activities with minimal protection (50-meter radius fenced area) of nests (ICF International 2010).

Northern Spotted Owl

The northern spotted owl was federally listed as threatened in 1990 due to habitat loss from timber harvest (55 FR 26114). The main threats to this species are past and current habitat loss, and competition from the barred owl. Critical habitat was designated in 1992 and revised in 2008 and 2012 and there are critical habitat units in California, Oregon, and Washington (77 FR 71875); however, there is no critical habitat designated in the project area. The species is also listed as threatened by the State of Oregon.

Northern spotted owl nesting, roosting, and foraging habitat occurs in structurally complex, older coniferous forests (FWS 2011). Important habitat features include a moderate to high canopy closure (60 to 90 percent); multilayered, multi-species canopy with large overstory trees; a prevalence of large trees with various deformities (large cavities, broken tops, mistletoe infections, and other evidence of decadence); presence of large snags; accumulations of fallen trees and other woody debris on the ground; and sufficient open space below the canopy for spotted owls to fly (Thomas et al. 1990). Spotted owls spend most of the day roosting in trees; they forage at night between sunset and sunrise, although they may also forage opportunistically during the day (Forsman et al. 1984, Sovern et al. 1994). Spotted owls exhibit high site fidelity, generally retaining the same breeding territories from year to year (Forsman et al. 2002). Courtship behavior begins in February or March, and eggs are typically laid in late March or April (Forsman et al. 1984, FWS 2011). Nests are usually found in old-growth coniferous trees (i.e., exceeding 200 years), and Douglas fir is the most common nest tree species (Forsman et al. 1984, LaHaye and Gutierrez 1999). Northern spotted owls could occur in the mixed conifer/deciduous forest near the terrestrial portion of the project, although it would be unlikely given that the surrounding forest is fairly fragmented due to housing developments and timber harvesting.

3.3.5.2 Environmental Effects

As the Commission's non-federal representative for carrying out informal consultation pursuant to Section 7 of the ESA, OSU consulted with NMFS and FWS in evaluating effects to the 41 threatened and endangered species that may occur in the project area (Table 3-16). Critical habitat has been designated within the project area for the Southern Distinct Population Segment (DPS) of the North American green sturgeon, Oregon Coast coho salmon, and the leatherback sea turtle, and proposed for southern resident killer whale and humpback whale.

Fish

The potential occurrence of ESA-listed fish in the project area is likely low, based on research and regional bycatch data. Because these fish are migratory, they are unlikely to remain in the marine project area and instead move through on a transitory basis. In general, project construction and operation could expose some threatened and endangered species to habitat alteration, underwater sound, and EMFs. This section evaluates the effects on threatened and endangered species, critical habitat, and EFH.

Threatened and endangered fish species that are likely to occur in the marine project area and which could be affected by the project include Chinook salmon, coho salmon, steelhead, green sturgeon, and eulachon. In addition, designated critical habitat for the southern DPS of North American green sturgeon and Oregon coast coho salmon includes the project area. Potential effects during construction and operation of the project on these species and designated critical habitat for green sturgeon and Oregon Coastal coho include effects caused by habitat alteration, underwater sound, and exposure to EMF. To minimize effects to ESA-listed fish, OSU proposes to implement these measures:

- Bury subsea cables at a depth of 1-2 meters, to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor. In areas where a cable cannot be buried or persistently becomes unburied, that portion of the cable would be on the seafloor and would be protected by split pipe, concrete mattresses or other cable protection systems.
- Implement the Acoustic Monitoring Plan to measure project-related sound emissions. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects (APEA, Appendix I, measure 3).

- Implement the EMF Monitoring Plan to measure project-related EMF emissions. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects (APEA, Appendix I, measure 1).
- Implement the Organism Interactions Monitoring Plan to track changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the installed components or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs.
- To the maximum extent practicable, bury subsea cables and utilize appropriate shielding on subsea cables and umbilicals, and other electrical infrastructure to minimize EMF emissions.
- Develop and implement a stormwater management plan for onshore construction activities to maintain existing drainage patterns and prevent contamination of streams with runoff.

NMFS has provided the following reasonable and prudent measrues in its biological opinion filed on December 20, 2019:

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.

NMFS has provided the following terms and conditions in its biological opinion filed on December 20, 2019:

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 parking lot. 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 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 meters 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 APEA. Appendix I, measure 6)
      (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

Our Analysis

Habitat Alteration

As discussed in greater detail in Sections 3.3.2.2 and 3.3.3.2 and in the BA, potential stressors caused by project-related habitat alteration are:

- Increase in suspended sediment during installation and redeployments;
- Disturbance of the benthic community from project structures;
- Change to marine community composition and behavior (e.g., use patterns, attraction, and avoidance); and
- Introduction of toxic substances to the water.

Suspended sediment resulting from cable laying, subsea connector installation, and anchor installation/removal at the project is expected last for minutes or tens of minutes. Suspended sediment during cable laying is expected to dissipate quickly and not reach levels that would harm ESA-listed salmonids (Newcombe and Jensen 1996), and salmonids, eulachon, and green sturgeon would likely move away from the area of disturbance.

As noted in Section 3.3.3.2, effects to the benthic community from project structures may include direct effects, such as burial of the cable and the presence of project components on the seafloor and indirect effects, such as scour associated with the anchors. The total area of benthic habitat disturbed at the WEC test site would be very small relative to the range of and available marine habitat and prey for the ESA-listed fish (particularly for the highly migratory salmonids and green sturgeon), and minor in comparison to surrounding available habitat (about 0.1 percent of the project area (2.65 acres) for direct effects to the seafloor from the maximum footprint of the anchors and about 3 percent (48 acres) of the project area for indirect effects to the seafloor at full build-out). Effects at PacWave South are expected to be minimized given that anchor installation/removal is not likely to occur more than once a year in a berth and anchors may be deployed for multi-year periods.

Potential changes to marine community composition and behavior as a result of WEC structures introduced to the marine environment could include changes in the marine community, forage opportunities, and predator/prey abundances. In general, although there is uncertainty about the degree to which marine animals may be attracted to WEC structures, there is no data that suggest that there would be any significant adverse effects to individuals or populations (Copping et al. 2016). Because of the small size of the project, it is not anticipated that the addition of project structures to the marine environment would represent a significant change to marine habitat, and the probability of the ESA-listed fish encountering and being affected by project structures is generally low. The ESA-listed fish are not anticipated to be attracted to or associate regularly with the structures; therefore, they would not be expected to be at increased risk of predation by predatory fish, seabirds, or pinnipeds, even if those predators associate with the structures.

There are two pathways that the project could contaminate the water quality in the project area: antifouling paints, and accidental spills of hazardous materials (e.g., fuel) from vessels during construction and operation. Contaminants could affect ESA-listed fish through direct mortality at high levels of exposure, or cause sublethal effects such as compromised immune response, increased susceptibility to pathogens, reduced reproductive success and reduced growth rates at lower concentrations. As discussed in section 3.3.2.2, toxic substances are not expected to adversely affect any aquatic resources or marine life in the project area. Implementing the Emergency Response and Recovery Plan offshore proposed by OSU would greatly reduce the likelihood that a spill of hydraulic fluids or other petroleum-based contaminants would be large enough to adversely affect more than a few individual fish, or to affect habitat function. Occurrence of the ESA-listed fish is likely to be low and/or short-term/transitory in the project area, thus their potential exposure to toxic substances, if they are released, would likely be very low. In addition, the location of project in the open ocean further minimizes the likelihood of impacts, because any minor effects on water or sediment quality would quickly dissipate.

The terrestrial transmission line would be installed by HDD and would avoid ground-disturbing activities and adverse effects along the proposed corridor to fish. As noted in section 3.3.3.2, potential effects on ESA-listed fish in surface waters in the project area include effects from potential hazardous materials release from the construction equipment itself (lubricating oils and fuel) or inadvertent returns of drilling fluids to a waterway from HDD operations. However, there are only three fish-bearing streams in the project area, which would be avoided entirely. The HDD plan would ensure that the depth of boring operations would be designed so that there is a low risk of inadvertent return of drilling fluids and an HDD contingency plan would be developed to minimize the adverse effects of a potential inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor. Implementing the stormwater management plan required by NMFS term and condition 3 would ensure that runoff related to onshore project construction would reduce the likelihood that a spill of hydraulic fluids or other petroleum-based contaminants would be large enough to adversely affect listed fish, or to affect habitat function. Through implementation of construction BMPs, no detrimental effects to listed fish are expected from hazardous materials releases.

Underwater Sound

As discussed in section 3.3.3.2, the primary sources of project-related underwater sound would be from vessels at the project and transiting between Newport and the WEC test site, subsea transmission cable installation, and from WECs and associated project structures. The threshold for causing temporary behavioral changes (startle and stress) on threatened and endangered fish species, as defined by NMFS and FWS, is 150 dB (FHWG 2009); project associated sounds could approach or occasionally exceed the threshold for behavioral effects. Potential effects of moderate (e.g., non-injury) anthropogenic noises on fish can include disturbance and deterrence, reduced growth and reproduction, interference with predator-prey interactions, and masking of communication (Slabbekoorn et al. 2010).

Based on the existing information, the short-term and temporary sounds from vessels transiting to or from the project site and within the project site itself (i.e., hours or less as the vessels pass), and from dynamic positioning vessels for cable laying during installation and deployment of WECs, as well as from continuous sounds from the WECs, even though they would occur over the license term, are not likely to adversely affect ESA-listed fish for several reasons: (1) these species are not particularly sensitive to sound; (2) the area affected (e.g., up to 125 meters around the WECs) would be insignificant compared to the range of these species, particularly for the highly migratory green sturgeon and salmonids; and (3) there is similar and abundant habitat available in the surrounding area that they could move to if they are exposed or disturbed by the sounds.

ESA-listed salmon, green sturgeon, or eulachon may swim around a WEC or avoid a vessel transiting between the Port of Newport and PacWave South, but there is no basis to expect that noise associated with the project, including deployment, O&M, retrieval, and environmental monitoring, would affect aggregating green sturgeon or the migratory path for salmonids leaving or returning to natal streams because of the offshore location of the project, the spacing of the WECs, and relatively low levels of noise associated with the project. All of the listed fish are highly mobile and migratory, and individual fish are unlikely to remain in the project area and be continually or repeatedly exposed to this stressor. Because of uncertainty associated with underwater sounds created by this new industry technology and in order to determine the actual sound levels emitted by WECs and other facilities at the project, OSU would implement the Acoustic Monitoring Plan as required by NMFS term and condition 1under the Adaptive Management Framework to detect and, if needed, mitigate any effects of WEC-related sound (APEA, Appendix I - measure 5). Implementation of the proposed mitigation measures would minimize potential effects of sound levels to listed fish in the marine environment.

EMF

As discussed in Section 3.3.3.2, evaluations of marine animal interactions with subsea cables have provided understanding that EMF produced by WECs and their subsea cables are in the magnitude of the sensitivity ranges of many marine animals; however, the ability to detect EMF does not necessarily translate to an effect or an impact on individuals, populations, or ecosystems (Normandeau et al. 2011, Gill et al. 2014). Most effects are assumed to be minor and limited to a close distance (meters), with the exception of elasmobranchs that are considered to be the most vulnerable because of their high sensitivity and use of EMF for important behaviors (e.g., prey detection) (Normandeau et al. 2011, Gill et al. 2014).

Recent studies have indicated that EMF from subsea cables has not affected fish (BOEM 2016, Kuhnz et al. 2011, Love et al. 2016, Kogan et al. 2006, see Section 3.3.3.2). Studies of unenergized and energized unburied subsea cables have found no differences in fish communities (BOEM 2016, Love et al. 2016). Although sturgeon can locate prey using electroreception and are more bottom-oriented, there is no compelling evidence that the EMF produced by energized power cables either attracts or repels electro-sensitive species including elasmobranchs (Love et al. 2016).

EMF emissions from the project are expected to be minor and limited to the immediate vicinity of the cable. However, there is higher uncertainty about EMF emissions from WECs, which has not been measured. Potential effects of EMF on green sturgeon, ESA-listed salmonids, and eulachon are uncertain but could include minor indirect effects such as altered behavior and migration at the project. However, all of the listed fish are highly mobile and migratory, and therefore, exposure to EMF is unlikely due to the very small spatial scale of the project relative to the area within which these species migrate and feed.

Even if individuals encounter and are exposed to magnetic fields, any potential effects are expected to be short-term and minor, because of the very localized fields relative to the earth's geomagnetic field potentially being used for navigation; therefore, listed fish species are not expected to be affected by EMF. Bottom-oriented fish could be more exposed to EMF from the subsea transmission cables than pelagic fish; however, the cables would be shielded, armored, and buried for the most part, limiting exposure to EMF. Based on the low levels of EMF expected, and spatially limited exposure to fish, it is anticipated that relatively minor, short-term potential effects, if any, could occur, and that the EMF Monitoring Plan (required by NMFS term and condition 2) within the Adaptive Management Framework (APEA, Appendix H and J) and implementation of the mitigation measures (APEA, Appendix I, measure 1) would minimize any potential effects to listed fish.

Critical Habitat

As noted in Section 3.2.1, the PBFs that are essential for the conservation of the North American green sturgeon, southern DPS in coastal marine areas are: migratory corridors that allow for the safe and timely passage between estuarine and marine habitats; water quality with adequate dissolved oxygen levels and acceptably low levels of contaminants; and adequate food resources including benthic invertebrates and fish. The PBFs in estuarine habitats include migratory corridors, water quality, and adequate food resources, as well as a diversity of depths and adequate sediment quality (74 FR 52300).

Potential stressors from the project including habitat alteration, underwater sound, and EMF emissions are not expected to adversely affect these PBFs. As discussed above, the project is not expected to affect green sturgeon movement. Water quality and sediment are not likely to be adversely affected because measures, as discussed in section 3.3.3.2, would be implemented to prevent the releases of hazardous materials and minimize seabed disturbance. Habitat alteration could affect prey resources of green sturgeon, mainly by providing habitat for reef-associated invertebrates and fish that could serve as prey resources for green sturgeon, but this would be a potentially beneficial, not adverse, effect. Any effect on the PBFs in coastal marine areas would be minor or even negligible, even considering repeated disturbances over the life of the project, given the small total footprint of the seafloor structures (about 2 acres) relative to the size of the marine portion of green sturgeon critical habitat (7.3 million acres). Even the total direct (project components on the seafloor) and indirect disturbance (seafloor potentially affected by scour) surface area, which is anticipated to be approximately 21,214 ft^2 per anchor, results in only approximately 48 acres, or 3 percent of the total project site being potentially affected during full build-out (see Section 3.3.3.2, *Effects of Benthic Community from Project Structures*). The project would not affect migratory corridors, depths or food resources in estuarine habitat. Therefore, the project would not adversely affect any of these PBFs and would not adversely modify critical habitat for green sturgeon.

In the project area, the Yaquina Bay estuary is designated critical habitat for Oregon Coast coho salmon. The essential elements of critical habitat in the estuary that support growth and development of coho salmon include forage, natural cover, water quality, water quantity, salinity, and passage free of obstruction. The marine area where the project is located is not designated critical habitat for Oregon Coast coho salmon. As discussed in section 3.3.2.2, the essential element that is likely to be affected would be water quality associated with habitat alteration from toxic substances introduced by the storage, staging, and transport of project facilities in the bay. However, we concluded that the release of toxic substances would not result in high enough concentrations for a long enough time to adversely affect water quality in the estuary. Thus, the project would not adversely modify critical habitat for Oregon Coast coho salmon.

Essential Fish Habitat

The proposed project area contains EFH for a number of fish species. Potential effects to EFH may include 1) changes in the marine and freshwater fish and invertebrate communities, 2) changes to predator/prey interactions, 3) EMF effects, and 4) the effects of underwater sound/vibration. However, as described above and in section 3.3.3.2, the project would have only minor and localized effects on the local marine and freshwater fish and invertebrate communities and thus on EFH.

NMFS concluded that the proposed project would adversely affect designated EFH because construction and operation would cause changes to benthic habitat and marine community composition and behavior associated with the WECs, anchors, and mooring systems. NMFS determined that potential adverse effects to EFH for Pacific salmon, groundfish, coastal pelagics, and highly migratory species would include:
(1) increased suspended sediments from seafloor disturbance associated with installing and removing anchoring systems and jet plowing for power cable trenching;
(2) 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; (3) increased underwater sound associated with vessel traffic, cable laying, and WEC operation; (4) introduction of EMF associated with power cables, WECs, and anchoring and mooring systems; and (5) changes to benthic habitat and marine community composition and behavior associated with the

WECs and their anchor and mooring systems.

NMFS provided the following conservation measures 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.

NMFS states that fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects to approximately 1,695 acres of designated EFH for Pacific Coast salmon, Pacific Coast groundfish, coastal pelagic species, and highly migratory species.

Our Analysis

The installation of the subsea cables, subsea connectors, and anchors would result in both temporary and long-term alteration of benthic habitat in the project area, potentially affecting groundfish EFH (see section 3.3.3.2), *Effects on Benthic Community from Project Structure*). Suction caisson, embedment, and plate anchors, if used, would be placed into and under the seafloor, and therefore would have no footprint on the seafloor other than the mooring line extending from the anchor under the seafloor up to the WEC. The maximum footprint of the other types of anchors would be 19,068 ft^2 (0.4 acre) for the initial development and 90,800 ft^2 (2 acres) for the full build-out (Table 2-1), which is approximately 0.1 percent of the total project site surface area (1,695 acres). The estimates are based on exclusive use of large 34-foot-diameter gravity anchors; however, other types of smaller anchors would likely be used for some of the WECs, and shared anchors may be used for some WECs when feasible, so the actual seafloor footprint is expected to be considerably smaller than these estimates. Once an anchor is removed, the local benthic habitat would likely return to normal within months.

Installation of the buried portions of the four subsea cables and single auxiliary cable (from the offshore WEC test site to the seaward end of the HDD bores) by jet plow in individual trenches would result in a temporary disturbance of the sand bottom and could displace or cover benthic and infaunal organisms.

Mobile invertebrates (e.g., crabs), fish species that feed on or near the bottom (e.g., green sturgeon), and species that shelter on the bottom at times would likely move away from the immediate vicinity of the anchors and cable and move to nearby areas during deployment and removal activities (Roegner and Fields 2015). While these activities would result in short-term benthic habitat disturbance, benthic fauna (e.g., polychaetes, clams, and amphipods) that inhabit the area are likely to be adapted to dynamic ecosystems and likely would be unaffected by sediment burial. The total area of benthic habitat disturbed at the WEC test site would be very small relative to the range of and available marine habitat and prey for EFH fish, and minor in comparison to surrounding available habitat (about 0.1 percent of the project area [2 acres] for direct effects to the seafloor from the maximum footprint of the anchors and about 3 percent [48 acres] of the project area for indirect effects [scour] to the seafloor at full build-out). Effects at PacWave South are expected to be minimized given that anchor installation/removal is not likely to occur more than once a year in a berth and anchors may be deployed for multi-year periods. OSU would implement the Benthic Sediments Monitoring Plan (as recommended by EFH recommendation 1) under the Adaptive Management Framework to detect and, if needed, mitigate any effects of project-related sound (APEA, Appendix I). Effects of benthic habitat alteration associated with the presence of these project components would be insignificant, due to the relatively small project footprint and prevalence of unconsolidated sand habitat offshore of Oregon.

Fish would likely avoid the project area during construction activities, moving to abundant similar habitat that is adjacent to the project area. During the scoping process, PFMC raised concerns on impacts the project may have on Seal Rock Reef, specifically along the habitat interfaces where fish species often congregate. PMFC suggested that the subsea cable route avoid rocky reef habitat, canopy kelp, and seagrass HAPCs. OSU's proposed subsea cable route would avoid reefs and other hard substrate to the greatest extent possible. Therefore, the project would not affect HAPC, including Seal Rock Reef or the associated habitat interfaces where fish congregate.

The introduction of project-related structures could result in localized habitat changes as the hard structures are colonized ("biofouled") by algae and invertebrates (see Section 3.3.3.2, *Changes in the Presence of Biofouling Species, Species Interactions, and Predator-Prey Interactions*), such as barnacles, mussels, bryozoans, corals, tunicates, and tube-dwelling worms and crustaceans, termed "biofouling" (Boehlert et al. 2008).

Project structures at or near the bottom (e.g., anchors) may also act as an artificial reef and provide habitat for structure-oriented fish, such as rockfish (Danner et al. 1994, Love and Yoklavich 2006, Kramer et al. 2015), potentially affecting groundfish EFH. Attraction to project structures could alter the fish species composition in and around the project area and may also affect predator/prey interactions (Wilhelmsson and Langhamer 2014). Some fish are also known to associate with or aggregate at 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 any associated biofouling could act as FADs and attract pelagic fish through visual and/or olfactory cues (Dempster and Kingsford 2003), potentially affecting coastal pelagic EFH.

Fish attracted to project components on the seafloor (e.g., anchors) could include the deep rocky reef (>25 meter depth) associated fish species and groundfish EFH. The project structures could provide additional habitat, enhanced forage opportunities, or expose some of these fish species to increased predation by predatory fish, seabirds, or marine mammals. However, most of these reef fish species are also known to occur at the bottom and midwater structures of oil platforms offshore of southern and central California (Casselle et al. 2002, Love et al. 2010), and negative population-level effects on reef-associated species at these oil platforms have not been reported. In fact, the oil platforms contribute to rockfish productivity and have some of the highest secondary production per unit area of any marine habitat studied globally (Claisse et al. 2014). The project would not be expected to have a population-level impact on rocky reef fish due to the small overall footprint and low density of WECs; moreover, the offshore oil platform studies suggest that artificial structure does not negatively affect rocky reef fish.

Typical FAD-associated fish species are tropical or subtropical, and do not occur in the project area. In temperate ocean waters of California, Oregon, and Washington, fish associations with midwater and surface structures were generally limited to some species of pelagic juvenile rockfish, 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), vertical structures of docks and pilings (Gallagher and Heppell 2010), and “SMURFs” (Ammann 2004, Caselle et al. 2010, Woodson et al. 2012, Jones and Mulligan 2014). None of the studies of fish assemblages at these structures reported juvenile or adult salmonids. OSU would implement the Organism Interaction Plan (as recommended by EFH recommendation 1) under the Adaptive Management Framework to detect and, if needed, mitigate any effects of project-related changes in species behavior and interaction (APEA, Appendix I). Due to the small project footprint and low likelihood a FAD effect (as discussed above), the proposed action is not expected to have an adverse effect on EFH for coastal pelagic, salmon groundfish, or highly migratory species.

Temporary sound associated with project construction and operations (i.e., WEC installation, maintenance, and removal), as well as the WECs themselves during operation, would generate underwater sound that could potentially affect EFH for groundfish, salmon, coastal pelagics, and highly migratory species (see Section 3.3.3.2, *Effects of Underwater Sound/Vibration on Fish*). Measurements taken at PacWave North indicate ambient underwater SPLs between 84 to 117 dB, with a mean level of 101 dB, and at PacWave South ambient underwater SPLs were between 83 and 116 dB, with 50th percentile of 101 dB (Haxel 2019). Sound from vessel types that would be used for project installation, operations and maintenance would not exceed 130 to 160 dB over a frequency range of 20 Hz to 10 kHz, except for the dynamic positioning cable laying vessel, which could create sound levels of 180 dB at 1 meter (NMFS 2015).

It is expected that a low level of additional sound could be produced by the WECs based on measurements taken at existing WECs deployments. The maximum SPL for Columbia Power Technologies' 1/7-scale WEC was estimated at 146 dB at 1 meter, and 126 dB at 10 meters (Thomson et al. 2012, as cited in NAVFAC 2014). In the EA 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 at 1 meter (NAVFAC 2014). 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). Per NMFS request, to be conservative a source term of 151 dB at 1 meter was used in this analysis. Implementing NMFS practical spreading model with the highest WEC sound source term, sound levels of WECs would attenuate to 120 dB at 125 meters. OSU would implement the Acoustic Monitoring Plan (as recommended by EFH recommendation 2) under the Adaptive Management Framework to detect and, if needed, mitigate any effects of project-related sound (APEA, Appendix I). Therefore, acoustic emissions from project vessels and WECs are unlikely to adversely affect EFH.

The subsea cables, umbilicals, subsea connectors, and WECs would produce EMF that could potentially affect EFH for highly migratory species, coastal pelagics, groundfish, and salmon (see Section 3.3.3.2, *Effects of EMF Emissions on Species Sensitive to Electric and Magnetic Fields*). As described above, studies on EMF from subsea cables observed little or no behavior change in fish, or effects on species composition, or attraction or repulsion by electro-sensitive species (BOEM 2016, Kuhnz et al. 2011, Love et al. 2016, Kogan et al. 2006), and similar responses are expected at PacWave South. In addition, the levels of EMF are expected to be low and would be minimized through armoring and subsea cable shielding and burial. Because the cables would be buried 1-2 meters (3-6 feet) below the seafloor, the physical separation would greatly reduce the amount of EMF exposure to marine animals (around 80 percent [Normandeau et al. 2011]). The magnetic field at the seafloor by would be expected to reach ambient conditions about 2 meters above the seafloor (Normandeau et al. 2011, Bull 2015, Gill 2015). To manage uncertainties and understand the magnitude and extent of project-related EMF emissions relative to the natural EMF background, OSU would implement the EMF Monitoring Plan (as recommended by EFH recommendation3) under the Adaptive Management Framework (Appendices H and J, respectively) to detect and, if needed, mitigate any effects of project-related EMF emissions (NNMREC 2015b). Consequently, EMF emissions from the project are not expected to adversely affect EFH.

The terrestrial transmission lines would be installed via HDD; therefore, avoiding impacts to EFH located in streams (see section 3.3.3.2). Potential effects to EFH in surface waterbodies in the project area could occur from the release of potential hazardous materials from the construction equipment itself (lubricating oils and fuel) or inadvertent returns of drilling fluids to a waterway from HDD operations. However, there are only three fish-bearing streams in the project area, which would be avoided entirely. The depth of boring operations would be designed so that the engineers determine there is a low risk of inadvertent return of drilling fluids and an HDD contingency plan would be developed to minimize the effects of an inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.

Adverse effects on water quality could occur during ground-disturbing activities at Driftwood and the UCMF site if sediment-laden runoff or hazardous materials from construction work areas enters nearby streams and the Pacific Ocean. Potential adverse effects of ground-disturbing activities at Driftwood and the UCMF would be minimized or avoided by developing and implementing OSU's proposed erosion and sediment control plan, storm water management plan, and implementing appropriate BMPs (e.g., minimizing impacts to wetlands by maintaining buffers around wetlands, and maintaining natural surface drainage patterns). Therefore, terrestrial construction activities are not expected to adversely affect EFH.

Marine Turtles

Potential stressors associated with the proposed project that may affect marine turtles include underwater sound, collision or entanglement with submerged structures, entanglement with debris (e.g., lost fishing gear) if it accumulates on surface or submerged structures, and toxic effects from accidental release of oil/toxic substances.

Our Analysis

Green, loggerhead, and olive ridley sea turtles have been observed in waters off the Oregon coast, but their presence is associated with unusual oceanic conditions

(Henkel et al. 2014). Therefore, due to their rare occurrence near the project, green, loggerhead, and olive ridley sea turtles are unlikely to be affected by the project.

For the leatherback sea turtle, NMFS noted that the species was not anticipated to forage or spend extended amounts of time in the vicinity of the similar PacWave North Project (NMFS 2012c) and it is expected that the same is true for the proposed PacWave South Project. It should be noted that NMFS's conclusions for the PacWave North Project were specific to the smaller project and a shorter deployment time. Nonetheless, OSU expects that the species is unlikely to occur near the PacWave South Project, and this is corroborated by a satellite tracking study completed by Benson et al. (2011) that reported leatherback sea turtles did not use the project vicinity; rather, most occurrences in Oregon waters were farther offshore or concentrated offshore of the mouth of the Columbia River.

As discussed in section 3.3.2.2, toxic substances are not expected to adversely affect any aquatic resources or marine life in the project area, including marine turtle species. However, in the event any harmful substances are accidentally released, OSU's proposed Emergency Response and Recovery Plan would minimize potential impacts to marine turtles.

Underwater Sound

Sound associated with vessels, cable laying, and continuous (non-impulsive) sounds from the WEC operations, could cause leatherback sea turtles to avoid the project area. Unlike marine mammals, sea turtles do not appear to vocalize or use sound for communication, but sound may be used to navigate, locate prey, avoid predators, and for general environmental awareness (Dow Piniak et al. 2012). Sea turtles, in general, appear to have a relatively narrow, low-frequency range of hearing sensitivity, and respond to only low frequencies between 250 and 1,000 Hz (Bartol and Ketten 2006). Juvenile loggerhead sea turtles respond behaviorally to sounds in the low frequency range of 200-700 Hz (Lavendar et al. 2012), and leatherback sea turtle hatchlings respond to stimuli between 50 and 1,200 Hz, with maximum sensitivity at 100-400 Hz (Dow Piniak et al. 2012). Data are lacking regarding sea turtle response to continuous sounds, but it is assumed that sea turtles exhibit avoidance behavior when exposed to high amplitude, low-frequency sounds (e.g., Lenhardt 1994, Bartol 2008, Popper et al. 2014). McCauley et al. (2000) did observations of sea turtles in cages and concluded that sound from airguns louder than 166 dB increased their swimming activity, and louder than 175 dB caused erratic behavior. They also estimated alert behavior at a distance of 2 kilometers from the sound source and escape behavior at a distance of 1 kilometer.

Other than installation of the proposed transmission cables using a DPV over a period of about 30 days, project activities are not expected to reach such sound levels.

However, they could reach levels that result in minor startle or avoidance behavior (Popper et al. 2014).

Effects or Risk of Collision/Entanglement

Should leatherback sea turtles occur in the proposed project area it is unlikely they would collide with WECs or mooring lines, because the WECs would be widely spaced (50 to 200 meters or more apart), which would provide ample space for sea turtles to pass between the devices and associated mooring lines and umbilical cables, even if their maneuverability is reduced in colder water temperatures. Also, mooring lines and umbilical cables would have little slack and would not form loops, which could entangle turtles. As discussed in section 3.3.3.2 above, OSU's proposal to monitor for debris that poses a potential risk of entanglement to marine species, notify NMFS (and other resources agencies) of the detection of entangled fishing gear or debris, and remove identified hazardous debris would minimize risk to any turtle species should they occur in the proposed project area.

Critical Habitat

NMFS identified one PCE essential to the conservation of leatherback sea turtles in marine waters of the U.S. West coast: occurrence of prey species of sufficient condition, distribution, diversity, and abundance to support individual as well as population growth, reproduction, and development (77 FR 4170). The proposed listing identified eight groups of activities that may have the potential to affect this PCE: pollution from point sources, runoff from agricultural pesticide use, oil spills, power plants, desalination plants, tidal energy projects, wave energy projects, and liquid natural gas projects (NMFS 2009b).

NMFS noted that possible impacts to features of the leatherback critical habitat include disturbance to their primary prey species, jellyfish, during the benthic polyp stage (77 FR 4170). Like most attached organisms, jellyfish polyps prefer to grow on hard substrates. It is therefore unlikely that the proposed project site provides suitable habitat for the benthic stage of jellyfish. At PacWave North, OSU found little fouling of concrete block anchors deployed for over two years at the site, and therefore, it can be expected that the introduction of hard structure (e.g., anchors) at PacWave South would not provide substrate for polyps. Little effect on jellyfish is expected, although, it should be noted that NMFS's conclusions for PacWave North were specific to a shorter deployment time. As noted above, the disturbance to the seafloor by the project would be short-term and temporary, occurring during installation activities. Therefore, the proposed project would not affect leatherback prey species' condition, distribution, diversity, or abundance.

Given their rarity and OSU's proposed measures to minimize potential adverse effects, we conclude that licensing the proposed project is not likely to adversely affect the green sea turtle, Olive Ridley sea turtle, loggerhead sea turtle, or leatherback sea turtle. In addition, because the proposed project is unlikely to affect prey species for the leatherback sea turtle, we conclude that designated critical habitat for this species is also not likely to be adversely affected. On December 20, 2019, NMFS concurred with our findings for all four turtle species and critical habitat.

Marine Mammals

As with the other aquatic animals discussed above in section 3.3.3.2, ESA-listed marine mammals in the project area would potentially be exposed to underwater sound, collision or entanglement risk, EMF, and toxic effects from accidental release of oil/toxic substances. Marine mammals are not known to be adversely affected by EMF (NMFS 2012c) and are therefore unlikely to be affected by project-related EMF emissions. The potential effect of toxic substances is discussed in Section 3.3.2.2, and we concluded that toxic substances are not expected to adversely affect any aquatic resources or marine life that could be in the project area. Accidental release of oil or toxic substances is unlikely to occur because OSU would develop and implement an emergency response and recovery plan that includes spill prevention and control protocols to minimize the potential for and, if needed, respond to accidental release of oils and toxic chemicals into the marine environment. Therefore, our analysis focuses on exposure to underwater sound and risk of collision and entanglement.

Although sei, sperm, north Pacific right, and western north Pacific gray whales have been observed off the coast of Oregon, they are associated with deeper water than the project site and are unlikely to be exposed to project effects. Therefore, our analysis focuses on the southern resident killer, humpback, blue, and fin whales.

Underwater Sound

The effects of underwater sound on marine mammals is discussed in detail in section 3.3.3.2, *Effects of Underwater Sound/Vibration on Marine Mammals, Fish, and Seabirds*. Measures proposed by OSU to avoid or minimize effects to marine mammals, including acoustics monitoring, measures to address use of DPVs, and measures to address impacts of sound from WECs and their mooring systems, as required by NMFS Terms and Conditions 1, 2 and 4, are also addressed in section 3.3.3.2.

Our Analysis

The primary sources of project-related underwater sound would be from vessels at PacWave South and transiting between Newport and the site during project construction and WEC and mooring installation, maintenance, and removal; cable laying; and operation of the WECs. Most of the sound pressure produced by vessels during construction, monitoring, or maintenance activities would attenuate to below background levels a short distance from the vessel, and sound associated with vessels would be temporary and of short duration (NMFS 2012c). As described above, underwater noise levels of up to 180 dB RMS are expected within 1 meter of the dynamically positioned vessel that would be used for cable laying operations. ESA-listed species of whales are not expected to occur within 1 meter of the DPV and thus, no whales are expected to be exposed to injurious levels of underwater noise from the DPV. None of the project components or other activities are expected to generate sound at levels that could cause injury. However, the sound levels from vessels during installation and operation, from cable laying, DPVs, and from non-impulsive sounds produced by WECs over the term of operation of the WEC test site is not expected to result in harassment of marine mammals (see letter from NMFS, APEA, Appendix N). Nearly all of the ambient sounds at PacWave North were reported at 84-117 dB (Haxel 2016), and 83-116 dB RMS at PacWave South (Haxel 2019). During higher sea states, both WEC and ambient noise levels would be expected to increase concurrently, likely resulting in partial or total masking of the WEC-generated sound. OSU's proposed mitigation measures would minimize to discountable levels the risk that marine mammals would be exposed to sound exceeding 120 dB, and adverse effects are therefore not likely to occur.

Whales could be displaced from foraging in the project area or from using it to move between foraging sites. However, the project area is not known to be an important foraging area for any of the ESA-listed whales, with the possible exception of humpback whales, where the project site overlaps about 0.2 percent of the feeding Biologically Important Area. Further, there is similar habitat in the surrounding area that would serve as alternate foraging areas for these species if they are displaced. Any disruption or delay in foraging would be temporary and persist only as long as it took for a whale to swim away from the noisy area (under an hour).

Because of uncertainty associated with this new industry and in order to determine the actual sound levels emitted by WECs at the project, OSU proposes to implement the Acoustic Monitoring Plan under the Adaptive Management Framework to detect and, if needed, mitigate any effects of project-related sound (APEA, Appendix I, measure 7); therefore, project-related sound would not significantly impair essential life functions (i.e., foraging, migration, rearing), or impair the health, survivability, or reproduction of individual whales, and is therefore not expected to rise to levels constituting harassment.

Collision/Entanglement Risk

The effects of collision or entanglement with project structures on marine mammals is discussed in detail in section 3.3.3.2, *Effects or Risk of Collision/Entanglement to Marine Mammals*. Measures proposed by OSU to avoid or minimize effects to marine mammals from entanglement in fishing gear that is entangled on project components and collision with project components (e.g. WECs), (APEA, Appendix I, measure 3), include monitoring and removal of derelict fishing gear and measures to be implemented if marine mammals strandings, entanglements, impingements, injuries or mortalities are observed, are also addressed in section 3.3.3.2.

Our Analysis

As discussed in the Section 3.3.3.2 and in the BA, southern resident killer whales use sonar for hunting and communication, and thus would likely be able to detect and avoid an array of WECs over the term of any license issued. The large size of the WECs is expected to be readily perceived by an approaching humpback, blue, or fin whale. Even though humpback whales may be common in the action area, the risk of a humpback whale colliding with a WEC, anchor, or mooring structure is expected to be low, as corroborated by similar projects (Sims 2016, Atlantic Marine Aquaculture Center 2008, NAVFAC 2014). The risk of a blue or fin whale colliding with a WEC, anchor, or mooring structure is expected to be very low because both species typically occur further offshore (Caretta et al. 2015) and in deeper water (Adams et al. 2014) in Oregon than where PacWave South would be located. In addition, whales are not known to collide or entangle with taut moorings, which would be used at PacWave South; whale entanglement appears to be associated with fishing gear such as crab pots (especially buoy lines) and lost nets. OSU would conduct opportunistic surface observations at least quarterly to detect and remove marine debris from the project (APEA, Appendix I), review results of Organism Interactions Monitoring Plan for lost fishing gear, and remove detected lost fishing gear to minimize potential risk of marine mammal entanglement.

Vessel strikes are so unlikely for any of the ESA-listed marine mammals as to be discountable. OSU would minimize the risk of project-related vessels colliding with these species by requiring vessels to avoid close contact with marine mammals and sea turtles and adhere to NMFS “Be Whale Wise” guidelines. Potential non-strike encounters (e.g., a whale approaching a service vessel that is on site) are expected to be sporadic with transitory behavioral effects and therefore would be insignificant. The small footprint of the project relative to the surrounding open ocean along the coastline also minimizes the likelihood of a collision occurring.

Effects on Proposed Critical Habitat for Killer and Humpback Whales

The project could potentially affect PBFs that form the basis for proposing critical habitat for the southern resident killer whale and humpback whale, such as prey and passage conditions.

Our Analysis

Passage conditions to allow migration, resting, and foraging is an essential feature of the proposed critical habitat in the project area. Sound, however, is not considered as a separate essential feature. Killer whales would be expected to easily pass around potential physical obstructions created by the project. Therefore, the project would not reduce the quality or function of this essential feature.

The proposed action may also affect food supply for southern resident killer whales by reducing availability of their primary prey, Chinook salmon (letter from NMFS, December 20, 2019). 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. 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 year's time) been intercepted by the killer whales across their vast range in the absence of the proposed activities. Therefore, like NMFS, we conclude that 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.

The marine action area is proposed critical habitat for humpback whales. The only PBF designated for critical habitat is prey (letter from NMFS, December 20, 2019). The proposed action could potentially 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, like NMFS, we agree that the proposed action would not reduce the quality and function of the prey PBF for humpback whales.

Birds

As discussed in sections 3.3.3 and 3.3.4, FWS and Oregon DFW recommend OSU implement its proposed BBCS Plan, which includes several measures to protect bird species occurring both in marine and terrestrial habitats, including species listed under the ESA. These include measures to minimize potential project effects of entanglement with marine debris, seabird perching on project equipment, and lighting on project structures and vessels. In addition, the BBCS Plan also includes measures to:

- Require vessel operators to follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout.
- Require vessel operators to remain 500 feet away from seabird colonies during the nesting season to minimize disturbance to nesting seabirds.
- Develop and implement an Emergency Response and Recovery Plan.
- No HDD construction equipment or construction activities would occur on Driftwood beach within suitable snowy plover nesting, roosting, or foraging habitat and is expected to be limited to the Driftwood parking lot, at least 164 feet (50 meters) from any potentially suitable habitat.
- HDD operations in the parking lot would occur during daylight hours, but if lighting is required at night it would be appropriately shielded and directed to minimize artificial light reaching western snowy plover nesting habitat at night. Animal-proof litter receptacles and related signage and coordination would be provided to minimize potential attraction of predators.
- Develop and implement an HDD contingency plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.
- If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat would be conducted. If nests are detected, measures specified in the BBCS Plan would be implemented, including noise monitoring and implementation of engineering controls, if appropriate (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers). If lighting is required at the UCMF or construction site at night, it would be appropriately shielded and directed to minimize artificial light attraction and prevent potential injury or mortality to seabirds. To the maximum extent practicable, while allowing for the public safety, low intensity energy saving lighting (e.g., low pressure sodium lamps) would be used, and bright white light would be minimized to the maximum extent practicable.

In addition, OSU proposes to implement its Acoustics Monitoring Plan that would monitor sound produced by WECs as well as measures to mitigate excessive sound are described in the Mitigation Measures (APEA, Appendix F).

Marbled Murrelet

Potential effects of the proposed project on marbled murrelets in the marine environment include collision with project structures (submerged or above-water), entanglement with debris (e.g., lost fishing gear) if it accumulates at surface or underwater project structures, attraction to operational lighting on service and supply vessels or navigational aid lighting on project structures, sound and vibration emitted from the WECs during ordinary operation or during HDD, and fouling of feathers and toxic effects from accidental release of oil/toxic substances. In the terrestrial portion of the proposed project potential effects include construction disturbance from equipment and human activity (e.g., noise, construction workers).

Oregon DFW recommends (10(j) recommendation 2A) modifying the proposed BBCS Plan to make sections pertaining to marbled murrelet consistent, as appropriate, with protection measures in the revised BA filed by OSU on August 27, 2019. OSU agreed to follow this recommendation in its letter responding to comments on the REA notice for the proposed project.

Our Analysis

<u>Effects or Risk of Collision/Entanglement</u>

Marbled murrelets are unlikely to collide with submerged structures, become in entangled in accumulated marine debris (e.g., lost fishing gear), or become entrapped or crushed by moving parts, because pursuit-diving seabirds such as marbled murrelets are agile swimmers and have high underwater visual acuity (Henkel et al. 2014). Alcids are wing-propelled pursuit divers that swim rapidly (approximately 1 meter per second) to pursue and capture mobile prey such as schooling fish, and can veer, turn, and glide underwater (Johnsgard 1987); thus, it is expected that their vision and agility is adequate for navigating around submerged structures.

Marbled murrelets reach peak densities at 300 to 1,000 meters from shore and are rarely observed seaward beyond 4 kilometers (Strong 2009). Further, this species was not observed at the WEC test site during boat surveys conducted from May 2013 to October 2015 (a total of 44 cruises) in the vicinity of the proposed project (Porquez 2016, Suryan and Porquez 2016). An analysis of the potential effects on marbled murrelets at a proposed wave park 4.6 kilometers offshore of Reedsport, Oregon, found a low likelihood of collisions with above-surface and submerged structures at the park due to the low density of marbled murrelets at that distance from shore, the spacing between the WECs (approximately 100 meters apart), and the relatively small area encompassed by the WECs (Kropp 2013). Similarly, due to the expected low density of murrelets in the proposed WEC test site area, and the relatively small area of the submerged and above-surface structures (maximum of 20 WECs with a maximum height of 10 to 12 meters above the water surface) compared to their available at-sea habitat, the likelihood of marbled murrelets encountering and colliding with project structures is low. The spacing of WECs 50 to 200 meters or more apart should also provide ample space for marbled murrelets to maneuver between WECs, further reducing the risk of collision.

Therefore, presence of marbled murrelets in the proposed marine WEC test site and exposure to risk of collision/entanglement from the WECs and project structures is low. In addition, OSU's proposed plan to monitor and remove accumulated marine debris identified as posing a risk to any marine bird species would also serve to protect any marbled murrelets should they occur in the area of the proposed test site.

Effects of Artificial Lighting

Some seabird species are highly attracted to artificial light in the marine environment, including murrelets. Typical sources of light include boats, lighthouses, oil and gas platforms, coastal resorts, and commercial fishery operations. Continuous high-intensity white lighting is more likely to attract seabirds than lower-intensity, colored lights and those that flash at intervals (Montevecchi 2006, Poot et al. 2008). Nocturnal seabirds are most susceptible to light attraction in cloudy, foggy, or hazy conditions, in light rain, and when the moon is absent or obscured. Immature and nonbreeding nocturnal seabirds tend to be more attracted to light than breeding adults (Montevecchi 2006, Miles et al. 2010).

OSU's proposed measures to use shielded, low-intensity, flashing lights on WECs, and minimizing nighttime vessel lighting during installation and maintenance activities would limit attraction to artificial lighting and hazards to murrelets. In addition, effects related to vessel lighting are expected to be short-term and intermittent because vessel use would be limited to installation of the WECs and periodic maintenance and repair activities.

Effects of Underwater Sound

Underwater sounds generated by the project may be similar to, or masked by, ambient underwater sounds in the proposed project area, which are reported to be higher than the typical deep ocean sound found in the northeast Pacific Ocean (Haxel et al. 2011), likely due to wave activity and existing vessel traffic. The presence of marbled murrelets in the WEC test site area and exposure to underwater sound and vibration emitted by the WECs during ordinary operation would likely be rare and limited to few individual birds. Some birds could be exposed to underwater sound and vibration from service and support vessels in nearshore waters as they transit between Yaquina Bay and the WEC test site, as a small number of birds (<10 total) were observed in this area during boat surveys conducted from May 2013 to October 2015 (Porquez 2016). Some birds could also be exposed to underwater sound and vibration emitted from HDD and the dynamic positioning thrusters during cable lay, as a small number of birds (<10) were observed in this area during boat surveys (Porquez 2016).

The threshold for underwater sounds to result in injury to marbled murrelets is 202 dB SEL (SAIC 2011), and 150 dB rms for behavioral effects such as flushing and avoidance of the area (FWS 2014b). None of the project components or activities are expected to generate sound at levels that could cause injury to marbled murrelets.

Underwater sound emitted by the WECs during ordinary operation is expected to be within the range of ambient sound levels, and thus is not expected to interfere with or disrupt normal behavior. Vessel sound throughout the life of the proposed project could cause short-term, temporary behavioral disturbances (i.e., minutes per trip) to marbled murrelets as the vessels transit through nearshore waters. During cable lay operations at the beginning of the project, and during installation of individual WECs throughout the project, sound from a vessel with dynamic positioning thrusters could also cause short-term, temporary behavioral disturbances.

Because noise associated with the proposed project would not result in injury or mortality and may only result in short-term temporary behavioral disturbances, there is little risk to individuals or the population of marbled murrelets as a result of exposure to sound and vibration from the project. In addition, the proposed Acoustics Monitoring Plan would monitor sound produced by WECs as well as measures to mitigate excessive sound are described in the Mitigation Measures (APEA, Appendix F) would also ensure noise-related effects to marbled murrelets would be minimal.

Effects of Toxic Releases

Accidental release of oil or toxic substances is unlikely to occur because OSU would develop and implement an emergency response and recovery plan that includes spill prevention and control protocols to minimize the potential for and, if needed, respond to accidental release of oils and toxic chemicals into the marine environment.

Effects of Terrestrial Activities

The mixed conifer/deciduous forest in the terrestrial project area does not contain suitable nesting habitat for marbled murrelets. However, murrelets could fly over or through the mixed conifer/deciduous forest in the terrestrial action area as they fly between at-sea and inland nesting habitats. However, they are unlikely to be affected by sound and human disturbance (e.g., movement of equipment and personnel) during construction activities given that these activities would occur in the Driftwood parking lot where disturbance from vehicles and human activity is already present, and at the UCMF, which is adjacent to Highway 101, and therefore also near existing disturbance.

Unlike other alcids, marbled murrelets fly between coastal/ocean habitat and inland nesting habitat in old growth forests (Miller et al. 2002), which could make them susceptible to impacts from terrestrial construction activities. However, inland flights of marbled murrelets occur around sunrise and sunset, which is outside of the typical construction schedule. Therefore, terrestrial construction activities are not expected to affect marbled murrelets.

Based on the preceding analysis, we conclude that licensing the proposed project is not likely to adversely affect the marbled murrelet. On October 16, 2019, FWS filed a letter with the Commission concurring with our finding for the marbled murrelet.

Short-tailed Albatross

Potential effects of the proposed project on short-tailed albatross include collision with above-surface structures of WECs and fouling of feathers and toxic effects from accidental release of oil and other toxic substances. This species could also be attracted to project-related service and support vessels (Hyrenbach 2001).

Our Analysis

Attraction of short-tailed albatross to vessel activity or to WECs is not likely to result in any adverse effects such as increased energy expenditure, given their ability to fly short distances with little energy cost (Sachs et al. 2012). Moreover, the Recovery Plan for short-tailed albatross does not include collisions with vessels as a potential threat despite their frequent attraction to vessels (FWS 2008). Potential accidental releases of toxic substances that could harm this species would be minimized by OSU's proposal to develop an emergency response and recovery plan.

Because short-tailed albatrosses are rare along the Oregon coast and the project area, project-related effects on the species are unlikely. However, should the species become more common in Oregon waters, the likelihood of albatrosses occurring in the WEC test site and being affected by WECs or vessels is still low. During boat surveys conducted from May 2013 to October 2015 (a total of 44 cruises), black-footed albatrosses (used as a proxy for short-tailed albatross due to similar habitat use) were primarily concentrated beyond 20 kilometers from shore, westward of the WEC test site (Porquez 2016, Suryan and Porquez 2016).

Should short-tailed albatrosses occur near the proposed WEC test site the likelihood of encountering project structures would still be low due to the relatively small area of the proposed above-surface structures (maximum of 20 WECs, maximum height of 10 to 12 meters above the water surface) compared to their available at-sea habitat. Although albatrosses are known to fly at altitudes of less than 30 meters, they tend to fly at higher altitudes when wind speeds increase (Ainley et al. 2015), which would reduce their likelihood of collision with WECs at higher wind speeds. When flying at lower altitudes during lower wind speeds, albatrosses would be better able to maneuver and avoid collisions. Additionally, the spacing of the WECs (50 to 200 meters or more apart) should provide sufficient space for individuals to maneuver between WECs.

For the reasons discussed above, we conclude that licensing the proposed project is not likely to adversely affect the short-tailed albatross. On October 16, 2019, FWS filed a letter with the Commission concurring with our finding for the short-tailed albatross.

Western Snowy Plover

Western snowy plovers could use the beach near the proposed cable landing site for nesting, wintering, foraging, and roosting. Western snowy plovers are known to occur on the sandy beaches along the central Oregon coast, and nesting was documented along the beach between the mouth of Alsea Bay to Seal Rock, to the south and the north of Driftwood beach in 2017 (L. Hillman, Oregon Parks and Recreation Department, pers. comm. 2017).

FWS and Oregon DFW recommend (10(j) recommendations 1 and 2, respectively) that OSU implement its proposed BBCS Plan, as outlined in its revised BA (filed August 27, 2019), which includes the following measures to minimize effects to the western snowy plover:

- No HDD construction equipment or construction activities would occur on Driftwood beach within suitable snowy plover nesting, roosting, or foraging habitat and is expected to be limited to the Driftwood Beach parking lot, at least 164 feet (50 meters) from any potentially suitable habitat.
- HDD operations in the parking lot would occur during daylight hours, but if lighting is required at night it would be appropriately shielded and directed to minimize artificial light reaching western snowy plover nesting habitat.
- If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat would be conducted by FWS-approved biological monitor(s) within 600 feet of the western edge of the Driftwood parking lot. If nests are detected, measures specified in the BBCS Plan would be implemented, including noise monitoring and implementation of engineering controls, if appropriate (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers).

As discussed above, OSU also proposes to develop and implement an HDD contingency plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.

For western snowy plover, Oregon DFW recommends (10(j) recommendation 2) modifying the proposed BBCS Plan to include additional recorded observations of plover nests occurring near the proposed project location in 2017, 2018, and 2019; and make sections consistent, as appropriate, with protection measures changed in the revised BA filed by OSU on August 27, 2019. In its reply comments to the agencies, OSU identifies the changes in the BA as follows: (1) if HDD is initiated during the western snowy plover nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat would be conducted by a FWS-approved biologist within 600 feet of the western edge of the parking lot at Driftwood; and (2) OSU would conduct a FWS-approved worker-awareness program to train construction personnel about federally listed species and their habitats in the project area. In its reply comments to Oregon DFW's REA comments, OSU agreed to include these recommendations.

Oregon DFW (10(j) recommendation 2) and Oregon PRD recommend that all proposed project activities, not just heavy-duty equipment activities, should occur at least 164 feet (50 meters) from suitable habitat for western snowy plover. Oregon PRD adds that project activities be approved through consultation with FWS and Oregon PRD. In its reply comments to the agencies, OSU did not agree to this modification.

In addition, Oregon PRD also recommends that development of terrestrial plans that have not been finalized include consultation with Oregon PRD, FWS, and Oregon DFW on what constitutes suitable nesting habitat; Oregon PRD be consulted on any adaptive management measures necessary for snowy plovers on the ocean shore and; Oregon PRD should be consulted in placement of sound barriers, signage, etc. along with any adaptive management measures necessary for snowy plovers.

Our Analysis

Snowy plovers that occur on the beach within the action area could potentially be affected by installation of the cables where they come ashore at Driftwood. Potential effects on plovers would largely or entirely be avoided by the use of HDD to install the cables from the onshore cable landing (beach manholes) at Driftwood parking lot, 50 to 100 feet under the beach and dunes, and beneath the seafloor to about the 10-meter isobath, a distance of about 0.6 nautical mile. The onshore cable landing installation would occur over a period of 6 to 8 months.

Human activity at the Driftwood parking lot associated with the project could attract predators (e.g., common ravens) to anthropogenic food sources, and with inadvertent return of drilling fluid at the beach. Human activity at the Driftwood parking lot associated with the project construction could result in additional disturbance to nesting western snowy plovers, in the form of increased light at night, and the potential to increase risk of predation due to a anthropogenic food sources associated with poorly contained refuse or debris (because Driftwood is already used by visitors, food sources are already likely present, but construction at the parking lot could potentially introduce additional food sources). Operations at the parking lot are proposed during daylight hours, but if lighting at night is needed OSU would use appropriately shielded and directed lighting to minimize artificial light reaching plover habitat. As discussed in section 3.3.4, to minimize and mitigate for human debris and food waste, OSU proposes to provide animal-proof litter receptacles to Driftwood, along with signage to notify construction crews and visitors after construction is completed about the importance of litter removal to wildlife. Construction crews would also receive guidance that includes the need to keep the parking lot and surrounding area clean of litter and food waste.

Inadvertent return of drilling fluids would not affect nesting and foraging habitat for western snowy plover because the depth of boring operations at 50 to 100 feet below the dunes and beach should curtail the risk of inadvertent return of drilling fluids to the beach. Regardless, OSU's proposal to develop an HDD contingency plan would minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor. The contingency plan would rely on beach access for containment response and monitoring, if necessary, to occur from existing vehicle access points such as Quail Street, approximately 1.32 miles north of the Driftwood.

The HDD rig is likely to be the loudest equipment used during operations from the Driftwood parking lot (Tetra Tech 2013). Sound emitted from the HDD rig is not likely to affect plovers on the beach because the HDD rig would be operated in the parking lot at least 300 feet from any potential nesting or foraging habitat for western snowy plovers. At a distance of 300 feet, and assuming no deflection or masking of the noise, the sound pressure levels of the HDD rig (the maximum sound pressure level of an HDD rig at 50 feet is estimated at 92 dBA [TetraTech 2012]) would be reduced by 40 percent to 76 dBA from the levels at the source. Blocking and deflection due to the elevational difference (Harmelink and Hajek 1973), estimated to be 40 feet, between plover habitat and the location of the HDD, and deflection and absorption due to dune vegetation (Huddart 1990, Fang and Ling 2003, van Renterghem et al. 2012, 2015) would further reduce HDD noise in plover habitat. Acoustic shadows created by temperature differences between the ground surface and near-ground atmosphere (West et al. 1989), late in the day, are also expected to further ameliorate noise from the drill rig.

Masking of HDD noise is also expected to be substantial due to heavy surf and strong onshore winds. Auditory perception is dependent, in part, on filtering background noise: near-constant ambient noise is expected to largely or completely mask noise associated with the HDD rig. Surf contributes substantially to ambient noise (e.g., Cato 2012), and surf-generated noise scales roughly with the square of the wave height (Deane 2000). Bathymetry affects surf-generated noise, influencing source level densities as well as the sound spectra (Fabre and Wilson 1997). While these studies refer to the noise underwater due to breaking waves, these sounds are also audible on the beach, in air. Bolin and Åbom (2010) recorded sound pressure levels in air ranging from 60 dB at 0.4-meter wave height to 78 dB at 2.0 meter wave height in the Baltic Sea, and Tollefsen and

Byrne (2011) recorded comparable levels across a similar range of surf heights. Ocean waves (i.e., not surf or breaking waves, *sensu* Bascom 1980) are regularly recorded offshore of the project site (NDBC, Station 46098)[47] that suggest local surf conditions, and thus surf-generated noise, regularly exceed these levels. The average wave height at sea exceeds 2 meters offshore of the project area and rarely falls below 1 meter, even in the summer; these wave heights translate to surf of comparable or greater size, depending largely on their period (Bascom 1980).

Wind-dependent noise is correlated with wind speed (Wenz 1962), and local wind conditions indicate that this is likely to be a substantial contributor to ambient noise. An average wind speed near 10 knots and the onshore direction of the prevailing winds[48] are expected to combine to further limit sound propagation from the HDD rig towards plover habitat (Tanaka and Shiraishi 2008, Oshima and Li 2013).

Therefore, the sound pressure level of an HDD rig (Engineering Page 2017) diminishes rapidly with distance from the source, and these estimates are expected to be an overestimation due to strong onshore winds, elevational differences between the sound source and plover habitat, and the effects of intervening vegetation. Ambient noise from the surf zone and strong winds that are common along the coastline of Oregon is expected to be high, masking HDD rig noise in western snowy plover habitat. Ambient noise in the surf zone has not been measured at Driftwood; however, surf noise would be expected to exceed 60 dBA at wave heights above 1 meter (Bolin and Åbom 2010, Tollefsen and Byrne 2011), and the surf at Driftwood beach is expected to be considerably greater. Noise is considered significant if it increases background noise by more than 10 dBA above background (ICF International 2010b), and HDD noise levels within potential snowy plover habitat are unlikely to exceed this value. For these reasons, effects to western snowy plover as a result of onshore cable installation or due to sound from HDD are expected to be insignificant.

As outlined in the proposed BBCS Plan, if HDD occurs outside of the nesting season (September 16 to March 14), but then extends into the nesting season, any western snowy plovers that initiate nesting near the parking lot while HDD is ongoing, are assumed to be undisturbed by the HDD, assuming there is no significant change in project operations after nesting is initiated.

---

[47] National Data Buoy Center, Station 46098 – OOI Waldport Offshore, www.ndbc.noaa.gov, accessed March 24, 2018.

[48] Winds measured at Station NWPO3 off Newport, Oregon, http://www.ndbc.noaa.gov/view_climplot.php?station=nwpo3&meas=ws (accessed March 24, 2018).

However, if HDD is initiated within the nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat would be conducted by OSU within 600 feet of the western edge of the parking lot (as modified by OSU in the revised BA) for signs of nesting western snowy plovers (eggs or chicks) following the *Western Snowy Plover Breeding Window Survey Protocol* (Elliott-Smith and Haig 2007). If no nests are detected, HDD can proceed. If nests are detected, then noise monitoring would be conducted to evaluate the sound levels within the nesting habitat. Noise monitoring includes evaluating existing ambient noise levels prior to start of HDD (7 to 14 days), during calm wind and ocean conditions (e.g., <10 mph winds, seas <1.5 meters) and at windy, high wave conditions (e.g., >15 mph winds, seas >2 meters). After HDD is initiated, additional sound monitoring may be conducted at calm conditions and windy, high wave conditions, 50 feet from the HDD rig (to determine if sound levels cited and analyzed in the BA, 92 dBA, are accurate), and at 300 feet from the HDD rig in snowy plover nesting habitat. If sound levels produced by the HDD rig are greater than 10 dBA above ambient conditions at 300 feet in either calm or windy conditions, then proposed engineering controls would be implemented to minimize HDD-related operational noise (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers). Specialized panels that absorb and deflect sound when effectively positioned around noise generating areas are commercially available. The effectiveness of noise-reducing measures would be tested upon deployment to verify that they reduce noise to less than 10 dBA above ambient conditions at 300 feet.

The westernmost section of the Driftwood parking lot is less than 164 feet from potential snowy plover habitat where some proposed project equipment and activities could occur. OSU's proposed BBCS Plan states that no project equipment or activities, including HDD equipment, would occur on Driftwood beach and that construction activities and equipment are expected to be limited to the Driftwood parking lot, at least 164 feet (50 meters) from any potential suitable habitat for western snowy plover.

Oregon PRD comments that the 50-meter buffer consistent with the [*Western Snowy Plover*] *Habitat Conservation Plan* was designed for protection from recreation-related disturbances (e.g., pedestrians), not potential disturbances associated with heavy-duty equipment activities. Oregon PRD further states that it considers all activities associated with the proposed project as potentially affecting nesting plovers. Therefore, Oregon PRD recommends that all proposed project-related activities occur at least 164 feet (50 meters) from suitable plover habitat and be approved through consultation with FWS and Oregon PRD. Oregon DFW also recommends (10(j) recommendation 2A) that all activities in the Driftwood parking lot occur at least 164 feet (50 meters) from potential suitable habitat for the plover. However, Oregon DFW does not raise any distinctions regarding proposed project activities as Oregon PRD.

OSU does not agree to the additional restriction that all proposed project activities, not just heavy-duty equipment activities, occur at least 164 feet (50 meters) from suitable habitat for western snowy plover and be approved through consultation with FWS and Oregon PRD restrict all activities as recommended by the two agencies. In response to Oregon PRD, OSU states that their recommendation would add to previously agreed measures by restricting all proposed project activities, regardless of the activities' noise levels, within 164 feet (50 meters) of plover habitat. OSU states that this would prevent a number of project activities from occurring at the western end of the parking lot including parking, repaving the parking lot after construction, and installing interpretative signs, which OSU would undertake to benefit to the park system as part of the needed easement from Oregon PRD. OSU confirms that proposed HDD construction activities involving heavy equipment are not expected to be closer than 164 feet to suitable plover habitat or potential plover nests.

On October 16, 2019, FWS filed a letter with the Commission concurring with staff's determination that licensing the proposed project is not likely to adversely affect the western snowy plover. FWS's concurrence is based on its review of OSU's project proposal outlined in the license application and the BA. In its letter, FWS notes that, according to OSU's BBCS Plan, all activities and equipment associated with onshore cable landing and HDD will be at least 164 feet from western snowy plover habitat. FWS concurs that sound emitted from the HDD rig is not likely to adversely affect plovers on the beach because the HDD rig will be operated in the eastern half of Driftwood parking lot away from any potential nesting or foraging habitat for snowy plovers. In addition, FWS concludes that after considering OSU's proposal, they anticipate that the proposed project activities in Driftwood would only result insignificant or discountable effects to western snowy plovers as a result of onshore cable installation or due to sound from HDD. However, FWS does not indicate that project activities not involving HDD heavy-duty construction equipment (e.g., sign installation, parking) should also not occur within the proposed 164-foot buffer, as Oregon PRD recommends. Additionally, in its letter providing section 10(j) recommendations, FWS recommends implementation of the BBCS Plan (10(j) recommendation 1) but does not recommend any modifications to the plan related western snowy plover, including any modifications to the 164-foot buffer.

The additional restriction and consultation recommended by Oregon PRD, to consult on and limit all project activities in Driftwood parking lot to the 164-foot buffer are unnecessary for protection of potential plover habitat. OSU's proposal to apply the buffer in the parking lot to noise producing HDD construction activities would provide adequate protection to minimize effects of the proposed project on the western snowy plover. The other proposed activities (described above) for the western edge of the parking lot are not anticipated to affect nesting plovers.

OSU agrees to implement Oregon PRD and Oregon DFW's recommendations to amend the BBCS Plan to include changes to measures for western snowy plover provided in the revised draft BA. In its reply comments to the agencies, OSU lists the changes which consist of two measures. One measure was modified that if HDD is initiated during the plover nesting season, surveys would be conducted within 600 feet of the western edge of the parking lot at Driftwood instead of 600 feet from the HDD rig. The measure also specifies that surveys would be conducted by Service-approved biologist. Project activities would take place within the entire footprint of the parking lot and potential plover nesting habitat occurs only west of the parking lot. Therefore, conducting surveys from the western edge of the parking would be more appropriate to identify nests that could be potentially disturbed by project activities. The second measure that was added to the revised BA, states that OSU would implement a worker-awareness program to train construction personnel about listed species in the project area, including the western snowy plover. While such training could benefit the plover and other listed species, OSU is expected to train their employees to the extent needed to maintain compliance with any license conditions, and therefore such consultation is unnecessary. Lastly, it's unclear what benefit would be provided by adding additional records of plover nesting near Driftwood to the BBCS Plan, as recommended by Oregon DFW (10(j) recommendation 2).

As recommended by Oregon PRD, consultation with Oregon PRD, FWS, and Oregon DFW to define suitable nesting habitat for the western snowy plover when finalizing the development of terrestrial plans, would ensure nesting habitat is properly delineated for implementing any relevant measures to minimize effects to nesting snowy plovers and their habitat. Because the Driftwood property is managed by Oregon PRD, Oregon PRD's recommendation for OSU to consult with them on the placement of any structures (e.g., sound barriers) and signage to help protect western snowy plover would be appropriate.

Oregon PRD also recommends they be consulted in any adaptive management measures necessary for snowy plovers on the ocean shore. However, as OSU notes, response actions for the listed plover are fully developed in the BBCS Plan and do not require adaptive management. Furthermore, the CWG did not identify snowy plover mitigation measures as appropriate for management under the Adaptive Management Framework. Staff agrees with this assessment and therefore consultation is unnecessary.

Based on the preceding analysis, we conclude that licensing the proposed project is not likely to adversely affect the western snowy plover. As noted above, on October 16, 2019, FWS filed a letter with the Commission concurring with this determination.

Northern Spotted Owl

If present, northern spotted owls could be affected by sound and human disturbance (e.g., movement of equipment and personnel) during proposed construction activities.

Our Analysis

The proposed terrestrial portion of the project area does not contain suitable nesting habitat for northern spotted owls, but the species could occur in the mixed conifer/deciduous forest in the terrestrial portion of the project. However, it is unlikely that the species inhabits the surrounding forest due to existing fragmentation, housing developments, and timber harvesting. Because the proposed project area is located along Highway 101, disturbance from vehicles, noise, and other human activities already exists.

As discussed above, OSU would install the proposed terrestrial lines using HDD, thereby minimizing potential impacts to potential forest habitat and avian collision and electrocution hazards typically associated with above-ground transmission lines. As such, we anticipate insignificant or discountable effects to northern spotted owls as a result of exposure to sound and human disturbance from construction activities. Therefore, we conclude that licensing the proposed project is not likely to adversely affect the northern spotted owl. On October 16, 2019, FWS filed a letter with the Commission concurring with our finding for the northern spotted owl.

3.3.5.3 Cumulative Impacts

Past and on-going uses of the project area, such as recreational and commercial fishing, creation of derelict fishing gear, commercial and recreational vessel traffic, dredge material disposal, testing of WECs at PacWave North, development and operation of the Camp Rilea Ocean Renewable Energy Project, and the OOI Project may have a small negative cumulative effect on federally listed species, designated critical habitat, and EFH. These activities introduce stressors to the marine environment that can result in changes in benthic habitat, species assemblages, water quality contaminants, and noise pollution. As described above, the PacWave South Project would affect a relatively small area of the OCS and avoid areas of HAPCs. Therefore, the project would minimally contribute to ongoing cumulative effects.

NMFS (2010) identified actions to improve the potential for recovery of green sturgeon, including determining if EMF produced by offshore energy projects alters green sturgeon migration patterns. The migration of green sturgeon from spawning habitats in California along the coast to overwintering grounds off British Columbia has been documented (Lindley et al. 2008) and recent observations of tagged green sturgeon off the Oregon Coast both at Reedsport and PacWave North as well as the proposed

PacWave South site, indicate that some individual sturgeon migrate quickly whereas other individuals can remain in an area for longer periods of time (Payne et al. 2015, Henkel 2017). A concern is that green sturgeon migration rate (speed of migration) could be delayed by EMF emitted from subsea cables that transmit power from multiple offshore wave and wind projects to the coast, because these cables cross green sturgeon migration corridors as well as designated critical habitat. PacWave South would be the first grid-connected wave energy project on the West Coast, although Camp Rilea would require cables to transmit power from offshore WECs to shore. In addition, scientific research projects such as the Ocean Observatory Initiative's Endurance Array off Oregon also requires cable to transmit data to shore and to transmit power to the nodes. When NMFS designated critical habitat for green sturgeon in 2009 (74 FR 52300), all proposed "alternative energy hydrokinetic projects" in coastal marine waters within 60 fathom (about 109 meters) depth were considered, and all those projects have been abandoned. The effect on migration from four projects off Oregon is unlikely to significantly delay migration of green sturgeon to overwintering habitats to the north or return migration south to spawning habitats in California because EMF from subsea cables has not been shown to affect marine life (BOEM 2016).

The terrestrial transmission lines would be installed using HDD from the Driftwood to the UCMF, which would avoid cumulative impacts to EFH in surface waterbodies in the project area. There are only three fish-bearing streams identified in the project area, which would be avoided entirely. EFH would be protected during construction due to use of HDD to install the terrestrial cable and implementation of other BMPs (e.g., implementing and erosion and sediment control plan).

3.3.6 Recreation, Ocean Use and Land Use

3.3.6.1 Affected Environment

Recreation

Coastal Recreation

In a statewide survey, Lincoln County ranked as the most visited county for "non-consumptive ocean recreation" in Oregon (Surfrider Foundation et al. 2011). In 2010, Oregon residents took an estimated 27 million trips to the coast; 88 percent of those trips were for recreation. A random sample of 4,000 residents found that over 80 percent had visited the Oregon coast at least once in the past 12 months, and the most popular activities were shore-based. Wildlife viewing activities such as exploring tide pools and going on whale watching tours were popular with nearly a third of respondents. Two to eight percent of respondents reported participating in ocean-based activities such as surfing, kayaking, and boating. Participation in these types of recreational activities appears to be increasing (Dean Runyan Associates 2016, Surfrider Foundation et al. 2011).

The unincorporated coastal community of Seal Rock is a popular vacation destination that includes a 5-mile stretch of beach along Oregon's scenic Pacific Coast Highway (Greater Newport Chamber of Commerce 2009). Seal Rock State Park provides access to tide pools as well as ocean views and a sandy beach. In Seal Rock, the viewpoint known by the residents as Elephant Rock is a large landmark that was formed by seismic activity in the 1700s and is a popular area for visitors to view wildlife and coastal storms. Rocks located off the coast of Seal Rock are part of the Oregon Islands National Wildlife Refuge (FWS 2014c). Another popular recreational site in Seal Rock is Quail Street Beach, which is a relatively secluded beach with tide pools and other unique features.

Marine Recreation

Popular marine recreational activities in the area include fishing, swimming, surfing, boating, and whale watching. Sport fishing occurs in rivers, estuaries, and off-shore areas throughout the Oregon coast by various trip types, including by shore, pier, small craft, and charter boat. Over the last decade, the State of Oregon has had a highly significant decline in the number of boat registrations and use days, which is consistent with the national trend. While recreational vessel registrations have declined in the State, the charter industry has shown steady growth over the same period. The Central Oregon Coast hosts over 22 percent of fishing guides in the state. In 2008, there were 15 charter vessels operating out of Newport (FINE 2008). Typically, charters operate year-round, weather permitting, with most of their business generated during from May to September.

In the City of Newport, which is located approximately 10 miles north of Seal Rock, marinas provide boat slips, fuel docks, boat ramps, parking, and boat wash areas (FCS Group 2014). On average, 9,500 recreational fishing boats were launched per year at the Port of Newport from 2005 to 2007 (FINE 2008). In the City of Waldport, which is 8 miles south of Seal Rock, the Port of Alsea Marina includes a public boat ramp and 25 moorage slips. The Oregon Marine Board estimates that there were 13,782 boating related trips in the Alsea Bay and Alsea River during 2011 (FCS Group 2014).

The recreational fishery targets primarily five species or species groups in ocean waters off the coast of Lincoln County; these include salmon, groundfish, Dungeness crab, albacore tuna, and halibut (FINE 2008). Coho salmon fishing was traditionally the backbone of the recreational fishery off of Lincoln County, which changed in the 1980s when restrictive harvesting regulations were placed on the fishery. Accordingly, the salmon fishery began to focus primarily on the Chinook salmon rather than coho salmon. Most Chinook salmon are caught from May to mid-September outside of state waters. A major recreational groundfish fishery is located about 3 nautical miles off Lincoln

County, Oregon. Interest in recreational fishing for halibut has been growing (FINE 2008). Groundfish, Pacific halibut, and albacore tuna became more popular recreationally as restrictions were imposed on other species.

Inland Recreation

The Driftwood site is located about 2 miles south of Seal Rock between Highway 101 and the ocean. Driftwood is known for its accumulation of driftwood that has washed up during heavy surf, and sand sculptures formed by strong winds and waves. The site is approximately 29 acres in area and offers beach access, picnicking and fishing opportunities, and is managed by Oregon PRD as a State Highway Rest Area under an agreement with Oregon Department of Transportation (Oregon DOT). The site is open year-round and annual day use attendance of the site is estimated to be approximately 145,500 (Oregon Parks and Recreation Department 2014).

Ocean Use

Waters in the vicinity of the Project 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 3-12), about 6 nautical miles from the project WEC deployment area. 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 Washington Sea Grant Tow Lane Charts, PacWave South would be located in the southern corner of the existing tow lane off the coast of Newport; however, OSU worked with the crabbers and tow boat operators and secured a provisional agreement to adjust the tow lanes so they avoid PacWave South.

The USACE maintains the Yaquina Bay federal navigation channel to federally authorized depths by periodically removing naturally occurring sedimentary material. Material removed from this area is placed at one of the two USACE designated Ocean Dredged Material Disposal Sites (North and South) located off the coast of Newport in the Yaquina Bay area (USACE 2012). The Ocean Dredged Material Disposal Sites are located about 6 nautical miles northeast of PacWave South and about 10 nautical miles north of the subsea cable route.

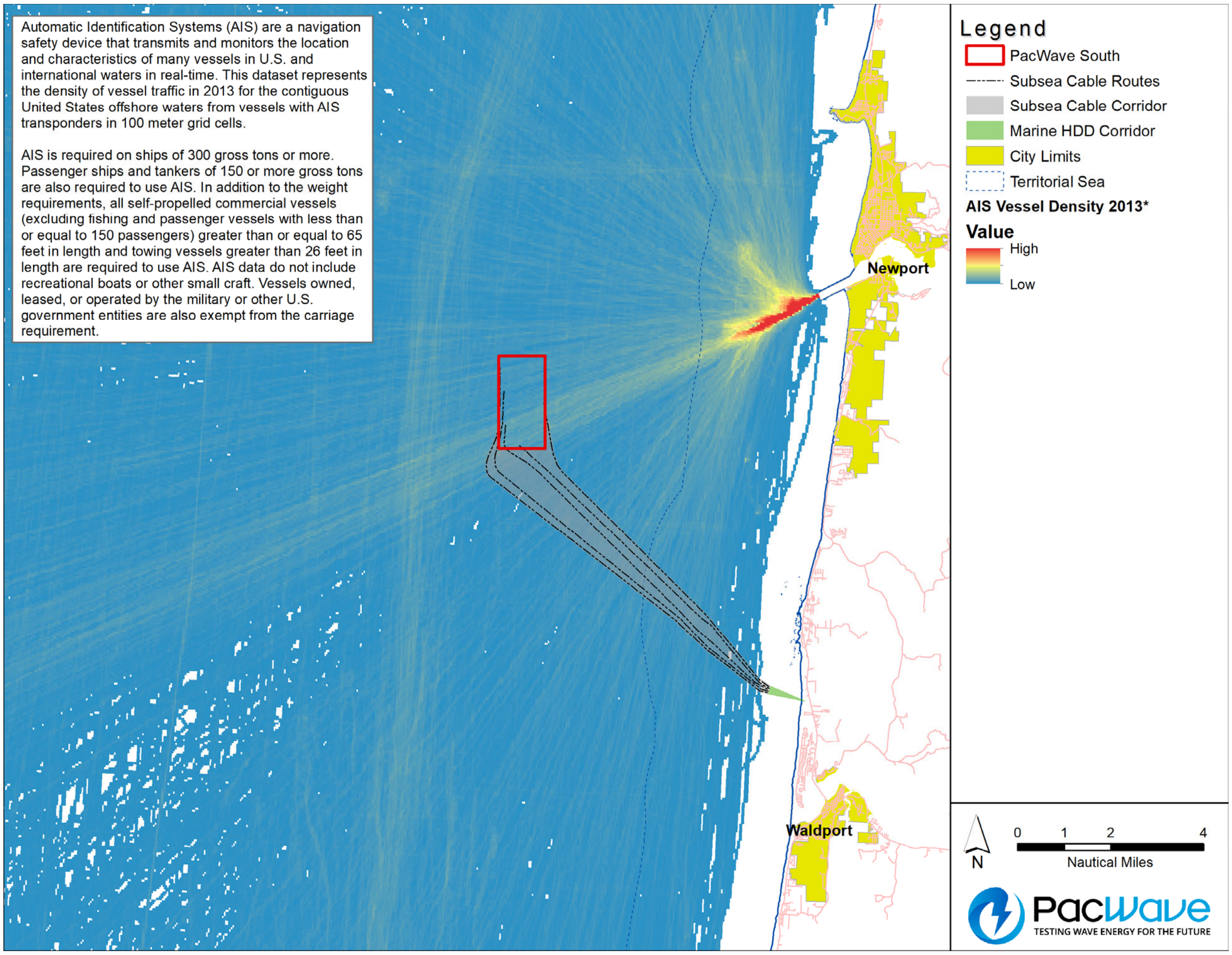

Figure 0-12. Vessel traffic in PacWave South and vicinity. (Source: NOAA Office of Coastal Management, available via the Marine Cadastre)

Land Use

Land ownership in Lincoln County includes areas managed by federal and state agencies, local municipalities, and private entities. Figure 3-13 shows land ownership in the Project area. The Lincoln County Department of Planning and Development is responsible for the administration of land use planning, which is administered through the locally adopted comprehensive land use plan. Along the coastline of Seal Rock, the land is zoned for residential and public facility uses. Driftwood is identified as a public facility surrounded by lands designated for rural residential uses. The terrestrial portion of the project area in Driftwood is a state park administered by the Oregon PRD. Land surrounding the Driftwood is owned by private entities.

Jurisdiction over the ocean is shared by state and federal governments. The state owns the ocean floor from shore to a distance of 3 nautical miles offshore (the Territorial Sea). The federal government owns the seafloor, resources, and regulates uses across the continental shelf and slope beyond the Territorial Sea. Oregon asserts its interests, but not ownership, in ocean resources in this area (Oregon DLCD 2001).

In Oregon, the public owns the beach up to the ordinary high tide line, but any beach above that is usually part of the adjoining upland property owner. Regardless, the public has a perpetual easement to use the dry sand beaches (even those privately owned) up to the statutory vegetation line, or the line of established upland shore vegetation, whichever is more inland. This is set out in the Oregon Beach Bill, which guarantees the public unobstructed use of dry sand beaches, even those that are privately owned. The public rights under the Beach Bill are managed and protected by the Oregon PRD. The Oregon PRD is responsible for managing and making permitting decisions for activities and improvements on the Ocean Shore State Recreation Area. The State Recreation Area is the area of land or water, or combination or both, that is administered by the Oregon PRD and used for recreational activities. The Ocean Shore is the land situated between the extreme low tide of the Pacific Ocean and the statutory vegetation line, or the line of established upland shore vegetation, whichever is farther inland. The Oregon Department of State Lands shares jurisdiction over beaches in managing the beds and banks of state waters and is responsible for managing the seafloor within 3 nautical miles of the shoreline (Oregon DLCD 2001). Figure 3-13 shows public access to the shore in the project area.

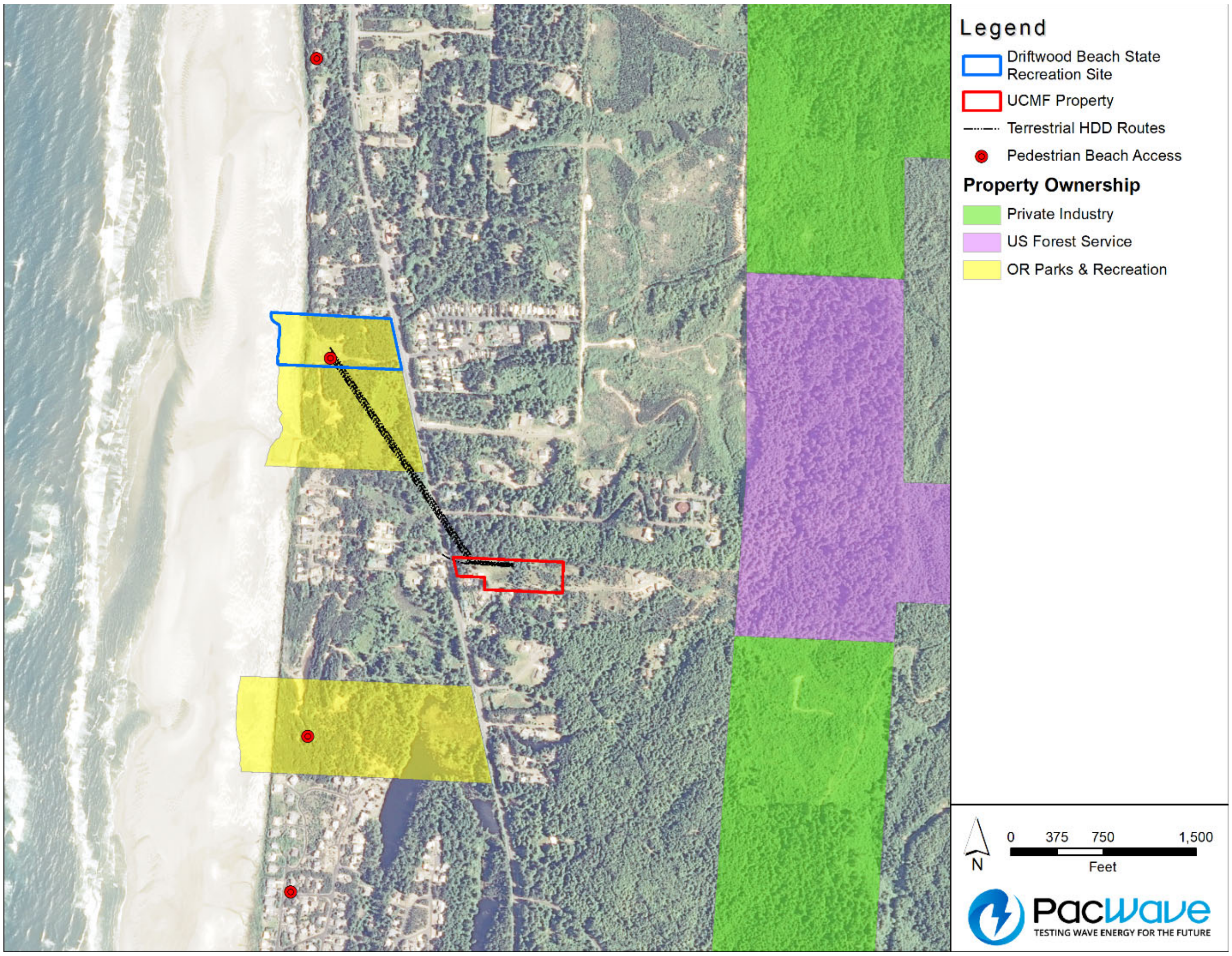

Figure 0-13. Land ownership and coastal access sites in the vicinity of PacWave South.

3.3.6.2 Environmental Effects

Recreation

Park/Beach Access and Use

OSU proposes to: (1) construct five beach manhole structures at Driftwood (Phase I); (2) use HDD to install the terrestrial transmission line conduit from the beach manholes at the Driftwood to the UCMF site (Phase I); (3) install and pull the terrestrial transmission lines into the cable conduit (Phase II); and (4) install an interpretive display at Driftwood describing the project, contingent that Oregon PRD accepts this proposal. This section provides a general description of the effects of the construction of these facilities on recreational resources.

<u>Driftwood Beach Manhole Construction, HDD, and Cable Installation</u>

OSU proposes to construct the five beach manhole structures within the existing paved parking lot at Driftwood. Each of the five beach manholes would consist of a pre-cast concrete splice vault, measuring approximately 10-feet long, by 10-feet wide, by 10-feet high, and would be buried, below grade, under the parking lot. Within each concrete beach manhole, the subsea cables would be connected to terrestrial transmission lines, that would then lead to the UCMF. Access to each beach manhole would be via a standard manhole cover, similar to those used to access underground utilities. After construction of the beach manholes, the conduits to house the terrestrial transmission lines between Driftwood and the UCMF would be installed by HDD. OSU proposes that equipment staging areas and active construction areas would be situated on previously disturbed ground (i.e. within the existing paved parking lot), to the extent possible. OSU would arrange the construction work area to maintain pedestrian access to the public beach, to the extent it is safe, practicable, and acceptable to Oregon PRD. OSU proposes to use construction fencing to isolate active construction areas from portions of Driftwood that may remain open to public use throughout both phases of construction; although, OSU anticipates that Driftwood would need to be closed to vehicle traffic during both phases. Phase I construction at Driftwood is proposed to begin in Spring 2020 and would be completed in approximately 6-8 months, and Phase II construction at Driftwood is proposed to begin in Spring 2021 and would be completed in approximately 45-60 days. OSU proposes to coordinate with Oregon PRD to mitigate impacts to public access and use of Driftwood and proposes to use signage to inform the public that access to the site would be affected during the construction phases; notifications about the construction activities would be posted at Driftwood prior to construction. OSU also indicates that, if possible, notice of the construction activities would be posted on the Oregon PRD website.

In comments filed in response to OSU's license application, Oregon PRD states that OSU must notify Oregon DOT at least 3 months prior to closures of the Driftwood site that would last 90 days or longer. Oregon PRD also recommends that OSU coordinate with Oregon DOT to ensure adequate signage, informing motorists of any temporary closures, is posted in advance of the closure, and that OSU secures the proper permits from Oregon DOT to post signage on the state highway (Highway 101)

Our Analysis

Beach manhole installation construction and HDD activities would have a short-term, but major effect on recreational resources at Driftwood. OSU anticipates that construction would result in an approximately 6- to 8-month closure of Driftwood to vehicular traffic for Phase I, and an approximately 45- to 60-day closure to vehicular traffic for Phase II. OSU states that an HDD drill rig would be positioned in part of the parking lot of Driftwood, and each bore would take approximately 1 month to complete. Although OSU does not describe construction crews' accessing the site, it can be assumed that workers would arrive in the morning and depart in the evening, daily, on weekdays; certain construction vehicles, like semi-trucks delivering the pre-cast concrete vaults and other construction equipment and supplies, would arrive at the site daily during scheduled times; and, other construction vehicles likely would be temporarily staged at the site. OSU's proposal to isolate active construction areas would prevent construction encroachment on areas that remain open to the public and prevent the public from accessing the construction area; however, OSU did not identify alternatives for where the public could park vehicles during the closures to access Driftwood on foot. Residents close-by could walk or cycle to Driftwood and access it along the site's entrance road; however, it is not clear where visitors arriving by vehicle would park to access the site. However, six other Oregon PRD sites, offering similar facilities as Driftwood (i.e. beach access, parking, and restrooms) are located within a ten-mile radius of the Driftwood, and could accommodate visitors who may not be able to access Driftwood during the periods of construction. Providing advanced notice to the public, by posting signage at Driftwood regarding the construction activities and closure of the site to vehicle traffic, could help visitors make alternative plans to visit one of the six other Oregon PRD sites close-by. In response to a comment on the draft license application,[49] OSU stated that it would work with Oregon PRD to develop a plan to mitigate impacts to public access and use of Driftwood and that the plan would include agreed-upon measures and protocols for coordination with Oregon PRD before, during, and after each phase of construction. However, OSU did not elaborate how the plan would be developed with Oregon PRD or provide details regarding the measures and protocols included therein. Additionally, OSU indicated it had communicated with Oregon DOT regarding the project construction within Driftwood and would continue to coordinate with them during licensing and construction of the project. Continuing coordination between OSU and Oregon DOT would help to inform Oregon DOT of project scheduling and activities that would impact the use of the state highway rest area at Driftwood.

To minimize and mitigate ground-disturbing activities and impacts to recreational use within Driftwood, OSU would: (1) construct the beach manholes below grade in the existing parking lot; (2) use HDD to install the terrestrial transmission line conduits; and (3) restore the impacted area upon completion of construction by returning any impacted facilities to original or better condition, including grading and repaving the parking lot and impacted sections of the entrance road. OSU states that the beach manholes and vaults, HDD conduits, and the terrestrial transmission lines would not require routine maintenance; however, it can be assumed that unplanned maintenance could occur during the duration of the project's license and could require visits by project personnel to Driftwood that may temporarily interrupt recreation access and use. As such, the effect on access and recreation use of the Driftwood, and access to the beach, would be

---

[49] See Appendix L-1, Comment Response Matrix, Volume III, PacWave South License Application. (PacWave 2019a).

noticeable but short-term during construction, and intermittent and temporary during the duration of the license.

Interpretive Display

OSU proposes to develop and install an interpretive display that describes the PacWave South project, contingent on Oregon PRD accepting the proposal. OSU also proposes to coordinate with Oregon PRD to develop a plan related to the interpretive display.

Our Analysis

Installing an interpretive display to provide visitors to Driftwood with information regarding the project would enhance visitors' awareness and knowledge of the project, but it likely would not attract more visitors to the site. In response to a comment on the draft license application, OSU states it would work with Oregon PRD to develop a plan regarding the interpretive display to describe the project;[50] however, OSU did not elaborate how the plan would be developed with Oregon PRD nor did it provide details about what interpretive content would be included. Developing and implementing a plan to develop interpretive materials with Oregon PRD and install the interpretive display with Oregon PRD's direction would ensure: (1) the interpretive content is appropriate and highlights the project's relationship to Driftwood; (2) size, design, and composition of materials for creating the interpretive signage, and the structure for displaying the signage, would be consistent with Oregon PRD interpretive design and construction standards; and (3) proper placement and installation of the structure within Driftwood.

Ocean Use

Navigation and Vessel Traffic

The USCG is responsible for providing the Commission with an evaluation of the potential effects of the proposed project on navigational safety and making recommendations to minimize potential adverse effects. The USCG's authority comes from the Ports and Waterways Safety Act (33 U.S.C. §§ 1221 et seq.), which requires the USCG to take into account all possible uses of a waterway to reconcile the need for safe access routes with the needs of all other waterway uses (USCG, 2007). The USCG is also authorized to approve private aids to navigation, such as those that will be used to mark the WECs and array areas. The characteristics of a private aid to navigation must

[50] See Appendix L-1, Comment Response Matrix, Volume III, PacWave South License Application. (PacWave 2019a).

conform to the requirements of the U.S. Aids to Navigation System at 33 C.F.R. § 62 Subpart B.

OSU proposes to mark project structures with navigational aids as required by the USCG and proposes to install subsurface floats at sufficient depths to avoid potential vessel strikes. OSU would require each WEC to be equipped with Automatic Identification System (AIS) equipment and the WEC deployment area boundaries would be clearly marked on NOAA navigation charts. OSU proposes to utilize low-intensity flashing lights, whose wavelengths would be bird-friendly, on project structures to minimize seabird attraction. OSU would follow the specifications for project lighting developed in consultation with the FWS and USCG. OSU also proposes to conduct outreach to inform mariners of the project facilities and activities that those mariners should avoid in the project area. Additionally, OSU does not anticipate navigational closures for the project (i.e., no exclusion zones). Vessels, including tugs, installation vessels, and other workboats would be employed during construction, maintenance, and removal phases of the project. Construction and removal would require multiple trips from Newport, or other ports, to the project site to install/remove the WECs, anchors, and moorings.

As indicated in Section 2.6.1 of OSU's license application, OSU selected the project site after extensive public outreach as part of the technical evaluation of candidate sites. The Ports of Newport and Toledo, Fishermen Involved in Natural Energy (FINE), and the public at large were heavily involved with the selection process, and the site was selected to minimize potential effects to ocean use, including to navigation. The project would be located within the southern corner of an existing tow lane off the coast of Newport, and OSU has worked with crabbers and tow boat operators and has reached a provisional agreement to realign the tow lanes to avoid the project area. WECs may be deployed for a period of 3-5 years. OSU does not anticipate the WECs to cause interference with communications, radar, or sonar of vessels navigating near-by, nor does it anticipate in-air and underwater noise levels during construction and operation to adversely impact passing vessels, aids to navigation, or sonar in the project area. Additionally, OSU does not anticipate adverse impacts to navigation as a result of EMF generated by the project.

On May 6, 2016, OSU submitted a draft Navigational Safety Risk Assessment (NSRA) to the USCG for its review.[51] The assessment considered environmental factors, vessel fleet characteristics, routes, and waterway characteristics in the vicinity of the project, and concluded that the introduction of the WECs in the project area would not significantly affect navigational safety. OSU states that although the assessment

---

[51] Appendix E of OSU's License Application provides an updated version of the Navigational Safety Risk Assessment.

acknowledges potential for some increased risk to navigation, such as during inclement weather or periods of reduced visibility, the assessment also determined that OSU's proposed measures to avoid, minimize, and mitigate impacts to navigation and commercial and recreational fishermen and crabbers substantially reduce the risk.

Oregon DFW 10(a) recommendation 1 suggests that lessons learned from the Reedsport Project's difficulty maintaining continuous navigation marking be applied to future ocean energy projects, such as the PacWave South project. Oregon DFW specifies that surface marker buoys deployed at the project should be designed in accordance with USCG requirements and approved by USCG, and that the markers should successfully and continuously mark the corners of the WEC deployment area for the life of the project (and mark other at-sea project components for the intended duration) as required by the license. In addition, Oregon DFW specifies that OSU should ensure that the surface marker buoys are capable of continuously marking of the four corners of the WEC deployment area for the life of the project, and that markers for any other at-sea equipment are durable enough to ensure continuous marking for the intended duration.

Our Analysis

Commercial and recreational boaters and other public safety personnel need to know the location and extent of the project facilities, and the hazards associated with navigation adjacent to, or within, the WEC deployment area. The measures OSU proposes would make this information available to a large percentage of the potential boaters that would normally use the area. The WEC deployment area boundaries would be clearly marked on NOAA navigation charts so vessels sailing in the area would be aware of the project location and could plan their routes accordingly to sail around the area. Additionally, OSU would implement any navigational measures required by the USCG (e.g., special designations, restrictions, notices, etc.). In the unlikely event that a WEC has a catastrophic emergency and separated from its mooring, the WEC would be a navigational hazard. OSU's requirement that each WEC be equipped with AIS equipment to allow for monitoring of its location would be important to quickly locate a separated WEC. In such an event, OSU would implement the Emergency Response and Recovery Plan to coordinate with agencies and retrieve the WEC. Implementing and successfully executing the plan would help to avoid vessel strikes on WECs and other project infrastructure.

Although OSU does not anticipate navigational closures as a result of construction, maintenance, and removal phases of the WEC arrays and other project infrastructure, the project would increase the volume of marine traffic (e.g., construction and maintenance vessels), which could present navigation hazards to non-project related vessels. Despite an increase in vessel activity that would be related to the above-mentioned construction, maintenance, and removal and installation of project facilities (e.g. WECs), project-related vessel traffic likely would have a noticeable but short-term effect on navigation because the vessels used for the project would be similar to other boats in operation along the coast, and project vessel use would be intermittent. Vessels passing by the project could collide with the WECs deployed at project berths and a WEC could pose a navigational hazard if it were to become dislodged from a mooring; however, OSU's outreach and USCG Local Notice to Mariners would inform mariners traveling in the vicinity of the project to avoid structures and project-related activities (e.g., during deployment of project infrastructure and WECs). Navigational markers and lighting, consistent with the specifications for project lighting developed in consultation with the FWS and USCG, would be used to identify the project facilities as potential navigational hazards, and would provide adequate lighting for warning nearby vessels to minimize the potential of collisions. Additionally, service and support vessels would use low-intensity, shielded lighting. In instances where non-project vessels sailing in the area may not be able to see this lighting, the non-project vessels could use radar, sonar, or other navigational instruments, that would enable them to navigate away from any service and support vessels. As described in section 1.4.9, USCG would need to approve markers (e.g., lighting and reflectors), and OSU would file its Private Aids to Navigation application to adhere to this requirement. Oregon DFW recommends that surface marker buoys deployed at the project should be designed in accordance with USCG requirements and be approved by USCG. OSU would then need to submit designs of the marker buoys to USCG for approval. As navigation markers and lighting, consistent with USCG specifications, would be utilized for the project, it would be practical of OSU to utilize marker buoys that are also consistent with USCG specifications, especially as those buoys would require USCG-approved lighting. The NSRA acknowledges potential for increased risk to navigation; however, OSU's proposed measures to avoid, minimize, and mitigate impacts to navigation and commercial and recreational fishermen and crabbers substantially reduce the risk.

The placement of the subsurface floats approximately 50 feet below the surface should minimize the potential for collision between surface vessels and subsurface components, if a vessel were to sail into the project area.

OSU's outreach to crabbers and tow boat operators to agree to realign the tow lanes to avoid the WEC deployment area would help to minimize the possibility of vessel and project infrastructure collision. As a result, we conclude that the project would have no effect on navigation of ocean-going tugs. Although there is potential that smaller vessels, such as commercial and recreational fishing boats, could collide with a buoy, this potential would be minimized by the measures identified above.

Commercial and Recreational Crabbing and Fishing, Entanglement

The WECs, moorings, and anchors would be deployed in 2.65 square mile area 6 nautical miles off Newport, Oregon. OSU consulted with FINE and other stakeholders as part of the outreach efforts and site selection process. As discussed in *Navigation and Vessel Traffic* above, OSU proposes to mark structures with appropriate navigation aids and conduct outreach to inform mariners of project structures and project-related activities. OSU also proposes to work cooperatively with commercial, charter, and recreational fishing entities and interests to avoid and minimize potential space-use conflicts with commercial and recreational interests during construction and operation of the project. OSU proposes to bury subsea cables 1- to 2-meters deep, to the maximum extent practicable, to minimize interactions with fishing gear and anchors, and it anticipates that once the subsea cables are laid and buried, they are unlikely to have any effect on fisheries. OSU also proposes to avoid, to the extent practicable, routing the subsea cable in areas known to contain hard substrate or rocky reef habitats identified by marine geophysical and geotechnical surveys. In areas where the subsea cable cannot be buried or persistently becomes unburied, that portion of the cable would be situated on the seafloor and would be protected by split pipe, concrete mattresses, or other cable protection systems. In addition, OSU proposes to develop and implement an anchoring plan for vessels, which may anchor at the project site, that avoids anchoring in known rocky reef or hard substrate habitats to the maximum extent practicable and minimizes the use of anchors within the project area wherever practicable by combining onsite vessel activities. During severe storm conditions, strong wind and waves could cause crab pots to drift into the project site and become entangled in mooring systems. OSU proposes that if fishing gear becomes entangled, it would monitor and remove the gear if it poses a threat to organisms or navigational safety; nets or free-floating line from any source and at any depth would be considered a threat and would be removed. If separate sets of fishing gear are observed entangled/collected on project facilities on four separate visits within a consecutive 12-month period, OSU would develop a plan to monitor the project more frequently to detect entangled gear. OSU would attempt to return entangled gear that is removed to its owner, if possible.

Oregon DFW 10(j) recommendation 9, supported by Oregon PRD, suggests OSU avoid rocky habitat by routing the subsea cable around such areas identified in the marine geophysical and geotechnical surveys. Additionally, Oregon DFW recommends OSU provide details regarding the cable route, including how it will avoid the rocky habitat and remain continuously buried.

Our Analysis

Project construction would result in short-term, temporary displacement of fisheries, for example, while the DPV or barges lay the subsea transmission cables, and when WECs are deployed. The presence of the WECs and moorings would result in some reduction of the area available for commercial and recreational crabbing and fishing as these activities would need to avoid the WEC deployment area; however, the small size of the deployment area relative to the surrounding open-ocean and OSU's communication and coordination efforts with stakeholders would help to minimize impacts to fishing and crabbing. The WECs, moorings, and anchors would have a very limited effect on surface fisheries (e.g., albacore), but risk of gear entanglement would increase with deeper trawl (salmon), Dungeness crab trapping fisheries, and purse seine fisheries (such as for market squid), and likely entirely limit commercial trawling fisheries (e.g., pink shrimp); although, as stated above, the small area that the project would occupy, compared to the surrounding open-ocean available for fishing and crabbing, would minimally impact these fisheries.

Because project site selection was based on a combination of community input and preferred site criteria, including: (1) physical and environmental characteristics, (2) subsea and terrestrial cable route options, (3) port and industry capabilities, (4) potential impacts to existing ocean users, (5) permitting considerations, and (6) stakeholder participation and support of the local fishing communities in the proposal process, the overall potential impact on commercial and recreational crabbing and fishing is expected to be minor. OSU's proposed subsea cable route would avoid reefs and other hard substrate to the greatest extent possible. In addition, implementing OSU's proposed anchoring plan would avoid anchoring in known rocky reef or hard substrate habitats to the maximum extent practicable and minimize anchor use within the project area, wherever practicable, by combining onsite activities. Implementation of the proposed measures would minimize potential effects on demersal fish and Dungeness crabs, thereby minimizing effects to those fisheries.

OSU proposes to continue working cooperatively with the local community, and particularly with commercial, charter, and recreational fishing entities, to avoid, minimize, and mitigate potential space-use conflicts with all types of fishing activities during construction and operation that could lead to situations where entanglement could occur. In the nearshore areas where the subsea cables may not be fully buried, the cable would be situated on the seafloor and would be protected by split pipe, concrete mattresses, or other cable protection systems, secured in place to protect the cables, which could increase occurrences that fishing gear would become entangled. OSU would periodically monitor and remove fishing gear that may pose a threat to organisms or navigation, and if possible, return the gear to the owner. Also, if the project structures (i.e., moorings, anchoring systems, etc.) attract sport fish, it is possible that recreational anglers would choose to fish the surrounding area, so the impact to recreational fishing could be minor and potentially positive.

Emergency Response and Recovery, Spills

Vessels used for the construction, operation, and maintenance of the project would contain fuel, hydraulic fluid, and other potentially hazardous materials. Also, while WECs are designed for survivability at sea, and to minimize the potential for leaks of hydraulic fluid, they do contain fluids toxic to marine life, such as hydraulic fluid. In the unlikely event that a spill occurred from a vessel or from a WEC (e.g., if a WEC broke free of its mooring and washed ashore), subsequent recovery and clean-up activities may affect coastal recreation, ocean use, and land use. In the unlikely event that a WEC has a catastrophic emergency and washed ashore, OSU would implement its Emergency Response and Recovery Plan that establishes specific procedures for the notification of agencies that have jurisdiction over the resources that may be affected by such an unexpected event. This plan also establishes response actions for emergency situations or system failure.

Our Analysis

OSU's Emergency Response and Recovery Plan provides notification procedures and preparedness actions for six types of situations:

1. The WEC has moved outside of operational boundaries, including becoming submerged.

2. Electrical fault has occurred either offshore or onshore.

3. Fluid has leaked out of a WEC.

4. Navigational lighting failure.

5. Subsea or terrestrial transmission cable is damaged.

6. Collision with WECs or other project equipment.

The plan addresses all the major types of emergency conditions that might occur during normal operation and maintenance activities and identifies lines of communication with regulatory agency personnel. Implementation of procedures described in the Emergency Response and Recovery Plan should minimize the potential effects on other resources, if one of the situations described in this plan were to occur.

Land Use

Property Rights Necessary to Use the Area Occupied by the Project, Permits

As discussed in section 1.1 and 2.1, project facilities would be located offshore in the OCS and in Oregon State territorial waters. The onshore project facilities would occupy portions of state, county, and privately-owned lands. The proposed project boundary encompasses approximately 8,205.7 acres of onshore and offshore areas. The project's test site (i.e. WEC deployment area) would occupy an area of approximately 2.65 square miles about 6 nautical miles off the Oregon coastline, and as such, some project facilities (e.g., subsea cable and cable protecting/anchoring materials) and project activities would occur in the territorial sea within 3 nautical miles of the Oregon coastline. The marine project boundary would encompass approximately 1,695 acres on the OCS (outer continental shelf). The terrestrial project boundary would encompass approximately 14.3 acres, including approximately 2 acres of Oregon PRD-administered land at Driftwood, approximately 4.5 acres of additional Oregon PRD-administered land directly adjacent to Driftwood, approximately 1.6 acres of private land owned by nearby residents, approximately 1.7 acres of land administered by the Oregon DOT (Highway 101), and approximately 4.5 acres at the UCMF site. Facilities within the OCS would be administered through a BOEM research lease and a potential easement. OSU is working with Oregon DLCD and Oregon PRD to obtain authorization to occupy state territorial waters and Driftwood. OSU would obtain easements for project facilities located within State of Oregon and private lands. FERC regulations require that a project licensee acquire fee title or the right to use the area occupied by the project.

OSU proposes to contain construction work areas and staging areas within previously disturbed areas to the extent possible and proposes to comply with all state and local permitting requirements for all construction work. As such, OSU proposes to set up the HDD drill rig in the Driftwood site parking lot and the terrestrial portion of the transmission lines would be installed in up to three underground bores from the beach manholes in Driftwood to the UCMF. The entire terrestrial transmission line route would be about 0.5-mile long. From the UCMF, transmission lines would also be installed by HDD, running west under Highway 101, to the grid connection point with the CLPUD overhead transmission line along the road – for this operation the HDD rig would be set up on the UCMF site. OSU's proposed project boundary is tentative and has not yet been surveyed. Following issuance of the FERC license, OSU would obtain easements needed to use lands owned by the State of Oregon and private parcels for project purposes and would file as-built maps following completion of the construction. Oregon PRD recommends that any use of state park property, if approved, would be contingent on avoiding sensitive resources.

The Oregon Parks and Recreation Commission (Oregon PRC) approves granting real property rights for use of Oregon PRD-administered lands. Oregon Administrative Rule 736-019-0070 provides criteria for the transfer of property rights initiated by parties other than the Oregon PRD; in this case, OSU. In this instance, the Oregon PRC may approve the transfer if it determines that the proposed transfer of property rights meets the criteria found in the rule. Draft proposals were presented to the Oregon PRC as an informational item, and an action item was scheduled to be discussed in November 2019. On November 20, 2019, the Oregon PRC, on behalf of Oregon PRD, approved a conveyance of easement to OSU for the project construction activities at Driftwood; although, at this time it is not known if approvals have been granted for the transfer of property rights related to state territorial waters use or other Oregon PRD-administered lands.[52] Oregon PRD anticipates that an Intergovernmental Agreement (IGA) would be required, in addition to any property rights documentation (e.g., easement), outlining requirements of OSU's use of Oregon PRD-administered property for construction of the project and the long-term underground use associated with the subsea cable and terrestrial transmission line route and manholes. Oregon PRD supports Oregon DFW's recommendations for components of an HDD contingency plan and expects to have language in the property rights documents regarding coordination on the plan. Oregon PRD would work with OSU on property rights and agreement documentation and anticipates that any unpermitted disturbance to habitat from unanticipated and unavoidable (e.g., emergency response) activities would require habitat mitigation and restoration, and such activities would be coordinated with Oregon PRD. Oregon PRD also expects to have, at a minimum, general decommissioning plan (see Section 3.3.3.2 *Decommissioning Plan*) language included in the easement and/or intergovernmental agreement

In addition to acquiring the necessary real property rights to use and occupy state-owned lands, OSU would coordinate directly with Oregon RPD to acquire necessary permits for project activities that would occur within the Ocean Shore State Recreation Area defined above in Section 3.3.6.1.

Our Analysis

The use of the ocean and seabed within 3 nautical miles of the coastline is under the jurisdiction of the State of Oregon and is managed by the Oregon DLCD. The state has the authority to enter into a lease agreement for the use of the area occupied by the project. OSU is working with Oregon DLCD and Oregon PRD to obtain authorization to occupy state territorial waters and Driftwood.

Oregon PRD and Park Service indicated during stage two of the pre-application consultation process that a portion of the Driftwood site is subject to the requirements of 6(f) of the Land and Water Conservation Fund Act (LWCF). Section 6(f) of the LWCF contains provisions to protect Federal investments and the quality of the associated resources. Any site that has been acquired, developed, or improved with funds from the LWCF grant program must be open to the public and maintained for public outdoor recreation (OPRD 2018). Where a non-recreation, non-public use will temporarily or permanently "convert" LWCF Section 6(f) park land, the state is required to consult with Park Service, evaluate the resource impacts associated with the loss of public park land

---

[52] On February 27, 2020, OSU filed to the PacWave project record its Federal Consistency Certification request, previously submitted to the Oregon DCLD, in which OSU states Oregon PRC approved conveyance of the easement (accession no. 20200227-5219).

and recreation opportunities and, if deemed necessary, provide replacement park land and recreation opportunities.

OSU coordinated with Oregon PRD and Park Service regarding the potential impacts of the project on the LWCF Section 6(f) park land. Based on that coordination, Park Service concluded that the project would not result in a "conversion" within the meaning of LWCF Section 6(f). The first phase of construction (during year one) at the Driftwood site falls within Park Service's underground utility variance. Phase two (i.e. the cable pull) would fall within Park Service's temporary non-conforming use policy. Each of these policies is described in Section 8 of Park Service's LWCF manual.[53] In making their determination, Park Service considered the fact that construction plans would allow the Driftwood site to remain open to the public as much as possible for the duration of the construction period, that no part of the park would be closed for a full year, and that OSU has committed to restore the impacted area. Figure 3-13 shows coastal beach access sites and Oregon State Parks in the vicinity of the project area.

The Commission includes as a standard license article that the project owner acquire the rights to use the area occupied by the project, either by fee title, easement, or use permit, and that these rights shall not be voluntarily relinquished during the life of the project without approval of the Commission. This standard article would address the ownership or control of all portions of the project area, including the seaward portion.

Use of HDD from the Driftwood site, through the intertidal area, and out to a breakout point about 800 meters offshore would avoid major ground-disturbing effects (i.e. open trenching to place the cable) to State of Oregon-administered lands in the nearshore, intertidal, and sand dune areas crossed by the cables. The HDD drill rig would be set up in the paved parking lot of the Driftwood site, and therefore, minimal disturbance to that property would occur from use of the rig to install the cables from the site. OSU could avoid sensitive areas within Driftwood by, as proposed, situating construction work areas on previously disturbed areas (i.e. within the existing paved parking lot) to the extent possible.

Use of HDD for installation of the terrestrial transmission lines from the Driftwood site to the UCMF, and from the UCMF to the CLPUD grid connection, would avoid major ground-disturbing effects (i.e. open trenching to place the lines) to State of Oregon-administered lands and private properties along the terrestrial transmission line route. The transmission lines would be installed in up to three HDD bores under the southern portion of Driftwood, under small sections of five or six private properties located on either side of Highway 101, and then to the OSU-owned UCMF parcel east of the highway. The total distance of the terrestrial transmission lines would be about 0.5

---

[53] Available at https://www.nps.gov/ncrc/programs/lwcf/manual/lwcf.pdf.

miles. The grid connection to CLPUD's distribution system would be installed by HDD from the UCMF to CLPUD's distribution lines on the west side of Highway 101. HDD drilling would be a one-time activity associated with construction of the project, and as such would be a short-term disturbance and minimally impactful to affected properties.

The UCMF compound would consist of an approximately three buildings and a parking/laydown area. The existing gravel lane (NW Wenger Lane) would be paved to accommodate semi-truck access to the UCMF. The entire area of the compound (i.e. where the buildings would be constructed) within the UCMF would be approximately 1.2 acres. The UCMF would be located on OSU-owned property and effects due to construction of the UCMF would result from clearing and site preparation of approximately 1.2 acres to accommodate the UCMF buildings, the paved and fenced exterior laydown area, parking, and NW Wenger Lane; state-owned lands and other private properties would not be affected by construction of the UCMF.

Oregon PRD states that OSU would need to submit an Ocean Shore Alteration Permit application for conducting ocean shore alterations such as installing the cable routes and the landing location. Additionally, prior to any work being conducted on the beach, OSU would need to acquire a Motor Vehicle on the Ocean Shore permit from Oregon PRD and consult with Oregon PRD staff if OSU would need to perform any activities on the Ocean Shore, such as in an emergency or other situation where vehicle staging and or access would occur on the beach. Vehicles accessing the beach for project purposes would use existing vehicle beach access points if needed, and OSU would need to coordinate with Oregon PRD to receive updated information about Ocean Shore areas to avoid before accessing the Ocean Shore. By securing the required permits for uses of the Ocean Shore, Oregon PRD would ensure OSU would be following state regulations protecting the public land resource. Coordination between OSU and Oregon PRD regarding access to the Ocean Shore would ensure the OSU avoid sensitive or off-limits areas when accessing the Ocean Shore.

3.3.6.3 Cumulative Impacts

Construction and operation of the project would result in obstacles (e.g., WECs and moorings) to navigation and commercial and recreational crabbing and fishing. The overall project area under the initial development scenario (6 WECs) and the full build-out scenario (20 WECs) represents a small area of the OCS approximately 6 nautical miles offshore, relative to the area available to commercial and recreational crabbers and fishermen. Given that the only other planned or existing ocean energy projects offshore of Oregon are PacWave North, and the Camp Rilea Ocean Energy project, located 9 and 100 nautical miles from PacWave South, respectively, the development of the PacWave South project would contribute a negligible cumulative effect on navigation and commercial and recreational crabbing and fishing.

3.3.7 Aesthetic Resources

3.3.7.1 Affected Environment

The Oregon Central Coast stretches 60 miles from Yachats up to Lincoln City and includes Waldport, Seal Rock, and Newport, which contains a variety of aesthetic resources including the ocean, rock formations, beaches, dunes, and dense forest. In addition to recreational and natural resources, the Oregon PRD oversees the protection of scenic resources along the coast. Permits are required for construction, alteration and vehicle use of the Ocean Shore (see Section 3.3.6.2 *Land Use*). Highway 101, which is a National Scenic Byway, runs along the upland shoreline near the terrestrial portions of the project area (National Scenic Byways Program 2010). In this area of the coast, Highway 101 offers intermittent ocean views to motorists. A variety of aesthetic resources occur at the Driftwood site, including accumulations of driftwood that wash up during heavy surf, as well as sand sculptures that are formed by strong winds and waves.

3.3.7.2 Environmental Effects

OSU's proposed project facilities that would be visible from, or within the Driftwood site, include WECs and beach manhole covers. Although OSU does not propose any measures specifically related to aesthetic resources, it does propose measures for minimizing and mitigating ground-disturbing activities (see Section 3.3.6.2 *Recreation*) that would equally protect visual resources within Driftwood. Oregon PRD suggests that effects to viewsheds should be considered during evaluation phases for each proposed technology (i.e. type of WEC) during the operational phase of the project. When the actual type of WEC for testing is known, then OSU should consult the Oregon Territorial Sea Plan visual resource protection standards to assess impacts to the viewsheds.

Our Analysis

The marine portion of the project would be located 6 nautical miles from shore in the ocean where no anthropogenic structures exist. WECs deployed at the PacWave South test area would comply with USCG requirements for navigational marks and lighting (e.g., low-intensity flashing lights), and as such could impact the quality of viewing the sea from shore. Project features potentially visible from shore would include the parts of the WECs that would be above the water surface during clear days and navigational lighting during clear nights. OPT's PB150, an example of a point absorber WEC, would extend about 30 feet above the water. For a person standing on shore, 5.6 nautical miles from the Reedsport OPT Wave Park, OPT determined that a PowerBuoy would appear to be 0.6 mm, at arm's length (Reedsport OPT Wave Park, LLC 2010). This is comparable to viewing the PacWave South WEC deployment area from the closest location from shore, which is approximately 6 nautical miles. An oscillating water column WEC would be a larger structure than a point absorber (estimated to extend about 35 feet above the water surface) but would similarly appear very small when viewed from shore. Lights and navigation aids would be visible at some distance but are necessary for maritime safety. The range of visibility would vary depending on time of day and weather conditions. OSU reviewed the visual resource protection standards established in the Oregon Territorial Sea Plan and the suggested project review criteria. Due to the distance from shore and small scale of the project, the level of change caused by deployment of the WECS to the existing seascape would be nominal. Although, manmade structures are not novel or unusual in the marine environment along the U.S. West Coast, and include objects in the water column and at the surface such as navigational buoys, piers, and oil platforms.

All land-based project components in Driftwood, including the terrestrial transmission lines and beach manholes, would be located underground and would not affect the aesthetics of the area once installed. During construction, activities associated with the installation of the underground concrete splice vaults, the surface level manhole covers, and the installation of the underground cables and lines by HDD, including construction-related traffic, would be visually and auditorily noticeable to recreational users in Driftwood and potentially to near-by residents; however, these activities and effects would be temporary. The manhole covers would be situated within the existing paved parking lot, and would be recognizable, but would be unobtrusive considering similar infrastructure is commonly found in roadways and parking lots.

The UCMF site would be situated within an approximately 4.5-acre private parcel, set back from Highway 101. The UCMF site would be paved and fenced and would cover approximately 1.2 acres within the property. The site would include three, one-story buildings and a parking/laydown area. The existing gravel access road (NW Wenger Lane) would be paved to accommodate semi-truck access to the UCMF. Construction-related traffic accessing the UCMF site could be noticeable to near-by residents, as well as would be noise during construction activities; however, these impacts would be minimal and temporary.

3.3.8 Cultural Resources

3.3.8.1 Affected Environment

Section 106 of the NHPA (Section 106) requires the Commission to take into account the effects of licensing a hydroelectric project on properties listed or eligible for listing in the National Register and allow the Advisory Council a reasonable opportunity to comment in any adverse effects on historic properties are identified within the project's APE.

Historic properties are defined as any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register. In this document, we also use the term "cultural resources" to include properties that have not been evaluated for eligibility for listing in the National Register. In most cases, cultural resources less than 50 years old are not considered eligible for the National Register. Cultural resources need enough internal contextual integrity to be considered historic properties. For example, dilapidated structures or heavily disturbed archaeological sites may not have enough contextual integrity be considered eligible. Traditional cultural properties (TCPs) are types of historic properties eligible for listing in the National Register because of their association with cultural practices or beliefs of a living community that: (1) are rooted in that community's history or (2) are important in maintaining the continuing cultural identity of the community (Parker and King 1998). Section 106 also requires that the Commission seek concurrence with the SHPO on any finding involving effects or no effects on historic properties. If TCPs have been identified, section 106 also requires that the Commission consult with the interested Native American tribes that might attach religious or cultural significance to such properties.

If existing or potential adverse effects have been identified on historic properties, license applicants need to develop a HPMP to seek to avoid, reduce, or mitigate the effects. Potential effects that may be associated with a hydroelectric project include any project-related effects associated with construction, or the day-to-day operations and maintenance of the project after issuance of an original license.

Cultural Historic Overview

Native American

The project area lies within the Pacific Northwest Coast Culture Area that extends from Yakutat Bay, Alaska to Cape Mendocino, California (Aikens et al. 2011). The biotic potential of the marine and terrestrial food sources is enormous, and as such prehistoric populations along the coast were often dense and sedentary (Aikens et al. 2011). The Pacific Northwest Coast Culture Area has been characterized as being similar in fishing and hunting technology, with similar aspects of religion and art as well, suggesting extensive contact, trade and shared information within this culture area (Aikens et al. 2011). However, even though there are many similarities, there are many local variations including language (Aikens et al. 2011).

Permanent settlements were common in this culture area, and on the southern Oregon coast single family homes were prevalent and "houses were square to rectangular in form, with a gabled or shed roof" (Aikens et al. 2011). Village communities were often found along shared river courses consisting of one to many houses (Aikens et al. 2011). Many sites along the Oregon coastline are later in time with up to 90 percent falling within the last 1,500 years (Aikens et al. 2011). High energy waves, tectonic uplift, and rising sea levels all may be contributing factors to explain the rarity of early sites along the coast (i.e., they have been eroded away and/or have been inundated) (Aikens et al. 2011).

There are three distinct cultural periods along the coast of Oregon. The Pre-Marine Culture (9,000-2,000 B.C.) is characterized by early projectile points that are probably from people that occupied the interior and were not marine based (Ross 1990). The Early Marine and Riverine Cultures (3,000 B.C. to 500 A.D.) utilized bone tools almost exclusively with few examples of stone tools (Ross 1990). Bone harpoons with unilateral barbs, antler-tine flake tools and wedges were most common (Ross 1990). Late Marine Cultures (500 to 1856 A.D.) had a more robust assemblage of artifacts and commonly made concave base, triangular, and tanged projectile points (Ross 1990). Bow and arrow technology probably reached the Oregon coast around 500 to 900 A.D. and in response the morphology of projectile points changed (Ross 1990). Other parts of their assemblage covered drills, hammerstones, pestles, scrapers, heavy choppers, net sinkers, bifaces, pipes, bowls, bone needles, awls, pendants, fish lures, composite harpoon heads, and gaming pieces, all a part of the Late Marine Culture (Ross 1990).

The Alsea Bay and river that are adjacent to the City of Waldport are named after the Alsea people who inhabited the area at the time of European contact (Minor 2008). The Alsea spoke a dialect of the Alsean language family that was shared with the Yaquina, who lived around Yaquina Bay to the north (Minor 2008, Thompson and Kinkade 1990, Zenk 1990).

The Alsea village *lku ·huyu·,* meaning "where one goes down to the beach" is located where Waldport is now built (Minor 2008, Zenk 1990). The Alsea were peripherally associated with a regional socio-economic network called "Greater Lower Columbia" that was centered on the lower Columbia River (Minor 2008). Participation in this network was evidenced by head flattening as a sign of free birth (Minor 2008).

After European contact the territory of the Alsea and Yaquina were allocated as part of the Siletz or Coast Reservation established in 1855, which included 125 miles of coast-line (Minor 2008). By December 21, 1865 an executive order was issued that opened the Alsea and Yaquina estuaries to pioneer settlement (Minor 2008, Beckham 1990). The Alsea and Yaquina were subsequently forced to relocate to the Siletz Reservation. The first population density estimations of the Alsea, Yaquina, and Siuslaw of the central Oregon coast totaled 6,000 people (Minor 2008, Mooney 1928). By 1900 only a dozen survivors were reported to be living at the Siletz Reservation (Minor 2008).

Euro-American

In 1788, a private American ship, called the Columbia, sailed along the Oregon coast near the project area in the pursuit of maritime fur trading in the Pacific Northwest.

A small boat was sent from the ship to inspect the shore where the Alseans were first encountered by Euro-Americans (Haswell 1969). Interestingly, the Columbia River was named after this ship when it entered the river in 1792. After reports from the Lewis and Clarke expedition of 1807, Euro-American trappers came in increasing numbers attracted to the Alsea River and Bay area during the first part of the 19th Century in the pursuit of fur bearing animals. A small trapping party, consisting of two men from the Hudson Bay Company, was dispatched from Fort Vancouver in 1826 along the "Alciyeh River" for beaver pelts. Clashes between Native groups and the incoming Euro-Americans trappers and "mountain men" ensued, as in an incident involving two trappers from the Hudson Bay Company and the Alsea resulted in the killing of the two trappers at Beaver Creek in 1832. In 1834 a Methodist mission was established for native peoples in the Willamette Valley by the Canadian missionary, Jason Lee. Lee on his visits back east, encouraged additional settlement of the Willamette Valley, extolling the virtues of good lands for settlement and agriculture. More permanent settlement of the area began in the following years with the establishment of the Oregon Trail in 1836 and followed in 1843 with the settlement of 900 individuals in the Willamette Valley. A decade later, the Oregon Territory was established by Congress in 1848, and Oregon became the 33rd state in the Union in 1859.

Lincoln County project was formed on February 20, 1893 as a split from Benton and Polk Counties (Moe 1993). The first county seat was in Toledo but moved to Newport in 1952 (Moe 1993). Lincoln County incorporates 53 miles of coastline and travels inland between 14 and 22 miles with a total coverage of 998 square miles. The major cities from the north to the south are Lincoln City, Newport, Waldport, and Yachats. Waldport is the closest city to the project area. Settlement in the Waldport area began in the 1870s. In 1884 a saw mill was built taking advantage of the wide Alsea Bay and river to float logs down as a natural flume (Moe 1993). Early German homesteaders named Waldport as a combination of the words "wald" meaning forest in German and the English word "port" (Moe 1993). The City was chartered in 1890 and incorporated in 1911. Waldport received electricity in 1926 from a water wheel that was placed in Eckman Creek which was later upgraded to a turbine that was turned by water fed through a 30-inch wooden penstock (Griswold 1993).

Improvements to the road network allowed for mail to be delivered from Waldport to Florence starting in 1897 (Hays 1976). By the 1930s a bridge was built from Waldport across Alsea Bay (Moe 1993). This bridge was just one of many commissioned for the Oregon Coast Highway a project which was completed in 1936 (Blakely 2014). The United States Government intended the Oregon Coast Highway to eventually be part of a highway that would extend from Canada to Mexico (Blakely 2014). The Oregon Coast Highway was later renamed Highway 101 when the bridge across the Columbia River was completed on July 29, 1966 and a continuous highway from Canada to Mexico was finally united (Blakely 2014).

Early Homesteaders to Lincoln County were German immigrants that often lived in close proximity to one another (Hays 1976). One of these families, the Ludeman family, built a saw mill powered by a water wheel (Hays 1976). This saw mill cut most of the wood to build and fix bridges within the county and gave the family the money to venture into a cannery that they built a quarter mile east of Waldport (Hays 1976). This cannery employed Chinese workers to operate the day to day activities (Hays 1976). Logging and fishing were the most important industries in the county from the late nineteenth to the mid-twentieth century as evidenced by the large number of sawmills, grist mills, and canneries in the county during this time period (Moe 1993, Hay 1976). Today, these industries are still important, but tourism is now the largest industry in the county.

Area of Potential Effects

Pursuant to section 106, the Commission must take into account whether any historic property could be affected by issuance on any original or new license within a project's APE. The APE is defined as the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The APE for the proposed project encompasses all lands where historic properties may be affected by construction along with operation and maintenance activities and consists of a marine and terrestrial portion. The marine portion of the APE includes the 2.65 square mile WEC test site (where the WECs would be deployed) and a slight buffer around the test site to accommodate construction activities, and an approximately 8.25-nautical-mile long subsea cable route. The APE does not include the area nearshore where the cable would be deployed well beneath the seafloor using HDD. The terrestrial portion of the APE is comprised of two discontiguous areas, the first being the area surrounding the Driftwood access road and the site's parking lot where the five beach manholes measuring approximately 10 feet deep, 10 feet wide, and 10 feet long would be constructed and would contain the splicing of the subsea cables to the terrestrial transmission lines. This area would capture all construction work areas, the access corridor, and staging needed to install the manholes and splice the cables and transmission lines. The second portion of the terrestrial APE consists of the area surrounding the UCMF compound, which consists of a 1.2-acre compound with three buildings and a parking area, as well as an access road, and CLPUD tie-in on the west side of Highway 101. The APE established around the UCMF compound encompasses associated areas needed for staging and access during construction of the UCMF.

Cultural Resources Investigations

The area reviewed by OSU includes the proposed project's APE and a 1.0-mile buffer around the APE, and was used to: (1) identify any previously recorded cultural resources within the APE so they can be revisited during fieldwork conducted for the project; (2) identify the types and density of resources found in the vicinity of the APE to better understand the types and density of resources that might be encountered within the APE; and (3) identify historical features shown on historic maps of the area, evidence of which might still be within the APE and can be field checked.

Using information obtained from the online Oregon SHPO databases, previously recorded cultural resources and previously conducted cultural resources investigations within a 1.0-mile radius of the APE were identified and reviewed by OSU. Four previous cultural resources investigations have taken place within 1.0-mile of the APE, one of which occurred within the APE (Table 3-17). These investigations occurred between 1976 and 2006, and were conducted prior to a variety of different undertakings, to include sewer/water utility improvements and culvert repairs. Additionally, one investigation represents an archaeological inventory of state parks and was not conducted prior to a specific undertaking but was conducted simply to inventory archaeological resources on state parks.

Table 0-17. Previous cultural resources investigations within 1.0 mile of the APE.

Count	SHPO ID #	Year	Prepared By	Report Name and Description	Within Project APE (Yes/No)
1	20418	2006	T. Cabebe, Q. Winterhoff, K. Wendland, S. Henrikson	Archaeological Survey of Forty-Nine (49) Culverts and Seven (7) Staging Areas in Region 2 for the Oregon Department of Transportation	No
2	19806	2004	G.L. Tasa, J.A. Knowles, J. Peterson	*Archaeological Resource Evaluation of Area 1 and Area 4, Oregon State Parks, 2003/2004 Surveys; Volumes I and II*. Driftwood Beach State Park. Pedestrian survey of 49 parks within the Area 1 and 4 management units of the Oregon State Park and Recreation system. A total 5,393.36 acres were surveyed, and 37 new sites and 56 previously identified sites were observed and documented.	Yes
3	27034	1997	R. Minor, K.A. Toepel	Archaeological Survey for the Seal Rock Water District System Improvements Project (Phase 3), Lincoln County, Oregon. Pedestrian survey of a 40-acre area near Seal Rock. No sites, Historical Sites or isolates were found.	No
4	248	1976	D.R. Brauner	The archeological reconnaissance of the Proposed Newport to Waldport and Waldport To Yachats sewer systems, Lincoln county, Oregon.	No

Based on information obtained from the online Oregon SHPO databases, OSU noted one previously recorded site located within 1.0 mile of the APE (see Table 3-18). The site consists of a prehistoric shell midden named Collins Creek Shell Midden and it is located almost 1.0 mile north of the APE. While the depth of the site is unknown the surface of the site has a dense concentration of shell, fire cracked rock, and charcoal. The Collins Creek Shell Midden is identified as unevaluated for listing on the National Register. No historic built environment resources were found to have been previously recorded within 1.0 mile of the APE.

Table 0-18. Previously recorded cultural resources within 1.0 mile of the project APE.

Trinomial or Resource Name	Temp No. or Agency No.	Recorder and Year Recorded	Description	National Register Evaluation[1]	Within Project APE (Yes/No)
35LNC80	LNCUO952	Erlandson 1995	**Prehistoric.** Dense Shell midden deposits with shell, fire cracked rock, and charcoal.	U	No

[1] National Register eligibility status is based on that provided by the Oregon SHPO's online database; U = Unevaluated.

The 1874 General Land Office (GLO) plat showing Township 13 South, Range 12 West does not show any historic roads, homes or other cultural features within a 1.0-mile radius of the APE or within the APE itself. The 1922 Waldport, Oregon 1:62,500 scale USGS topographic quadrangle shows four unimproved roads, one light duty road, six structures, and one school within a 1.0-mile radius of the APE, of which, two unimproved roads fall within the APE. The 1942 Waldport, Oregon 1:62,500 scale USGS topographic quadrangle shows Highway 101, three light duty roads, one unimproved road, Smithy Ranch, and seven structures within a 1.0-mile radius of the APE, of which, Highway 101 falls within the APE.

NOAA nautical charts and GIS data indicate that shipwrecks are in the area of the Yaquina jetty and elsewhere within the Newport South Quadrangle area (between Newport and Seal Rock), but no shipwrecks occur in the proposed project's APE.

OSU also consulted with the Siletz Indians and the Confederated Tribes of Grand Ronde.[54] Representatives from the Siletz Indians also participated in cultural resources work groups organized by OSU. Both tribes received copies of the cultural resources inventory reports involving the terrestrial portions of the proposed project's APE.

[54] The Commission initiated consultation with both tribes in letters issued on April 25, 2014.

Results of Cultural Resources Investigations

Marine Portion of APE

In 2014, OSU conducted geophysical surveys at the proposed WEC test site and subsea cable routes (i.e., the marine portion of the APE). Surveys included: (1) a high-resolution chirp multibeam sonar survey producing detailed bathymetry and backscatter coverage of the WEC test site and potential cable routes; (2) a chirp sub-bottom survey; (3) a boomer seismic survey; and (4) a magnetometer survey. OSU conducted additional geophysical and geotechnical surveys in 2018 at the PacWave South WEC test site and within the subsea cable corridor. The review and assessment of these data on historic properties identification and the potential for the marine portion of the proposed project to affect historic properties has been completed and documented in a study report (Davis 2019, HDR 2019). The completed marine study assessed the following data sets to identify cultural resources that could be potentially affected by the project: (1) GIS modeling to predict the location of submerged precontact sites; (2) a review of previously identified archaeological resources (e.g., shipwrecks); (3) sidescan sonar and magnetometry signal data were examined to look for evidence of large precontact sites expressed at or near the surface of the seafloor and for magnetic anomalies that might represent the remains of historic shipwrecks; and (4) marine cores were collected and analyzed in order to facilitate groundtruthing of the range of variation seen in subbottom profiler geophysical signatures in areas with possible archaeological interest. The marine study did not identify the presence of any cultural resources within the marine portion of the APE and concluded that the project is not expected, nor likely to negatively affect submerged and/or buried cultural resources within the marine portion of the APE. As a result, no cultural resources were identified, therefore, no historic properties would be affected within the marine portion of the APE.

Terrestrial Portion of APE

In September 2017, a pedestrian survey (using 15-30 meters apart transects), augmented with subsurface probing, was conducted across the terrestrial portion of the APE (HDR 2018, 2019). No historic or prehistoric cultural resources were encountered. A cultural resources inventory report was prepared documenting these efforts and the findings, and was submitted to Native American tribes, agencies, and Oregon SHPO for review. Oregon SHPO concurred with the report findings and the final report and associated consultation materials were filed with FERC (see Oregon SHPO letter, dated July 6, 2018, filed by OSU on August 28, 2018).

3.3.8.2 Environmental Effects

No historic properties have been identified within the proposed project's APE, and OSU has submitted their findings to the Oregon SHPO and whereupon the Oregon

SHPO concurred (See Oregon SHPO letter, dated December 17, 2019, filed by OSU on January 23, 2020.

Our Analysis

No historic properties were identified within proposed project's APE, and as a result, the proposed project would not affect historic properties. Nevertheless, there is always a possibility that unknown archaeological resources may be discovered in the future as a result of the project's construction, operation, or project-related activities. Consultation with the Oregon SHPO and involved Indian tribes, in the event that a significant cultural resource is inadvertently discovered during project construction, operation, or maintenance activities, would ensure that any adverse effects to historic properties can be avoided, reduced, or mitigated.

3.3.9 Socioeconomics

3.3.9.1 Affected Environment

The terrestrial portion of the project would be located in Seal Rock, Lincoln County. Seal Rock is a relatively small coastal town located in central Oregon between the popular coastal cities of Newport and Waldport. Newport is located approximately 10 miles north of Seal Rock. Waldport is located on the Alsea River and Alsea Bay, 8 miles south of Seal Rock.

The unincorporated town of Seal Rock (zip code 97376) has a population of 1,301 (USCB 2016a). Waldport is larger than Seal Rock with an area of 3 square miles and a population of 2,081. Newport has an area of 9 square miles and a population of 10,268 (Table 3-19). In October 2016, the seasonally adjusted unemployment rate was 5.9 percent in Lincoln County, 5.4 percent in Oregon, and 4.9 percent nationally (Bureau of Labor Statistics 2016).

Table 0-19. Project area demographic information.

Demographic	Lincoln County	Newport*
2015 Estimated Population	47,038	10,268
Land area (square miles)	979.77	9.05
Persons per square mile, 2010	47.0	1,103.6
Median household income, 2008-2012	$42,429	$40,448
Persons below poverty level, 2008-2012 (percent)	18.8%	18.5%

* No demographic data available for Seal Rock. Source: U.S. Census Bureau 2016a.

Historically, Oregon was dependent on its timber, agriculture, and fishing industries to generate wealth in the state by exporting products to other states and countries. In the 1980s there was a large shift from traditional resource extraction sectors to a high-tech sector, especially near Portland, Oregon (FCS Group 2014). In Lincoln County, principal industries remain more traditional and include fishing, tourism, government, services, retail, and forest products (Lincoln County 2014).

Although Oregon's export mix has changed over the years, the ports have continued to support commerce and economic activity (FCS Group 2014). Oregon is one of the most trade dependent states in the nation and economic activity in other countries helps drive the state's economy. For example, the value of exports from Oregon to foreign countries was $20.08 billion in 2015 (USCB 2016b). The state's largest trading partners are China, Canada, Malaysia, Japan, and South Korea. However, Oregon's trade with other U.S. states far exceeds its trade with foreign nations (Oregon Secretary of State 2014).

In addition to serving as state, national and international transportation gateways, the 23 ports in Oregon provide other commercial, economic, and recreational services to residents and businesses in Oregon and elsewhere (Oregon Public Ports Association 2014). The Port of Newport District is located on the central coast at the junction of US 20 and Highway 101. It is a major economic hub in the area.

The Port District's facilities are divided into two distinct development areas, the North Shore Development Area and the South Beach Development Area. The North Shore Development Area is Newport's working waterfront where the commercial fishing fleet is based, including local fishing fleets and the Newport-based distant water fleet (commercial fishing boats that spend much of the year in waters off the coast of Alaska; FCS Group 2014).

The South Beach Development Area is primarily of facilities designed to support recreational fishing and tourism. The South Beach Marina provides moorage for 450 recreational vessels and other amenities. The South Beach Development Area is home to the Marine Science Cluster, which includes the OSU Hatfield Marine Science Center and the new NOAA Pacific Coast Marine Operations Center for its fleet of research ships (FCS Group 2014).

The Port of Alsea District is located on Alsea Bay at Waldport on the Oregon coast, near the junction of Highway 101 and Oregon Highway 34 and serves as a recreation and tourism destination for the area around Waldport. The Port of Alsea offers a number of amenities for local fisherman and tourists, including sport fishing docks and a boat launch. In addition, the Port leases land to restaurant and retail shop businesses, as well as a kayak rental establishment. The annual economic impacts of the Port of Newport and Alsea are identified in Table 3-20.

Table 0-20. Annual economic impacts of the Ports of Newport and Alsea (FCS Group 2014).

Economic Impact	Port of Newport	Port of Alsea
Total Port-related Oregon employment	3,089	89
Oregon output (gross sales)	$389 M	$7.35 M
Oregon GDP	$207 M	$4.08 M
Oregon labor income	$124 M	$2.55 M
Annual local and state of Oregon tax revenue/payments	$21 M	$526 K
Annual federal tax revenue/payments by Oregon enterprises/employees	$28 M	$555 K

Source: FCS Group 2014.

Commercial Fishing

The Port of Newport is one of 23 port districts established by the state of Oregon (FCS Group 2014). The natural harbor of Yaquina Bay provides a protected haven for commercial fishing vessels, and the Port provides a number of support facilities for the local fleet and the locally-based distant water fleet (commercial fishing boats that spend much of the year in waters off the coast of Alaska), including moorage, space for suppliers and services, fuel, and other essentials. The Port also leases space to seafood processors (FCS Group 2014).

The North Shore Development Area of the Port is Newport's working waterfront, which includes a 214-slip marina that is used primarily by commercial fishermen and the Newport-based distant water fleet (Port of Newport 2013). In addition to these and other amenities, there is over 240 feet of floating moorage for boat maintenance, and a 220-foot fixed moorage that contains four hoists of varying capacities, enabling vessels to perform gear changes, off-load fish product, and do other maintenance or repair work (Port of Newport 2013).

In 2000, the most recent year for which data are available, 393 commercially registered vessels (residents and non-residents) delivered landings to Newport. The vessels participated in the following fisheries: 17 in the coastal pelagic fishery, 99 in the crab fishery, 179 in the groundfish fishery, 180 in the highly migratory species fishery, 181 in the salmon fishery, 2 in the shellfish fishery, 38 in the shrimp industry, and 106 in other fisheries (NOAA 2007). (Note: some vessels participate in multiple fisheries.)

In 2000, Newport residents owned 90 commercial vessels, which participated in the following fisheries: one in the coastal pelagic fishery, 35 in the crab fishery, one in the highly migratory species fishery, 56 in the salmon fishery, 11 in the shellfish fishery, 37 in the shrimp fishery, and 41 in other fisheries (NOAA 2007). In 2018, about

124.8 million pounds of commercially harvested fish and shellfish were processed at the Port in Newport, equating to over $62.4 million dollars. The highest landings were for hake, rockfish, pink shrimp, Dungeness crab, sablefish, flatfish, albacore tuna, Chinook salmon, and hagfish: hake accounted for approximately 66 percent of the total landings with an estimated worth of $7.2 million dollars, followed by pink shrimp, which accounted for approximately 9 percent of the total landing and an estimated worth of $8.8 million dollars (ODFW 2019).

Commercially important species are caught with a variety of techniques, such as traps (e.g., Dungeness crab), long-lines (e.g., sablefish), pole-and-line (e.g., albacore tuna), trolling (salmon) and trawling at different locations within the water column (e.g., mid-water trawls for Pacific whiting and bottom trawls for groundfish species). While some species are landed only seasonally (e.g., albacore tuna, salmon), others are landed fairly consistently throughout the year (e.g., shortspine thornyhead; ODFW 2017). There has been a developing commercial purse seine fishery for market squid off coastal Oregon, with landings in recent years in Newport (ODFW 2019).

The commercial fishing industry affects the local economy through increases in personal income from harvesting and processing, as well as by providing support to local industries and businesses. The Newport area also is positively affected by the distant water fleet, which uses Newport as a home port as well as for repairs and/or provisions. In 2018, about 124 million pounds of commercially harvested fish and shellfish were processed at the port in Newport, equating to over $62 million dollars (ODFW 2019) (Table 3-21). As described in Section 3.3.6, the highest landings were for hake, pink shrimp, Dungeness crab, sablefish, rockfish, sole, albacore tuna, Chinook salmon, and hagfish (ODFW 2019).

Table 0-21. 2018 Pounds and values of commercially caught fish and shellfish landed in Newport.

Month*	Million Pounds	Million Dollars**
January	2.6	5.3
February	6.3	15.7
March	2.3	5.2
April	1.8	2.6
May	7.5	3.6
June	20.9	5.0
July	21.3	7.4
August	26.2	6.9
September	22.2	5.1
October	10.0	3.1
November	2.1	1.2
December	1.0	0.6
Total	124.8	62.4

Source: ODFW 2019.
*Landings by month reflect the date of purchase by the dealers and may not necessarily indicate the date the fish were caught.
**Value based on the ex-vessel price per pound paid to fisherman.

In addition to the commercial fishing fleet, the Port's operations involve four sport fishing markets, including ocean charters, ocean and freshwater private trailerable boats, ocean and freshwater private moored boats, and bank and pier pole and shellfish anglers. Over the last decade, the state has seen a significant decline in the number of boat registrations and use days, both on an absolute and a per capita basis, which is consistent with the national trend. While recreational vessel registrations have declined, the charter industry has grown steadily and the Central Oregon Coast accounts for over 22 percent of fishing guides in the state (Port of Newport 2013).

Sport fishing is a major contributor to the local economy. For example, in 2010 the regional economic impact of saltwater sport fishing trips on the Oregon coast was estimated at $822 thousand for salmon and $3.5 million for species including bottom fish, halibut, and tuna.[55] Travel generated expenditures for fishing in Lincoln County was estimated at over $32 million for fishing and almost $7.7 million for shellfish fishing in 2008. Local recreation expenditures (i.e., lodging, meals) accounted for an additional $3.5 million in activity in the County (Port of Newport 2013).

---

[55] This estimate includes charters, private boats, and bank access to ocean and estuary sites. Expenditures on capital items, such as boats, vehicles to pull boats, and second homes, are not included.

3.3.9.2 Environmental Effects

This section evaluates the following potential effects on socioeconomic resources:

- Effects of the project on recreational and commercial crabbing and fishing;
- Effects of the project and potential navigation restrictions on marine transportation; and
- Effects of local, state, and regional economic benefits resulting from the development and presence of the project.

Effects of the Project on Recreational and Commercial Crabbing and Fishing

Entanglement of commercial and recreational fishing gear with the project could occur, especially with regard to the equipment used by salmon trollers and Dungeness crab fishers. To minimize the effects of the project on commercial and recreational fishing, OSU consulted with FINE and other stakeholders as part of the outreach efforts and site selection process (See Section 2.6.1). OSU would: (1) work cooperatively with commercial, charter, and recreational fishing entities and interests to avoid and minimize potential space-use conflicts during construction and operation, (2) where feasible, bury subsea cables 1 to 2 meters deep to minimize interactions with fishing gear and anchors, and (3) engage with the fishing community to inform mariners traveling in the vicinity of project structures or activities to be avoided. This would include requesting the USCG to issue a Notice to Mariners and working with appropriate parties to post project information flyers at marinas and docks.

During severe storm events, strong wind and waves may cause crab pots to drift and become entangled in the WEC mooring lines. Nevertheless, the overall potential impact on commercial and recreational fishing from the project is expected to be minor because of the small project footprint relative to the surrounding open ocean.

Our Analysis

The selection of the project site was based on a combination of preferred site criteria and community input, including impacts to existing ocean users and support of the local fishing communities. Since identifying the project study area off the coast of Newport, OSU has continued to maintain ongoing communication and coordination with the local community, and with the fishing industry in particular.

As mentioned above, there are some impact expected on commercial crabbing and fishing; however, the overall potential impact on commercial and recreational fishing from the project is expected to be minor because of the small project footprint relative to the surrounding open ocean. If the surface equipment attracts fish, it is likely that recreational fishers would use the area near PacWave South for recreational fishing, so the actual impact on recreational fishing would be minor or potentially positive.

Effects of the project and Potential Navigation Restrictions on Marine Transportation

As mentioned in Section 3.3.6.2, no navigational closures are anticipated for the project (i.e., no exclusion zones), and OSU would implement a variety of measures to minimize potential effects to marine navigation, including the following: (1) mark project structures with appropriate navigation aids, as required by the USCG, (2) conduct outreach to inform mariners of project structures or activities to be avoided in the area (e.g., Notice to Mariners, flyers posted at marinas and docks), (3) develop and implement an Emergency Response and Recovery Plan, and (4) install subsurface floats at sufficient depth to avoid potential vessel strike.

A number of vessels, including tugs, installation vessels, and other workboats would be employed during construction, maintenance, and removal of the project. These vessels would make multiple trips from the Newport or other ports to the project site to install the WECs, anchors, and moorings. However, project-related vessel traffic is not anticipated to affect navigation because the vessels used for the project would be similar to existing boating traffic along the coast and their usage would be intermittent.

USCG Local Notice to Mariners would be requested for the deployment of in-water infrastructure and equipment associated with the project. USCG-compliant navigational markers and lighting would be used to identify navigational hazards. While the project is located near a tow lane, as noted in Section 2.6.1, OSU selected the project site after an extensive public outreach program to gain broad support for the selected site as part of the technical evaluation of candidate sites. The Ports of Newport and Toledo, FINE, and the public at large were involved with this process.

In the unlikely event that a WEC had a catastrophic emergency and washed ashore, OSU would implement the Emergency Response and Recovery Plan. OSU would require that each WEC be equipped an AIS system to allow for monitoring of its location.

Our Analysis

OSU submitted a draft Navigational Safety Risk Assessment to the USCG for its review. This assessment considered environmental factors, vessel fleet characteristics, routes, and waterway characteristics in the vicinity if the project. Based on this assessment, the introduction of the WECs in the project area would not significantly affect navigation safety, and the presence of the WECs and associated construction and service vessels would not affect marine transportation in the project area, the Ports of Newport or Toledo, or along the Oregon Coast.

Effects of Local, State, and Regional Economic Benefits Resulting from the Development and Presence of the project

The Energy Policy Act of 2005 encourages the development of renewable energy resources, including wave energy, to reduce the country's dependence on foreign oil and other hydrocarbon energy sources. The State of Oregon has also implemented a number of initiatives to encourage the development of wave and other types of renewable energy projects, including the Oregon Wave Energy Trust and the Oregon Renewable Portfolio Standard. OSU does not propose any measures related to economic development.

In evaluating the feasibility of wave energy projects, the Electric Power Research Institute (EPRI) stated that the development of wave energy projects would result in a number of public benefits including job creation (construction, operation, and maintenance of wave energy projects), economic development, and increased energy self-sufficiency (EPRI 2011).

For the construction of OPT's first planned WEC in Oregon, OPT estimated that deployment of the single WEC would create 30 jobs for workers at the facility where the WEC was being fabricated, and that the deployment of the planned additional nine WECs (the Reedsport OPT Wave Park) would provide employment for an additional 180 skilled workers for seven months. OPT estimated that project deployment would result in six new local jobs while helping maintain 10 to 12 existing jobs and creating $1 million in wages to the local economy. During operation of the 10-WEC project, OPT estimated that the project would support eight full-time employees, while periodic maintenance would create temporary positions for about five additional workers (Reedsport OPT, LLC 2010, FERC 2010).

In our EA for the Reedsport Project, FERC (2010) described findings of the report to the Oregon Wave Energy Trust (EcoNorthwest 2009), which estimated multiplier effects for constructing and operating a 7- to 10-MW wave research and development facility on the Oregon Coast. EcoNorthwest estimated that this type of project would create total construction employment for 45 workers, and that operation of the facility would create 40 direct jobs and another 51 jobs associated with facility and employee spending for goods and services (FERC 2010).

Our Analysis

While the extent of the PacWave South contribution to employment in the region is not known, one can conclude that construction and operation of the project would result in employment and related worker earnings. The project would attract WEC test clients to the area, which would generate business for hotels, restaurants, and other local businesses. In addition, promotion of the marine renewable energy converter market off the coast of Oregon could lead to future projects elsewhere in the region, which could result in subsequent jobs.

3.3.9.3 Cumulative Impacts

The potential for the following effects of the project to result in cumulative impacts in combination with other current or reasonably foreseeable actions were evaluated:

- Effects of the project on recreational and commercial crabbing and fishing;
- Effects of the project and potential navigation restrictions on marine transportation; and
- Effects of local, state, and regional economic benefits resulting from the development and presence of the project.

As noted in Section 3.3.6.4, construction and operation of the project would result in obstacles (e.g., WECs and moorings) to navigation and commercial and recreational crabbing and fishing. The overall project area of the initial development scenario (6 WECs) and the full build-out scenario (20 WECs) represents a small area of the OCS approximately 6 nautical miles offshore, relative to the area available to commercial and recreational crabbers and fishermen. Given that the only other planned or existing ocean energy projects offshore of Oregon are PacWave North and the Camp Rilea Ocean Energy projects, located 9 and 100 nautical miles from PacWave South, respectively, the development of the PacWave South project would have a negligible cumulative effect on navigation, and commercial and recreational crabbing and fishing.

As noted above, the development and operation of the project would contribute to the growth of various industries related to, or that would support, ocean energy. Thus, it is expected that there would be a small positive cumulative effect to the economy from the project, in combination with the PacWave North and Camp Rilea projects.

3.4 NO-ACTION ALTERNATIVE

Under the no-action alternative, the project would not be constructed. There would be no changes to the physical, biological, or cultural resources of the area, and electrical generation from the project would not occur. The benefits associated with the project, including generation, WEC testing, and development of wave energy converters, would not occur. The power that would have been developed from a renewable resource would likely be replaced by nonrenewable fuels.

4.0 DEVELOPMENTAL ANALYSIS

4.1 POWER AND ECONOMIC BENEFITS

Table 4.1 summarizes the assumptions and economic information we use in our analysis. This information, unless otherwise identified, was provided by the applicant in its license application and subsequent filings. We find that the values provided by the applicant are reasonable for the purposes of our analysis. Cost items common to all alternatives include taxes and insurance costs; estimated future capital investment required to construct, maintain, and extend the life of equipment and facilities; licensing costs; and normal operation and maintenance cost.

Table 0-1. Parameters for the economic analysis of the PacWave South Project (Source: OSU and staff).

Parameter	Value
Period of analysis (years)[a]	30
Federal income tax rate (%)[b]	N/A
Initial construction cost ($)[c]	55,000,000
Licensing cost ($)[c]	6,250,000
Energy value ($/MWh)[c, d]	21.49
Future operation and maintenance ($/year)[c, e]	4,586,500
Discount rate (%)[f]	8

[a] Regardless of the potential license term (e.g., 5-year pilot, 30, 40 or 50 years), we perform a 30-year economic analysis.

[b] Oregon State University is a public university of the state of Oregon and is exempt from federal income taxation.

[c] Provided by the applicant in the license application.

[d] As stated in exhibit D of the FLA, the annual value of power generated by the proposed Project will vary depending on the number of WECs installed for testing at any given time combined with their performance characteristics; therefore, the annual value of power generated by the proposed project cannot be reliably estimated.

[e] The total cost of project operation and maintenance over the five-year period of operations is $4 million. The cost shown in the table is levelized over the 30-year period used for the FERC Mead analysis. Operation and maintenance expenses, include interim replacements, insurance, administrative and general expenses, and contingencies.

[f] Estimated by staff.

4.2 COMPARISON OF ALTERNATIVES

Table 4-2 summarizes the installed capacity, annual generation, cost of alternative power, estimated total project cost, and the difference between the cost of alternative power and total project cost for each of the action alternatives considered in this EA.

Table 4-2. Summary of annual cost of alternative power and annual project cost for the action alternatives for the PacWave south Project (Source: Staff).

	No Action	**Proposed**	**Staff Alternative**
Installed capacity (MW)	N/A	20	20
Annual generation (MWh)	N/A	21,900[a]	21,900
Dependable capacity (MW)	N/A	20	20
Annual cost of alternative power ($)	N/A	$3,665,000	$3,665,000
($/MWh)	N/A	167.34	167.34
Annual project cost ($)	N/A	$11,350,000	$11,363,000
($/MWh)	N/A	518.26	518.866
Difference between the cost of alternative power and project cost ($)	N/A	($7,685,000)	($7,699,000)
($/MWh)	N/A	(350.92)	(351.53)

[a] Approximate annul generation estimated by the staff.

4.2.1 No-Action Alternative

Under the no-action alternative there would not be a grid-connected wave energy WEC test facility to facilitate industry commercialization and fully reap the benefits of this clean, renewable energy resource. The no-action alternative would not produce renewable energy and would not provide economic benefits through job creation on the Oregon coast. More importantly, the future incorporation of wave energy into the power grid would be hindered by the limited advancements in wave energy converter technology.

4.2.2 Proposed Action

As proposed, the project would have an installed capacity of 20 MW and generate an average of 21,900 MWh of electricity annually. The average annual cost of alternative power would be $3,665,000, or $167.34/MWh. The average annual project cost would be $11,350,000, or about $518.26/MWh. Overall, the project would produce power at a cost that is $7,685,000, or $350.92/MWh, more than the cost of alternative power.

4.2.3 Staff Alternative

As recommended by staff, the project would have an installed capacity of 20 MW and generate an average of 21,900 MWh of electricity annually. The average annual cost of alternative power would be $3,665,000, or $167.34/MWh. The average annual project cost would be $11,363,000, or about $518.87/MWh. Overall, the project would produce power at a cost that is $7,699,000, or $351.53/MWh, more than the cost of alternative power.

4.3 COST OF ENVIRONMENTAL MEASURES

The estimated cost for pre-installation environmental studies already completed, planned, or in progress is approximately $2 million. These studies included acoustic Doppler current profiling, wave modeling and far field effects analysis, underwater acoustics studies, aquatic species studies, marine mammal studies, oceanographic/ bathymetrical/benthic studies, and terrestrial and cultural resources studies.

As part of this project, the OSU proposes to undertake certain measures designed to gather environmental and operational data regarding the operation of the WECs. This information would be utilized to evaluate the effects of the project and individual WECs and may result in modifications to the project's operations. Due to the nature of the project as a WEC test site, many of the proposed monitoring plans are being applied to wave energy technology for the first time, making precise estimates for the overall cost of each plan extremely difficult. However, OSU estimates that the total annual cost to conduct the activities described in the proposed monitoring plans would be approximately $500,000 per year. Specific costs of proposed environmental measures are provided below in Table 4-3.

Table 0-3. Estimated costs of proposed environmental measures.

Proposed Environmental Measures	Entities	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$) [a]
General Environmental Measures				
1. Implement the Adaptive Management Framework in conjunction with specific PM&E measures to evaluate study results, identify any project effects, and implement and/or modify response actions in consultation with key agency stakeholders.[b]	OSU, Oregon DFW, FWS, NMFS, staff	$0	$50,000	$57,300
2. Beginning five years and six months after deployment of the first WEC at the project, and recurring every five years thereafter, the licensee shall file with FERC a Five-Year Report and provide copies to BOEM, NMFS, FWS, and ODFW. Contents of the report are further described in APEA, Appendix I, Protection, Mitigation, and Enhancement Measures.[b]	OSU, Oregon DFW, FWS, NMFS, staff	$0	$25,000	$28,700
3. Submit annual reports to NMFS that document the extent of incidental take described in the Incidental Take Statement is not exceeded to include: (a) the results of the benthic sediments, organism interactions, acoustics, and EMF monitoring; (b) WEC installation and removal activities; and (c) one report on construction completion that describes HDD installation of the terrestrial transmission lines, and HDD and jet plow installation of the subsea transmission cables.[b]	NMFS, staff	$0	$5,000	$5,700
4. Employ periodic, routine inspection and maintenance methods to ensure structural integrity of project components (Operation and Maintenance Plan).[b]	OSU, Oregon DFW, FWS, NMFS, staff	$0	$20,000	$22,900
Geologic and Soil Resources Measures				
5. Use HDD to install the terrestrial transmission lines under the nearshore and intertidal habitat (to approximately the 10-m isobath) to minimize substrate disturbance. Use HDD to install the cables in up to three bores, from the beach manholes at the Driftwood Beach State Recreation Site to the UCMF, and from the UCMF to the Highway 101 grid connection point, to minimize habitat disturbance.[c]	OSU, FWS, staff	$12,000,000	$0	$1,222,200

Proposed Environmental Measures	Entities	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$) [a]
6. Develop an HDD Plan to install the subsea cables and terrestrial transmission lines.[g]	staff, Oregon DFW, FWS, NMFS	$50,000	$0	$5,100
7. Provide refined geological information of the subsea cable route.[g]	Oregon DFW	$10,000	$0	$1,000
8. Avoid rocky substrate and achieve continuous burial of the subsea transmission cable.[g h]	Oregon DFW	$5,000,000	$0	$509,300
9. Follow best practices during installation, operation, and removal activities to avoid or minimize potential effects to sediment, including: 9a. Minimize the time that the seafloor is disturbed, and sediment is dispersed and the associated effects by completing cable laying and other construction activities during appropriate construction windows and within one construction season to the extent practicable.[c]	OSU, Oregon DFW, FWS, NMFS, staff	$40,000	$0	$4,100
9b. Develop and implement an erosion and sediment control plan, where appropriate, to minimize effects of ground-disturbing activities associated with installation of the terrestrial cables and/or other terrestrial construction.[c]	OSU, Oregon DFW, FWS, NMFS, staff	$30,000	$0	$3,100
10. Implement the Benthic Sediments Monitoring Plan to evaluate effects on benthic habitat from anchors, WECs, and other equipment during operation, maintenance, and monitoring activities. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects.[d]	OSU, Oregon DFW, FWS, NMFS, staff	$10,000	$90,000	$104,200
11. Project components in the estuarine environment should not bottom out so as to prevent nearshore/estuarine habitat effects.	OSU, Oregon DFW, FWS, NMFS, staff	$0	$0	$0
12. To the extent possible, minimize frequency of anchor installation/removal cycles and reuse installed anchors.	OSU, Oregon DFW, FWS, NMFS, staff	$0	$0	$0
Water Resources				

Proposed Environmental Measures	Entities	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$) [a]
13. Follow industry best practices[e] and guidelines for antifouling applications (e.g., TBT-free) on project structures such as marker buoys, subsurface floats, and WEC[b] and fabricate project components at existing permitted land-based facilities.	OSU, Oregon DFW, FWS, NMFS, staff	$0	$10,000	$11,500
14 Restrict project use of the estuary to commercial navigation channels and existing permitted docks and dredge areas.	FWS	$300,000	$0	$30,600
15. Develop and implement an emergency response and recovery plan with spill prevention, response actions, and control protocols, as well as and provisions for recording types and amounts of hazardous fluids contained in WECs and other project components.[b]	OSU, Oregon DFW, FWS, NMFS, staff	$0	$40,000	$45,900
16. Modify Fish and Wildlife Emergency Plan Notification	FWS	$25,000	$0	$2,500
17. Require all vessel operators to comply with an emergency response and recovery plan for installation and maintenance of project facilities.[b]	OSU, Oregon DFW, FWS, NMFS, staff	$0	$10,000	$11,500
18. Prepare waste management, hazardous material, and spill prevention plans, as appropriate, for onshore project facilities.[b]	OSU, Oregon DFW, FWS, NMFS, staff	$0	$10,000	$11,500
19. Minimize storage and staging of WECs outside of existing dock, port, or other marine industrial facilities.[b]	OSU, Oregon DFW, FWS, NMFS, staff	$0	$5,000	$5,700
20. Require that all project chartered, or contracted vessels comply with all current federal and state laws and regulations regarding aquatic invasive species management.[b]	OSU, Oregon DFW, FWS, NMFS, staff	$0	$5,000	$5,700
21. Develop and implement an HDD contingency plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor.[c]	OSU, Oregon DFW, FWS, NMFS, staff	$100,000	$0	$10,200

Proposed Environmental Measures	Entities	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$) [a]
Aquatic Resources and Threatened and Endangered Species – General				
22. Bury subsea cables at a depth of 1-2 meters, to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor. In areas where a cable cannot be buried or persistently becomes unburied, that portion of the cable would be on the seafloor and would be protected by split pipe, concrete mattresses or other cable protection systems.[c]	OSU, Oregon DFW, FWS, NMFS, staff	$18,000,000	$0	$1,833,300
23. To the maximum extent practicable, utilize shielding on subsea cables, umbilicals, and other electrical infrastructure to minimize EMF emissions.[c]	OSU, Oregon DFW, FWS, NMFS, staff	$3,000,000	$0	$305,600
24. Implement the EMF Monitoring Plan to measure project-related EMF emissions. Based on monitoring results, implement the specified measures to mitigate for potential adverse effects.[d]	OSU, Oregon DFW, FWS, NMFS, staff	$20,000	$80,000	$93,800
25. In the event of an emergency in which fish or wildlife are being killed, harmed, or endangered by project facilities or operations in a manner that was not anticipated, OSU would notify agencies with regulatory authority as soon as possible and take action to promptly minimize the impacts of the emergency, including implementing any guidance pursuant to agency legal authorities.[b]	OSU, Oregon DFW, FWS, NMFS, staff	$0	$10,000	$11,500
Aquatic Resources and Threatened and Endangered Species – Fish and Invertebrates				
26. Implement the Organism Interactions Monitoring Plan to track changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to the installed components or affected due to the potential for reduced fishing pressure, as well as biofouling on the anchors/WECs.[d]	OSU, Oregon DFW, FWS, NMFS, staff	$5,000	$55,000	$63,600
27. Develop cable routes that avoid crossing areas with rocky reef and hard substrate to the maximum extent practicable to protect sensitive habitat features.[c]	OSU, Oregon DFW, FWS, NMFS, staff	$2,500,000	$0	$254,600

Proposed Environmental Measures	Entities	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$) [a]
28. Develop and implement an anchoring plan or protocol for any project vessels that may anchor at the project site, that:[b] • Avoids anchoring in known rocky reef or hard substrate habitats to the maximum extent practicable; and • Minimizes the use of anchors within the project area wherever practicable by combining onsite activities.	OSU, Oregon DFW, FWS, NMFS, staff	$0	$25,000	$28,700
Aquatic Resources and Threatened and Endangered Species – Marine Mammals				
29. Entangled Fishing Gear 29a. Conduct opportunistic visual observations from the water surface in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work and review any underwater visual monitoring conducted for other purposes to detect entangled fishing gear that has the potential to increase the risk of marine species entanglement. The licensee would ensure that surface observations occur during all visits to the project test site and at least once per quarter each year for the duration of the license.[b]	OSU, staff	$0	$100,000	$114,700
29b. Annually following the peak storm season and period of maximum activity for the Dungeness crab fishery, the licensee shall conduct surface surveys of active WEC berths during the spring season (mid-March through mid-June), or the earliest possible time after that period that avoids jeopardizing human safety, property, or the environment.[b]	OSU, staff	$0	$30,000	$34,400
29c. Conduct annual subsurface surveys of moorings and anchor systems using ROV or other appropriate techniques with approval by NMFS concurrent with spring (mid-March through mid-June) monitoring under the Organism Interactions Monitoring.[d]	OSU, staff	$20,000	$40,000	$47,900
29d. If entangled fishing gear or marine mammal (or sea turtle) stranding, entanglements, impingements, injuries, or mortalities is detected, implement the specified measures to minimize risk of marine mammal entanglement and to make every effort to return the fishing gear to the owners.[b]	OSU, staff	$0	$50,000	$57,300

Proposed Environmental Measures	Entities	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$) [a]
30. Require vessels in transit to/from the project site to avoid close contact with marine mammals and sea turtles and adhere to NMFS "Be Whale Wise" guidelines to minimize potential vessel impacts to marine mammals.	OSU, staff	$0	$0	$0
31. Comply with current regulations that require marine mammal observers for certain vessel-based activity (e.g., sub-bottom profiling).	OSU, staff	$0	$0	$0
32. Require WEC testing clients to keep their equipment in good working order to minimize sound due to faulty or poorly maintained equipment.	OSU, staff	$0	$0	$0
33. Implement the Acoustics Monitoring Plan to quantify sound levels using field measurements and validated sound propagation models. Based on monitoring results, implement specified measures to mitigate for potential adverse effects.[d]	OSU, staff	$30,000	$70,000	$83,300
34. Minimize construction activities during key gray whale migration periods, to the extent possible.[c f]	OSU, staff	$1,500,000	$0	$152,800
35. For use of DPVs or other equipment that may exceed NMFS's published threshold for injury.[c f] • Avoid use of these vessels to the maximum extent practicable during Phase B gray whale migration (April 1-June 15). If these construction activities are proposed during this migration period, the licensee would consult with ODFW regarding the timing of such activities including cable-laying in state waters. • With technical assistance from NMFS, establish and carry out the following actions and protocols necessary to maintain an appropriate acoustic zone of influence in accordance with NMFS's published harassment threshold (120 dB) during DPV operations to minimize behavioral disturbance and protect marine resources. o Post qualified marine mammal observers during daylight hours. o The licensee would conduct dynamic positioning (DP) activities during daylight hours when feasible to ensure observations may be carried out. o DP for cable laying may occur during all hours; however, DP start up for cable laying would only occur during daylight hours.	OSU, staff	$100,000	$0	$10,200

Proposed Environmental Measures	**Entities**	**Capital Cost (2019$)**	**Annual Cost (2019$)**	**Levelized Annual Cost (2019$) [a]**
o The licensee would carry out DPV ramp-up procedures, which may be modified by agreement of the licensee and NMFS. • Implement such additional measures as may be imposed pursuant to a Marine Mammal Protection Act authorization.				
36. Make opportunistic visual observations of pinnipeds in the portions of the test site which are being visited to conduct operations, maintenance, or environmental monitoring work. If pinnipeds are observed to be hauled out on project structures, the licensee would follow the reporting and haulout protocols.[b]	OSU, staff	$0	$20,000	$22,900
37. To the extent practicable, direct the WEC testing clients to design and maintain cables and moorings in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement and follow the reporting and haulout protocols.	OSU, staff	$0	$0	$0
38. Avoid use of DPVs during Phase B gray whale migration (April 1-June 15).	Oregon DFW			
Aquatic Resources and Threatened and Endangered Species – Seabirds				
39. Implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy to assess, minimize, and avoid impacts to birds, described below:	OSU, Oregon DFW, FWS, Oregon PRD, staff			
39a. Conduct opportunistic visual observations from the water surface in the portions of the test site that are being visited to conduct operations, maintenance, or environmental monitoring work, and review any underwater visual monitoring conducted for other purposes, to detect derelict gear that has the potential to increase the risk of marine species entanglement. If monitoring shows that derelict gear has become entangled or collected on any project structure, the risk that it poses would be assessed based on type of gear, and the derelict gear would be removed as soon as is practicable while avoiding jeopardizing human safety, property, or the environment.[b]	OSU, Oregon DFW, FWS, Oregon PRD, staff	$0	$15,000	$17,200

Proposed Environmental Measures	Entities	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$) [a]
39b. Conduct opportunistic visual observations in the portions of the WEC test site during vessel-based visits for operations, maintenance, or environmental monitoring work, to detect and document any instances of seabird perching.[b]	OSU, Oregon DFW, FWS, Oregon PRD, staff	$0	$15,000	$17,200
39c. Use low-intensity flashing lights and bird-friendly wavelengths on the project structures to minimize seabird attraction and follow the specifications for project lighting developed in consultation with the FWS and USCG.[d]	OSU, Oregon DFW, FWS, Oregon PRD, staff	$5,000	$5,000	$6,200
39d. Minimize lighting (e.g., use low intensity, bird-friendly wavelengths, shielded lighting not providing upward-pointing light or light directed at the sea surface) used at night by service and support vessels to reduce the potential for seabird attraction.[d]	OSU, Oregon DFW, FWS, Oregon PRD, staff	$5,000	$5,000	$6,200
39e. Require vessel operators to follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout.	OSU, Oregon DFW, FWS, Oregon PRD, staff	$0	$0	$0
39f. Require vessel operators to remain 500 feet away from seabird colonies during the nesting season to minimize disturbance to nesting seabirds.	OSU, Oregon DFW, FWS, Oregon PRD, staff	$0	$0	$0
Terrestrial Resources and Threatened and Endangered Species				
40. Minimize or avoid terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species).[c]	OSU, Oregon DFW, FWS, staff	$2,500,000	$0	$254,600
41. Use HDD to install the cable conduits under the beach and sand dune habitat.[c]	OSU, Oregon	$300,000	$0	$30,600

Proposed Environmental Measures	Entities	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$) [a]
	DFW, FWS, NMFS, staff			
42. Use HDD to install the terrestrial cable conduits directly from the Driftwood site to the UCMF, and from the UCMF to the Highway 101 grid connection point, minimizing effects to wetlands, streams, and terrestrial habitat.[c]	OSU, Oregon DFW, FWS, NMFS, staff	$100,000	$0	$10,200
43. Employ environmental measures during installation, operation, and removal to avoid or minimize potential effects to sediment and soils. For example:[c] • Minimize disruption of terrestrial geology and soils by maintaining buffers around wetlands to the degree practicable. • Develop and implement erosion and sediment control plans and maintaining natural surface drainage patterns. • Develop and implement stormwater management plan at terrestrial facilities to maintain existing drainage patterns, protect project-adjacent habitat, and prevent contamination of streams. Develop a stormwater plan that meets all federal and state legal requirements during site design of the UCMF and associated facilities prior to any construction activities at the site.	OSU, Oregon DFW, FWS, NMFS, staff	$500,000	$0	$50,900
44. Avoid to the extent practicable, disturbance of snags and of wildlife or legacy trees including live or dead trees that provide benefit to wildlife. If unavoidable, additional pre-construction, species-specific surveys may be necessary to minimize effects.[c]	OSU, Oregon DFW, FWS, staff	$140,000	$0	$14,300
45. Avoid to the extent practicable, disturbance of forested wetlands.[c]	OSU, Oregon DFW, FWS, staff	$50,000	$0	$5,100
46. Avoid to the extent practicable, disturbance of wetlands and adjacent areas that may provide habitat for turtles, amphibians, and other semi-aquatic wildlife.[c]	OSU, Oregon DFW, FWS, staff	$2,000,000	$0	$203,700
47. Avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short	OSU, Oregon	$160,000	$0	$16,300

Proposed Environmental Measures	Entities	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$) [a]
timeframe. Natural hydrology should be restored after construction is complete and may require a restoration plan with monitoring until successful restoration can be determined.[c]	DFW, FWS, staff			
48. Minimize disturbance of streams that support fish or are connected to fish-bearing streams. Unavoidable work within or adjacent to fish-bearing streams may be subject to in-water work windows. If terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the federal or state ESA, consult with NMFS/FWS staff to avoid and minimize any potential effects to listed species.[c]	OSU, Oregon DFW, FWS, NMFS, staff	$10,000	$0	$1,000
49. Avoid to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood Beach State Recreation Site. The current construction footprint has the project well within the parking lot boundary of Driftwood, therefore interaction with kinnikinnick would be unlikely. Where unavoidable, species-specific surveys may be necessary on properties outside of Driftwood Beach State Recreation Site but within the construction footprint to determine the extent of occupied habitat and associated mitigation.[c]	OSU, Oregon DFW, Oregon PRD, FWS, staff	$100,000	$0	$10,200
50. Develop a revegetation plan, in consultation with NMFS, ODFW, and appropriate agencies, using native species to the extent practicable for areas disturbed during construction. This plan would include the minimization measures identified in letters commenting on the DLA filed with FERC by NMFS (dated July 18, 2018) and ODFW (dated July 20, 2018) as appropriate.[c]	OSU, Oregon DFW, FWS, staff	$50,000	$0	$5,100
51. Develop measures that would limit the introduction or spread of invasive species, to be included in a construction plan.[c]	OSU, Oregon DFW, FWS, staff	$50,000	$0	$5,100
52. Implement the Environmental Measures section as described in the Bird and Bat Conservation Strategy to assess, minimize, and avoid impacts to birds and bats; these are annotated below.[c]	OSU, staff	$3,000,000	$0	$305,600

Proposed Environmental Measures	Entities	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$) [a]
• No HDD construction equipment or construction activities would occur on Driftwood Beach within suitable snowy plover nesting, roosting, or foraging habitat and is expected to be limited to the Driftwood Beach parking lot, at least 164 feet (50 meters) from any potentially suitable habitat. • HDD operations in the parking lot would occur during daylight hours, but if lighting is required at night it would be appropriately shielded and directed to minimize artificial light reaching western snowy plover nesting habitat at night. Animal-proof litter receptacles and related signage and coordination would be provided to minimize potential attraction of predators. • Develop and implement an HDD contingency plan to minimize the potential for inadvertent return of drilling fluids, provide timely detection, and address potential releases by describing monitoring, containment, response and notification procedures to be implemented by the contractor. • If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat would be conducted. If nests are detected, measures specified in the BBCS would be implemented, including noise monitoring and implementation of engineering controls, if appropriate (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers). • Prior to any vegetation clearing that occurs within the nesting season, pre-construction surveys for nesting birds would be conducted to ensure that no nests would be disturbed during vegetation clearing. • To minimize project-related impacts on non-listed terrestrial nesting birds and avoid the creation of potential conflicts or constraints that the presence of active nests would have on project activities (vegetation clearing), nest-starts would be removed for any birds (except raptors or listed species) when observed, if found within the project footprint and within 100 feet of a construction zone and where feasible. • If an active nest is found sufficiently close to work areas to be disturbed by these activities, the biologist would determine the extent of a				

Proposed Environmental Measures	Entities	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$) [a]
construction-free buffer zone to be established around the nest (typically 300 feet for raptors and 100 feet for other species), to ensure that no nests of species protected by the MBTA would be disturbed during project construction. • If nesting bald or golden eagles are identified, activities would be restricted near nest sites according to guidelines suggested in the National Bald Eagle Management Guidelines (FWS 2007). • If construction activities would not be initiated until after the start of the nesting season, all potential nesting substrates (e.g., bushes, trees, snags, grasses, and other vegetation) that are planned to be removed, would be removed in late winter, prior to the start of the nesting season. • If necessary, the prescribed no-disturbance nesting buffers may be adjusted to reflect existing conditions including ambient noise, topography, and disturbance with approval of ODFW. • Conduct preconstruction surveys for roosting bats, and minimize construction impacts from high frequency sound disturbance, night lighting, and air quality degradation near roosts by implementing bat roost buffers, or excluding bats within bat roost buffers, or developing species and equipment specific buffers, use noise controls, and monitor bat roost activity before, during and after construction. • If lighting is required at the UCMF, it would be appropriately shielded and directed to minimize artificial light attraction and prevent potential injury or mortality to seabirds. To the maximum extent practicable, while allowing for the public safety, low intensity energy saving lighting (e.g., low pressure sodium lamps) would be used, and bright white light would be minimized to the maximum extent practicable.				
53. Modify the Bird and Bat Conservation Strategy to include:				
53a. That all project-related activities, not just heavy-duty equipment activities, occur at least 50 meters from western snowy plover habitat and be approved in consultation with FWS and Oregon PRD.	Oregon PRD, Oregon DFW	$0	$0	$0

Proposed Environmental Measures	Entities	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$) [a]
53b. The results of surveys performed in July 2019 for bat maternity roosts, reported in the PacWave South – Bat Roosting Habitat Survey Results memorandum dated August 27, 2019.	Oregon DFW, FWS	$0	$0	$0
53c. If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat would be conducted within 600 feet of the western edge of the parking lot at Driftwood.	Oregon PRD, Oregon DFW, staff	$0	$0	$0
53d. Construction personnel would participate in a Service-approved worker environmental awareness program on federally listed species and their habitats.	Oregon PRD, Oregon DFW, staff	$0	$0	$0
53e. Observations of western snowy plovers nesting in 2017, 2018, and 2019 on the beach immediately adjacent to and near Driftwood.	Oregon DFW	$0	$0	$0
53f. Modify page 17 in accordance with Oregon DFW's recommendation to install terrestrial cables with a single HDD bore beneath the sensitive bog/fen wetland complex associated with Buckley Creek.	Oregon DFW	$0	$0	$0
54. Consult with Oregon PRD on placement of any necessary sound barriers, signage, etc. as described in the BA for protecting nesting western snowy plovers.	Oregon PRD, staff	$0	$0	$0
55. Consult with Oregon PRD on any adaptive management measures necessary for snowy plovers on the ocean shore.	Oregon PRD	$0	$0	$0
Recreation, Ocean Use, and Land Use – Ocean Use and Recreation				
56. Implement Navigation Safety Risk Assessment	OSU, Oregon DFW, staff	$0	$63,502	$72,800
57. Mark project structures with appropriate navigation aids, as required by the USCG.[d]	OSU, Oregon DFW,	$150,000	$50,000	$72,600

Proposed Environmental Measures	Entities	Capital Cost (2019$)	Annual Cost (2019$)	Levelized Annual Cost (2019$) [a]
	Oregon PRD, staff			
58. Conduct outreach to inform mariners of project structures or activities to be avoided in the area (e.g., Notice to Mariners, flyers posted at marinas and docks).[b]	OSU, staff	$0	$10,000	$11,500
59. Install subsurface floats at sufficient depth to avoid potential vessel strike.[d]	OSU, staff	$25,000	$25,000	$31,200
60. Work cooperatively with commercial, charter and recreational fishing entities and interests to avoid and minimize potential space-use conflicts with commercial and recreational interests during construction and operation.[b]	OSU, staff	$0	$50,000	$57,300
Recreation, Ocean Use, and Land Use – Terrestrial Use and Recreation				
61. If acceptable to OPRD, develop and install an interpretive display describing PacWave South in the Driftwood Beach State Recreation Site. OSU would work with OPRD to develop a plan regarding the interpretive display.[c]	OSU, staff	$25,000	$0	$2,500
62. Use construction fencing to isolate work areas from park lands.[c]	OSU, staff	$200,000	$0	$20,400
63. Although non-project related vehicular access to the Driftwood Beach State Recreation Site would be prohibited during construction, OSU would arrange the construction work area to maintain pedestrian public beach access, if safe and practicable. OSU would coordinate with OPRD to minimize impacts to public access and use of Driftwood Beach State Recreation Site.[c]	OSU, Oregon PRD, staff	$100,000	$0	$10,200
64. Notify Oregon DOT at least 3 months in advance of construction-related closures of the Driftwood site that would be 90-days in duration, or longer, and coordinate with Oregon DOT to ensure adequate signage is posted to inform motorists in advance of any temporary closure.[c]	Oregon PRD, staff	$25,000	$0	$2,500
65. Aquire an Ocean Shore Alteration Permit and a Motor Vehicle on the Ocean Shore permit for activities such as installing the cable routes and landing location and performing activities on the beach that would require the use of vehicles on the beach, respectively.[c]	Oregon PRD, staff	*See* Item "Develop an HDD Plan"		
66. Conduct ground-disturbing construction activities and staging within previously disturbed areas, as practicable.[c]	OSU, staff	$500,000	$0	$50,900
Socioeconomic Resources – Included above under Recreation, Ocean Use and Land Use				

[a] Levelized annual costs is calculated based on the annualized cost of the capital expenditures for 30 years of analysis financed over 20 years.

[b] A recurring cost not associated with any capital costs.

[c] Capital cost or capital expenditure associated with project design and/or construction.

[d] A recurring cost requiring initial capital costs. For example, purchase of equipment to be used during the implementation for on-going monitoring plans.

[e] Industry standards are sometimes published in written documents (e.g., the International Cable Protection Committee's cable recommendations available at https://www.iscpc.org/publications/recommendations/) or in manufacturer guidelines (e.g., for a vessel anchor, providing the recommended ratio of water depth to anchor line paid out). These standards are sometimes required as a condition of insurance or warranty. In other cases, industry standards represent unpublished best practices commonly implemented by a particular industry and that evolve over time.

[f] Estimated 10% contingency for additional costs associated with adding constraints to dynamic positioning vessel scheduling. Limiting the operational window by avoiding the Phase B migration period means the Project may not be able to take advantage of DPVs that may be in the local area and could then face additional vessel mobilization and demobilization costs.

[g] Cost estimated by staff.

[h] Cost would only be incurred if Oregon state agencies refused to issue permits unless subsea cable installation avoids rocky substrate and achieves continuou burial.

General:

- Costs to implement environmental measure associated with Project construction are included in the approximately $55 million (2019$) construction cost estimate.
- Costs to implement environmental measure associated with Project operations and maintenance are included in the approximately $4 million (2019$) annual O&M cost estimate.
- Costs to implement environmental measure associated with Project environmental monitoring are included in the approximately $500,000 (2019$) annual monitoring cost estimate.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 COMPREHENSIVE DEVELOPMENT AND RECOMMENDED ALTERNATIVE

Sections 4(e) and 10(a)(1) of the FPA require the Commission to give equal consideration to the power development purposes and to the purposes of energy conservation, the protection, mitigation of damage to, and enhancement of fish and wildlife (including related spawning grounds and habitat), the protection of recreational opportunities, and the preservation of other aspects of environmental quality. Any license issued shall be such as in the Commission's judgment would be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses.

PacWave South would serve as an integrated test center to evaluate the performance of commercial scale or near-commercial scale WECs. As a secondary benefit, the project would provide electricity to the Oregon coast region. This project would be consistent with the mission, vision, and goals of the DOE Office of Energy Efficiency and Renewable Energy Water Power Technologies Office to improve performance, lower costs, and accelerate deployment of innovative technologies for clean, domestic power generation from resources such as hydropower, waves, and tidal power technologies.

From its contribution to a diversified generation mix and the potential for displacement of non-renewable fossil-fueled generation, the project would help meet a need for power in the region.

5.1.1 Measures Proposed by OSU

Based on our environmental analysis of OSU's proposal discussed in section 3, and the costs discussed in section 4, we recommend including the following environmental measures proposed by OSU in any license issued for the project. Our recommended modifications to OSU's proposed measures are shown in ***bold italics***.

General Measures

Project Operation

- Implement the Adaptive Management Framework filed as part of the application (Appendix J), which would guide the evaluation of monitoring results, identification of unanticipated adverse effects, and implementation of and/or modification of response actions to include mitigation or revised monitoring (Appendix I) in consultation with resource agency stakeholders.

- Prepare and file a Five-Year Report, that includes the following information on past and future project operations, beginning 5.5 years after deployment of the first WEC at the project, and recurring every 5 years thereafter:
    - a review of all WEC deployments and associated project activities from the prior 5 years including a description of the types and number of WEC devices deployed, frequency and duration of WEC deployments, monitoring activities and results, and any adaptive management criteria or response actions that were applied or modified.
    - a description of WEC deployment activities that are planned or that are reasonably foreseeable in the next 5 years including the types and number of WEC devices likely to be deployed, and the likely duration of such deployments.

- Develop decommissioning plan to remove project facilities and restore the site in the future as the license term nears its end and implemented when the project is decommissioned.

Geologic and Soil Resources

Project Construction

- Use HDD to install the subsea transmission cables under the nearshore and intertidal habitat (to approximately the 10-m isobath) to minimize substrate disturbance.

- Use HDD to install a maximum of three conduits that carry the onshore transmission lines from the beach manholes at Driftwood to the UCMF site, and from the UCMF to the Highway 101 grid connection point, to minimize terrestrial habitat disturbance.

- Develop an erosion and sediment control plan to minimize potential effects of project construction, operation, and maintenance activities on sediment and soils.

- Follow best management practices during installation, operation, and removal activities to avoid or minimize potential effects to sediment, including:
    - Minimize the time that the seafloor is disturbed, and sediment is dispersed and the associated effects by completing cable laying and other construction activities within one construction season to the extent practicable, during appropriate weather-related construction windows.

Project Operation

- Avoid grounding of project components on the bottom substrate during transport to protect nearshore and estuarine habitats.

- Minimize the frequency of anchor installation/removal cycles and reuse installed anchors.

Water Resources

Project Construction

- Develop a stormwater management plan for onshore construction activities with spill prevention, response actions, and control protocols, and provisions to maintain existing drainage patterns and prevent contamination of streams with hazardous materials runoff.

- Develop an HDD contingency plan to minimize the adverse effects of an inadvertent return of drilling fluids with provisions for timely detection to include monitoring, containment, response and notification procedures for protection of water quality.

Project Operation

- Follow industry best practices and guidelines for antifouling applications (e.g., free of the biocide TBT on project structures such as marker buoys, subsurface floats, and WECs.

- Minimize storage and staging of WECs outside of existing dock, port, or other marine industrial facilities to protect water quality from toxic materials.

- Implement the Emergency Response and Recovery Plan (APEA, Appendix G) with spill prevention, response actions, and control protocols for offshore activities, including provisions for recording types and amounts of hazardous fluids contained in WECs and other project components; require all vessel operators to comply with the plan during installation and maintenance of offshore project components.

Aquatic Resources and Threatened and Endangered Species

General

Project Construction

- Bury subsea cables at a depth of 1-2 meters, to the maximum extent practicable, to minimize the amount of habitat conversion (soft bottom to hard structure) from laying exposed cable on the seafloor. Protect portions of the cable on the seafloor in areas where it cannot be buried or persistently becomes unburied with split pipe, concrete mattresses, or other cable protection systems.

- Utilize shielding on subsea cables, umbilicals, and other electrical infrastructure, to the maximum extent practicable, to minimize EMF emissions.

- Require all project-chartered or -contracted vessels comply with current federal and state laws and regulations regarding aquatic invasive species prevention and control (measure to also be implemented during project operation).

- Notify agencies with regulatory authority as soon as possible in the event of an emergency in which fish or wildlife are being killed, harmed, or endangered by project facilities or operations in a manner that was not anticipated, and take action to promptly minimize the impacts of the emergency, based on guidance from those agencies they notify (measure to also be implemented during project operation).

Project Operation

- Implement the EMF Monitoring Plan (Appendix H) to measure project-related EMF emissions and implement measures based on monitoring results to mitigate unanticipated adverse effects on marine aquatic resources (APEA, Appendix I).

Fish and Invertebrates

Project Construction

- Avoid crossing areas with rocky reef and hard substrate when installing the subsea cable, to the maximum extent practicable, to protect sensitive habitat features.

- Develop a vessel anchoring plan that avoids anchoring in known rocky reef or hard substrate habitats, to the maximum extent practicable, and minimize the use of anchors within the project area wherever practicable by combining onsite activities to avoid or minimize adverse effects to hard substrate habitat (measure to also be implemented during project operation).

Project Operation

- Implement the Organism Interactions Monitoring Plan to detect behavioral changes to pelagic and demersal fish and invertebrates (particularly Dungeness crab) that might be attracted to or affected by the installed project components due to the potential for reduced fishing pressure, or biofouling on the anchors/WECs.

<u>Marine Mammals, Sea Turtles, and Seabirds</u>

Project Construction

- Require vessels in transit to/from the project site to avoid close contact with marine mammals and sea turtles and adhere to NMFS's "Be Whale Wise" guidelines to minimize potential vessel impacts to marine mammals (measure to also be implemented during project operation).

- Provide marine mammal observers for certain vessel-based activity (e.g., sub-bottom profiling) (measure to also be implemented during project operation).

- Minimize construction activities during key Phase B gray whale migration periods (April 1-June 15) (measure to also be implemented during project operation).

- When using Dynamic Positioning Vessels (DPV) to install project facilities or other equipment that may exceed NMFS's published threshold for injury to marine mammals (measure to also be implemented during project operation):
    - Avoid use of these vessels to the maximum extent practicable during Phase B of the gray whale migration (April 1-June 15). If construction activities are proposed during this migration period, consult with Oregon DFW regarding the timing of such activities including cable-laying in state waters.
    - With technical assistance from NMFS, establish and carry out the following actions and protocols necessary to maintain an appropriate acoustic zone of influence in accordance with NMFS's published harassment threshold (120 decibels (dB)) during DPV operations to minimize behavioral disturbance and protect marine resources:
        - Post qualified marine mammal observers on vessels during daylight hours.
        - Conduct dynamic positioning (DP) activities during daylight hours when feasible to ensure observations may be carried out.
        - Implement DP start up for cable laying during daylight hours.
        - Ramp-up DP thrusters upon initial operation and, except during cable laying, reduce power to the extent practicable if a mammal approaches

the acoustic zone of influence and increase power once the zone is clear of marine mammals, as may be modified by agreement of the licensee and NMFS.

Project Operation

- To minimize potential stranding, entanglements, impingements, injuries, or mortalities of marine mammals and birds associated with entangled fishing gear:
    - Once per quarter each year for the term of the license, conduct opportunistic (i.e., non-systematically collected) visual observations, including review of any underwater visual monitoring, at the project site to detect any entangled fishing gear that has the potential to increase the risk of marine species entanglement.
    - Conduct annual surface surveys of active WEC berths for entangled fishing gear and debris during the spring season (mid-March through mid-June) following the peak storm season and period of maximum activity for the Dungeness crab fishery.
    - Conduct annual subsurface surveys of moorings and anchor systems using ROV or other appropriate techniques with approval by NMFS concurrent with spring (mid-March through mid-June) monitoring under the Organism Interactions Monitoring Plan (APEA Appendix H).
    - If entangled fishing gear or marine mammal (or sea turtle) stranding, entanglements, impingements, injuries or mortalities are detected, notify FWS, NMFS, and Oregon DFW and remove fishing gear as appropriate and make every effort to return the fishing gear to the owners (APEA Appendix I).

- Ensure that WECs are maintained in good working order to minimize sounds that might injure marine mammals or alter their behavior due to faulty or poorly maintained equipment.

- Make opportunistic visual observations of pinnipeds when conducting operations, maintenance, or environmental monitoring work at the WEC test site. If pinnipeds are observed to be hauled out on project structures, follow the reporting and haulout protocols specified in APEA, Appendix I.

- Ensure that WEC cables and moorings are designed and maintained in configurations that minimize the potential for marine mammal or sea turtle entrapment or entanglement, to the extent practicable, and follow the reporting and haulout protocols specified in APEA, Appendix I.

- Implement the BBCS Plan (APEA Appendix B) that includes the following measures to minimize impacts to birds:
    - Once per quarter for the term of the license, conduct opportunistic visual observations at the WEC test site to determine if seabird perching and nesting results in equipment fouling or interference with project operations and, if necessary, develop a plan in consultation with FWS to discourage perching and nesting with minimal impacts to seabirds.
    - Use low-intensity flashing lights and bird-friendly wavelengths on the project structures to minimize seabird attraction based on specifications for project lighting developed in consultation with the FWS and USCG.
    - Minimize lighting used at night by service and support vessels at the WEC test site and at the UCMF (e.g., use low intensity, bird-friendly wavelengths, shielded lighting not providing upward-pointing light or light directed at the sea surface) to reduce the potential for seabird attraction.
    - Require vessel operators to follow FWS instructions regarding appropriate handling and release of seabirds in the event of seabird fallout.
    - Require vessel operators to remain 500 feet away from seabird colonies during the nesting season to minimize disturbance to nesting seabirds.

Terrestrial Resources and Threatened and Endangered Species

Project Construction

- Minimize or avoid terrestrial activities in sensitive ecological areas (e.g., jurisdictional wetlands and nesting areas for listed avian species) during project construction.

- Minimize ground disturbance and maintain protective buffers around wetlands to avoid adverse environmental effects.

- Develop a revegetation plan for using native species to the extent practicable, to revegetate areas disturbed during construction to minimize impacts to local plant communities and wildlife populations. ***The proposed revegetation plan should include details of specific measures to ensure long-term success of revegetation efforts and control the spread of invasive plant species.***

- Avoid disturbance of snags and wildlife or legacy trees, including live or dead trees that provide benefit to wildlife, to the extent practicable. If unavoidable, conduct additional species specific surveys prior to construction activities to minimize effects.

- Avoid disturbance of forested wetlands to the extent practicable.

- Avoid to the extent practicable, disturbance of riparian wetlands where restoration of natural hydrology may be unsuccessful within a short timeframe. Restore natural hydrology after construction is complete, and develop and implement restoration plan with monitoring, as necessary, until successful restoration can be determined.

- Minimize disturbance of streams that support fish or are connected to fish-bearing streams. Unavoidable work within or adjacent to fish-bearing streams may be subject to in-water work windows based on consultation with Oregon DFW, FWS, and NMFS. If terrestrial activities directly or indirectly affect any stream used by anadromous fish or fish listed as threatened or endangered under the ESA, consult with NMFS staff to avoid and minimize any potential effects to listed species.

- Avoid to the extent practicable, disturbance of seaside hoary elfin butterfly habitat within and in the vicinity of Driftwood. Where unavoidable, conduct species-specific surveys on properties outside of Driftwood but within the construction footprint to determine the extent of occupied habitat and associated mitigation. ***The proposed revegetation plan should outline the survey requirements and methods, and determination of the specific mitigation methods to be implemented to ensure that habitat for the elfin butterfly is maintained in the long term.***

- Develop measures that would limit the introduction or spread of invasive species, to be included in the proposed revegetation and restoration plan.

- Implement the BBCS Plan (APEA Appendix B) that includes the following measures to minimize effects to bats and landbirds, including the federally listed western snowy plover:
    - ***Include any measures for marbled murrelet and western snowy plover modified in the revised BA filed by OSU on August 27, 2019.***
    - ***Consult with Oregon PRD, FWS, and Oregon DFW to define suitable nesting habitat for the western snowy plover in the project area when finalizing the development of the BBCS Plan (or other relevant plans) to ensure nesting habitat is properly identified for implementing any relevant measures to minimize effects to nesting plovers and their habitat.***
    - HDD construction equipment or construction activities would not occur on Driftwood beach within suitable snowy plover nesting, roosting, or foraging habitat, and would be limited to the Driftwood parking lot, at least 164 feet (50 meters) from any potentially suitable habitat.
    - HDD operations in the parking lot would occur during daylight hours, but if lighting is required at night, it would be appropriately shielded and directed

to minimize artificial light reaching western snowy plover nesting habitat. Animal-proof litter receptacles and related signage and coordination would be provided to minimize potential attraction of nest predators.

- If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), conduct surveys of suitable nesting habitat prior to operation of the HDD. If nests are detected, implement measures specified in the BBCS Plan, including noise monitoring and implementation of engineering controls, if appropriate (e.g., install temporary noise barriers such as berms, stockpiles, dumpsters, bins, and/or engineered acoustical barriers). ***Consult with Oregon PRD on the placement of any necessary structures (e.g., sound barriers) and signage to protect western snowy plover.***
- Conduct surveys for nesting birds prior to any vegetation clearing that occurs within the nesting season and implement the following measures for active nests found during the surveys:
  - Remove nest-starts for any birds other than raptors or listed species when observed if found within the project footprint and within 100 feet of a construction zone, and where feasible.
  - If an active nest is found, determine the extent of a construction-free buffer zone to be established around the nest (typically 300 feet for raptors and 100 feet for other species), to ensure that no nests of species protected by the MBTA would be disturbed during project construction.
  - If necessary, the no-disturbance nesting buffers may be adjusted to reflect existing conditions including ambient noise, topography, and disturbance with approval of Oregon DFW.
  - If nesting bald or golden eagles are identified, restrict activities near nest sites according to guidelines outlined in the National Bald Eagle Management Guidelines (FWS 2007b).
- If construction activities would not be initiated until after the start of the nesting season, remove all potential nesting substrates (e.g., bushes, trees, snags, grasses, and other vegetation) in late winter, prior to the start of the nesting season.
- Conduct preconstruction surveys for roosting bats to identify sites to minimize construction impacts from high frequency sound disturbance, night lighting, and air quality degradation near roosts by implementing bat roost buffers, or excluding bats within bat roost buffers, or developing species and equipment specific buffers, use noise controls, and monitor bat roost activity before, during and after construction.
- ***Include results from bat maternity roost surveys conducted in July 2019 (filed February 19, 2020).***

Recreation, Ocean Use, and Land Use

Ocean Use and Recreation

- Mark project structures with appropriate navigation aids, as required by the USCG.

- Conduct outreach to inform mariners of project structures or activities to be avoided in the area (e.g., Notice to Mariners, flyers posted at marinas and docks).

- Install subsurface floats at sufficient depth to avoid potential vessel strike.

- Work cooperatively with commercial, charter and recreational fishing entities and interests to avoid and minimize potential space-use conflicts with commercial and recreational interests during construction and operation.

Terrestrial Use and Recreation

- If acceptable to Oregon PRD, develop a plan to install an interpretive display describing PacWave South in the Driftwood (also an operation measure).

- Use construction fencing to isolate work areas from park lands to provide safe access for visitors to the beach and to recreational facilities unaffected by construction activities within Driftwood.

- Maintain pedestrian public beach access at Driftwood during construction activities, if practicable, and coordinate with the Oregon PRD to mitigate impacts to public access and use of the site.

- Conduct land-disturbing and staging activities during construction in previously disturbed areas, as practicable.

Socioeconomic Resources

- See Recreation, Ocean Use, and Land Use measures.

Cultural Resources

- Should historic properties be identified in the future, modify the project to exclude the historic property from the project's APE (i.e., avoid any potential project effects to the historic property) or would develop a historic property management plan

(HPMP) to consider and manage historic properties throughout the life of the license.

5.1.2 Additional Measures Recommended by Staff

In addition to OSU's proposed measures listed above, we recommend including the following staff-recommended measure in any license issued for the PacWave South Project.

- Develop an HDD plan that is based on criteria outlined in the Commission's HDD Plan Guidance (FERC 2019. *Guidance for Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plans*) and on Commission criteria for HDD crossings beneath wetlands (FERC 2013. *Wetland and Waterbody Construction and Mitigation Procedures*) to reduce risks of construction complications and inadvertent return, and to minimize adverse environmental effects of HDD for protection of natural resources.

- Notify Oregon DOT at least 3 months in advance of construction-related closures of the Driftwood site that would be 90-days in duration, or longer, and coordinate with Oregon DOT to ensure adequate signage is posted to inform motorists in advance of any closure.

Below, we discuss our rationale for our additional staff recommended measure and modifications to the proposed measures.

HDD Plan

Potential adverse effects on environmental resources could result from releases of drilling mud and fluids forced to the surface by inadvertent return (frac-out) during HDD operations for installing the terrestrial transmission lines.

OSU proposes to develop a plan with contingency measures to minimize the effects of an inadvertent return of drilling fluids by providing timely detection, and addressing potential releases with monitoring, containment, response and notification procedures to be implemented by the HDD contractor.

Oregon DFW recommends (10(j) recommendation 8) that the HDD installation of the conduits that carry the terrestrial transmission lines be designed to reduce the risk of inadvertent return of drilling fluid by developing an HDD plan that includes: (1) a description of how OSU would minimize risks of inadvertent return in the marine environment; (2) a description of the HDD locations (both marine and terrestrial), maps, coordinates and spatial dimensions; (3) protocols for locating the depth of the water table and an assessment of the risks of avoiding or drilling through the water table; (4) a description of the HDD laydown area location at Driftwood, the manhole spacing (e.g. 20 feet apart), and the protocols for drill site preparation and set up; (5) a description of the HDD target minimum depth beneath dunes, beach, wetland and stream habitat, diameter of the HDD hole, and approximate dimensions (distance, width, depth) of the HDD subsea cable and transmission line corridors; (6) a description of the geotechnical analysis conducted by OSU to ensure successful HDD and reduce the risk of inadvertent return to the maximum extent (e.g. identify vulnerabilities or hazards and how they will be avoided) (7) the HDD methods (e.g. drill and leave); (8) the HDD scope (e.g. five separate marine HDD bores, one large terrestrial HDD bore) to include installation of the terrestrial transmission lines in a single HDD bore hole to increase the likelihood of maintaining bore hole stability and reduce the potential for an inadvertent return; (8) the schedule and timing of HDD installation (e.g. one month per marine borehole, 6-8 months in total); (10) the construction best operating procedures designed to minimize the potential for inadvertent return of drilling fluids; (11) a description of anticipated support services such as marine vessels or divers; (12) a description of inspection procedures to facilitate timely detection of inadvertent return or leaks, if any; (13) protocols for monitoring (e.g. drill mud pressure and volume), containment, response recovery and clean-up of inadvertent return, and notification procedures, including notification of Oregon DFW; (14) protocols for storing emergency response equipment on-site during HDD operations; (15) descriptions of alternate or contingency crossing methods should the primary method fail as a successful cable and transmission line installation location; (16) a map of alternative vehicle beach access points and description of consultation procedures with Oregon PRD to inform the public; (17) a map of environmentally sensitive sites (e.g. western snowy plover potential habitat, seaside hoary elfin potential habitat, streams, wetlands, dune habitat); (18) approved locations for spoil piles on previously disturbed, paved, areas selected to avoid impacts on habitat; (19) a list of additives used in drilling fluid and procedures and approved disposal sites for spoils and drilling mud; and (20) a description of demobilization procedures for HDD machinery and equipment.

FWS notes that although OSU proposes to develop HDD contingency measures to minimize the impacts of an inadvertent return (frac-out), such measures would only address actions that OSU would take once a frac-out occurs, which are likely to prove insufficient to address damage to sensitive wetlands. FWS believes that an HDD plan with measures to avoid or limit the potential for a frac-out should be taken. Consistent with OSU's proposal, FWS recommends (10(j) recommendation 4) that the number of HDD bores from Driftwood to the UCMF beneath the wetland habitat be limited to three or fewer.

Using HDD to install buried subsea transmission cables and terrestrial transmission lines is less intrusive than traditional open-cut trenching and minimizes land and wetland disturbance. However, because HDD uses non-toxic slurry and drilling fluids under pressure, the fluid may be forced to the surface (an inadvertent return) resulting in adverse environmental effects, if appropriate planning and precautions are not taken.

Although OSU does not propose to develop a detailed HDD plan, it has conducted geophysical and geotechnical surveys, and prepared maps and a general description of the HDD routes and installation methods. As a precaution, OSU proposes to develop and develop a plan with HDD contingency measures that would minimize the effects of an inadvertent return of drilling fluid, provide timely detection, and address potential returns by describing monitoring, containment, response and notification procedures to be implemented by the HDD contractor. OSU notes that subsequent consultations with an expert HDD contractor would be necessary before final HDD technical engineering details and specifications can be developed.

Development of an HDD plan, in consultation with a qualified HDD contractor, that includes measures recommended by Oregon DFW, and is based upon criteria outlined in the Commission's HDD Plan Guidance[56] and Commission criteria for HDD crossings beneath wetlands[57] would reduce risks of construction complications, inadvertent return, and minimize potential adverse environmental effects of HDD to the terrestrial and the marine environment. Including OSU's proposed contingency measures in the plan, such as describing materials, equipment, and methods used to contain and clean-up an inadvertent return of fluids, would minimize the adverse effects on offshore and onshore natural resources. We believe the estimated cost of $50,000 for the plan is worth the benefits to reduce the potential for an inadvertent return during HDD drilling to minimize effects on natural resources in the project area.

OSU's proposal to use from one to three bore holes for HDD installation of the conduit that would carry the terrestrial transmission lines is consistent with the FWS recommendation for the number of HDD bore holes. OSU states that Oregon DFW's recommendation for one bore hole is not based upon expert engineering analysis. OSU points out that such a recommendation would impose an inappropriate engineering restriction on the project that may prevent it from being constructed, if OSU is unable upon

---

[56] The Commission's guidance (FERC 2019. *Guidance for Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plans*) includes specific criteria for contingency planning.

[57] The Commission's guidance (FERC 2013. *Wetland and Waterbody Construction and Mitigation Procedures*) at section V.B.6.d requires a site-specific plan prior to beginning construction for all HDD crossings of wetlands and waterbodies.

consultation with its selected HDD contractor, to have 5 or 15 lines[58] carried in a single conduit from Driftwood to the UCMF site.

Given the geophysical and geotechnical survey information that is available for the project site, the risks of an inadvertent return are extremely low onshore because the HDD borings are expected to reach depths of over 200 feet and would be located in moderate to higher strength rock to maintain bore hole stability when passing under the Buckley Creek wetland system and Highway 101. Implementing the provisions of the staff recommended HDD plan discussed above would reduce the likelihood of an inadvertent return for installing the transmission lines in up to 3 HDD bore holes as proposed by OSU. In addition, the current state of HDD with gas and oil pipeline installation,[59] suggests that inadvertent return of drilling fluids has been associated with some larger diameter borings, which require more reaming to enlarge the bore hole after the pilot boring hole is completed, than does smaller diameter borings. For these reasons, we find that Oregon DFW's recommendation to limit the installation of the terrestrial transmission lines in a single HDD bore hole, is not technically necessary to reduce the likelihood of an inadvertent return, and therefore, we do not recommend it.

Coordination with Oregon DOT

Oregon PRD recommends that OSU notify Oregon DOT at least 3 months in advance of any construction-related closures of the Driftwood site that would be 90-days in duration or longer. Additionally, Oregon PRD recommends that OSU coordinate with Oregon DOT to ensure adequate signage is posted to inform motorists in advance of any temporary closure, since the Driftwood site is a State Highway Rest Area. OSU proposes to coordinate with Oregon DOT during construction of the project. Continuing coordination between OSU and Oregon DOT would help to inform Oregon DOT of project scheduling and activities that would impact the public's ability to use Driftwood. Therefore, we recommend these coordination measures and conclude that the benefits of them would outweigh the estimated levelized annual cost of $2,500 and conclude the benefits of this measure outweigh the cost.

---

[58] If three-conductor terrestrial lines are used, then one terrestrial line would be needed for each subsea cable, plus an auxiliary (i.e., five terrestrial lines total). If single-conductor terrestrial lines are used, three terrestrial lines would be needed for each subsea cable (i.e., 15 terrestrial lines total).

[59] Rover Pipeline Docket Number: CP15-93-000: J.D. Hair & Associates, Inc. 2017. Third-Party Review of Design and Construction Activities Rover Pipeline Project: 42-inch Tuscarawas River Crossing by Horizontal Directional Drilling.

Acoustic Monitoring Plan

OSU has developed an Acoustic Monitoring Plan to: (1) characterize the level and signature of sound from various project components; and (2) allow for comparison to established sound thresholds to minimize the potential exceedance of thresholds and determine the extent of any such exceedance.

Sound measurement systems that produce high-amplitude flow-noise and/or self-noise can mask the propagating sound produced by WEC. Reducing this noise is needed to avoid contaminated samples that could interfere with successful monitoring. To address this issue, OSU's proposed plan includes a modified system (fixed seafloor lander system with near real-time capability for acoustic monitoring) that would allow for rapid detection of any self-noise problems. Further, as part of the plan, OSU proposes the following methods to help to minimize acoustic self-noise: (1) securing and/or eliminating any loose mechanical connections; (2) potting flexible mechanical joints (e.g., shackles) in a thick urethane compound to minimize sound produced by joint motion; and (3) for drifting systems with a surface expression, reducing the surface area for wave impacts and pathways for water to drain off the surface expression in a way that produces a "splashing" noise on contact with the water surface. The plan also includes a list of conditions under which future samples would be excluded from further analysis, including obvious vessel noise, whale vocalizations, or self-noise generated by the monitoring equipment.

Oregon DFW is concerned these exclusions may lead to dismissal of a number of future samples significant enough to result in not satisfying the monitoring plan objectives. Oregon DFW recommends that the plan be implemented (10(j) recommendation 1) as modified by 10(j) recommendation 3, which would require the licensee to collect sufficient acoustic data adequate to fulfil the stated objectives of the monitoring plan. Oregon DFW notes that data analysis should be based on sufficient future sampling robust enough to support analysis and completion of monitoring objectives. OSU comments that similar monitoring programs have produced high quality data acoustic data.

We agree with Oregon DFW's concern that there be sufficient uncontaminated sound measurements to adequately characterize sound levels and compare to threshold levels. OSU's proposed plan minimizes, to the extent practicable, potential self-noise issues but monitoring can be challenging. The monitoring activities under this plan would be reported annually in OSU's annual report, which would be filed with the Commission and provided to the AMC. This would provide an opportunity to ensure that measurements are sufficient to meet the plan's objectives and need for any modifications to the plan. We believe that the minimal additional costs would be worth the benefits. Therefore, we recommend that the plan be modified to require that the annual report evaluates whether the data is sufficient to meet objectives of the plan and include recommendations to modify the plan during the next sampling period, as appropriate.

Revegetation Plan

As discussed in section 3.3.4.2, *Effects on Upland Habitat*, the project would result in short- and long-term impacts to upland vegetation and associated native wildlife and plant species. OSU proposes to develop a revegetation plan to address long-term impacts and address the spread of invasive plant species in its construction plan. Oregon DFW recommends (10(j) recommendations 4A and 7) that the proposed revegetation plan be developed after consultation with Oregon DFW and include:

A. Methods and a schedule for implementation, monitoring, and reporting. Completion timeframes, success criteria, and secondary mitigation measures including reseeding, soil amendment, supplemental irrigation or other water management to ensure establishment of native vegetation.
B. Methods to address soil compaction and erosion control, and to restore natural drainage patterns.
C. Short-term soil stabilization measures, if necessary.
D. Noxious weed control measures and monitoring of noxious weed control and revegetation efforts for three years post construction, two times per year (spring and fall) and every third year thereafter to determine success.
E. Mitigation areas, if necessary, with mitigation goals to be met by revegetation.
F. Plans to seed and plant with native vegetation in consultation with Oregon DFW to maximize benefits to fish and wildlife.
G. Compliance with OSU's proposed PM&E measures described in the HMP, pursuant to the Oregon's Fish and Wildlife Habitat Mitigation Policy.

Although OSU has not provided any detailed provisions for its proposed revegetation plan, it has agreed to include the aforementioned provisions recommended by Oregon DFW.

The measures recommended by Oregon DFW would ensure that the revegetation plan provides for long-term success of revegetated areas, maintains native vegetation species, and prevents the spread of invasive species. The cost of developing a revegetation plan that includes Oregon DFW's recommend provisions would be $50,000. We find that the benefits of the plan would be worth this cost; therefore, we recommend the development of the revegetation that includes Oregon DFW's provisions.

Project construction activities could result in the loss or disturbance of kinnikinnick, a larval host plant for the seaside hoary elfin butterfly (see section 3.3.4.2, *Effects to*

Seaside Hoary Elfin Butterfly Habitat). To determine the need for mitigation measures, Oregon DFW recommends that OSU contract a specialist to assess and possibly survey, in the appropriate season, kinnikinnick patches delineated within the project area, but outside of Driftwood, to determine if habitat is suitable for, or occupied by, the seaside hoary elfin butterfly (10(j) recommendation 4B).

As part of the proposed revegetation plan, OSU would conduct species-specific surveys, if needed, within the construction footprint to determine the extent of occupied habitat and mitigate for any loss to kinnikinnick. Mitigation could include transplanting or relocating kinnikinnick plants prior to construction, replanting after construction, or enhancing habitat growth by removing encroaching forest habitat.

Transplanting or relocating kinnikinnick prior to construction or replanting kinnikinnick after construction would protect the elfin butterfly, a rare coastal butterfly subspecies that uses kinnikinnick as habitat. The levelized annual cost of adding this provision to the revegetation plan would be minimal. We find that the benefits to the butterfly justify this cost. As such, we recommend that the revegetation plan include provisions outlining the survey requirements, methods, and potential mitigation measures to be implemented based on the survey results to ensure that kinnikinnick for the elfin butterfly at the project are protected during the term of any license issued for the project.

5.1.3 Measures Not Recommended by Staff

Complete Burial of Subsea Transmission Cables

Oregon DFW (10(j) recommendation 9) recommends that OSU avoid rocky substrate, achieve continuous burial, and provide refined information on the cable route during installation of the four buried subsea transmission cables and one auxiliary cable. Oregon DFW explains that the Territorial Sea Plan Part 4 requires continuous burial of subsea cables unless the approving state agencies make findings that burial cannot be practically achieved and all affected parties agree that adverse effects of not burying the cable have been reduced, avoided, or mitigated to the extent practicable. Oregon DFW states that the use of split pipe, concrete mattresses, or other mechanisms to protect unburied cable, as proposed by OSU, could increase scour effects on seafloor habitat and introduce ecological and fishing hazards.

Although OSU proposes a subsea cable route that, to the extent practicable, avoids rocky substrate and would allow OSU to bury cables, it does not eliminate the possibility that segments of the cables will not be able to be buried. OSU has collected refined subsurface geological information in its selection of a proposed cable corridor. OSU initially investigated three potential subsea cable routes in the nearshore environment to determine the best route to shore from the WEC test site, to avoid rocky substrates and maximize burial depth. Results of geophysical surveys conducted in 2014 by OSU (Goldfinger et al. 2014) determined that the southern-most route to an onshore landing at Driftwood held the best potential for avoiding rocky substrate. OSU notes that this route is significantly longer than the most direct path and, as a result, would increase construction costs substantially, while attempting to avoid rocky substrate.

Upon conducting additional detailed geophysical and geotechnical surveys in 2018 (TerraSond 2019), OSU determined that some rocky substrate is likely present within the nearshore portion of the proposed subsea cable corridor to Driftwood. However, OSU believes that based on the 2018 survey results, the majority of the subsea cable segment would, to the extent practicable, be buried to a target depth of 1 to 2 meters from the WEC test site back to the HDD conduits. In short sections where burial is not feasible, OSU proposes to lay the subsea cables on the seafloor and protect them with split pipe, concrete mattresses, or other cable protection systems, consistent with industry best practice. The placement of cable protection systems would bury benthic organisms and permanently alter soft bottom habitat to hard bottom habitat in some areas. In other areas, the systems could be placed on bottom habitat already classified as hard bottom substrate. Cable segments covered by concrete mattresses or other cable protection systems would likely be colonized as hard substrate by benthic organisms. However, the type of organisms recolonizing over the cable protection system may differ from the original benthic community if portions of the original substrate were soft sediment. Based upon OSU's consultations with fishermen who have been involved with cable installations in Oregon waters, including members of FINE, any unburied but armored cable segments would not be expected to interfere with local fishing practices in the nearshore environment.[60] OSU has done everything technically and financially feasible to avoid rocky substrate in determining the appropriate subsea cable corridor; however, that effort does not completely eliminate the potential that OSU would not be able to practically achieve complete burial of the entire extent of the subsea cable.

For these reasons, we find that Oregon DFW's recommendation for complete burial of the transmission cable is not technically feasible, and therefore, lacks the substantial evidence needed to justify the measure. Therefore, we do not recommend it. For the aforementioned reasons, we also find that OSU's proposal to avoid rocky substrates when the laying the cable, burying as much of the cable as possible, and protecting unburied

[60] FINE is a group of commercial fishermen appointed by Oregon coastal county commissioners to focus on the potential impact of ocean energy development on commercial fisheries. FINE's members represent the salmon, albacore tuna, Dungeness crab, pink shrimp, groundfish, long line and distant water fisheries, charter and sports fishing, and seafood processors.

portions of the cable with split pipe, concrete mattresses, or other cable protection systems, consistent with industry best practice, could cause minor adverse effects on the benthic community and no effects on local fishing practices. Because the project requires a transmission cable and because OSU's proposed transmission cable route and protective measures would be the most feasible way to site the cable while at the same time protecting environmental resources, we find that the minor cost of OSU's proposal to the benthic community would be justified by the electrical energy and educational benefits provided by the project.

Modification to Estuary Protection Measures

OSU proposes to minimize storage and staging of WECs outside of existing docks, ports, or other marine industrial facilities. To minimize impacts on estuary habitat, Oregon DFW 10(j) recommendation 5 calls for: (1) fabrication of project components at existing permitted land-based facilities, allowing all coatings and paints to fully cure prior to deployment into the estuary; and (2) restrict use of the estuary to commercial docks with dredged channels that are designed and permitted for dock use. FWS 10(j) recommendation 2 calls for a measure identical to measure 1 of Oregon DFW's recommendation above and a second measure to restrict all project use of the estuary to commercial navigation channels, and existing permitted docks and dredged areas (this would include storage and staging of WECS). In its reply comments to FWS and Oregon DFW's recommendations, OSU states that it does not have the ability to impose fabrication location requirements before WEC test clients are under contract with OSU. OSU objects to FWS's recommendation to restrict the locations of project use generally (not just storage of WECs), which would thwart operation and maintenance activities.

Under OSU's proposal, WEC developers would fabricate project components (i.e., WECS, subsea cables, anchor and mooring systems, navigational buoys, and monitoring equipment) at land-based facilities and transport them to staging areas, mainly at the Port of Newport but may include the Port of Toledo. Once at the staging area, one or more WECs at a time would be moored dockside in Newport or Toledo prior to transport to the WEC test site. Mooring buoys and any subsurface floats would be treated with antifouling applications (i.e., paints and coatings) by WEC developers to prevent marine life from colonizing these components. Antifouling applications are commonly used in marinas, offshore structures, and ships.

Antifouling paints could leach from the project site, or from the WECs in port when the WECs are moored dockside, as well as during transport from port to the WEC test site. The Port of Newport moors many vessels that are coated in antifouling paint and are docked for many months or that transit waters off the coast of Oregon. WEC developers would likely use the Port of Newport dockage or other commercial facilities within Yaquina Bay that have been designed, permitted, and are used for dockage.

OSU proposes to minimize storage and staging of WECs outside of existing docks, ports or other marine industrial facilities within Yaquina Bay, which would be similar to activities that already occur in the bay at existing marine industrial infrastructure and facilities. Using existing facilities for these purposes and ensuring that project facilities such as WECs do not ground and disturb the bottom or nearshore substrate during transport in or out of the bay, as proposed by OSU, would prevent nearshore and estuarine adverse environmental effects.

Fabrication of WECs and other project components by WEC developers, including coatings and painting, at properly equipped and properly located facilities would minimize potential effects on the estuary water quality and habitat. OSU's proposal for it and WEC developers to use commercial and noncommercial dockage that have been designed and permitted for industrial use, with existing dredged channels, to store and stage project components including WECs, would minimize effects on water quality and on turbidity or direct shading to sensitive eelgrass habitat within or adjacent to the permitted dock facility.

The potential impacts on the estuary in Yaquina Bay described above are too attenuated from the Commission's authority over construction and operation of the PacWave South Project to require the recommended measures. Further, existing state or federal requirements regulating industrial fabrication, storage, and transport within the Ports of Newport and Toledo should ensure those activities are done properly to minimize effects on the aquatic environment of the estuary to require the recommended resource agency measures. Therefore, we do not recommend Oregon DFW's and FWS's recommended modifications to OSU's proposed estuary protection measures.

Gray Whale Phase B Migration Period

Oregon DFW recommends that installation of the four buried subsea transmission cables and one auxiliary cable avoid the Phase B migration period (April 1 through June 15) of the gray whale, a state-listed endangered species in the state of Oregon. Oregon DFW is also concerned that use of DPVs could be used more extensively than OSU indicates. Oregon DFW believes that use of DPVs may occur throughout the life of the project whenever WECs are connected to subsea cables and not just for the initial installation of the five cables.

The Phase B migration period is when mother-calf pairs are migrating northward. Although this migration primarily occurs within 3 nautical miles of the shoreline, some gray whales would be expected to migrate close to the location of the project (see figure 3-7), which is greater than 6 nautical miles offshore.

The subsea cables would be buried by jet plow from DPVs that can produce noise up to 180 dB and would take about 30 days to install the five cables and another 10 days to inspect the installation. Although these noise levels would dissipate with distance (would be reduced to 150 dB at 328 feet), levels could exceed NMFS's 120-dB level B harassment threshold (behavioral disruption) for marine mammals for up to 2 miles (BOEM 2015).

Although OSU proposes to avoid the Phase B migration period to the maximum extent practicable, it does not eliminate the possibility that use of DPVs could occur during that period. The flexibility in timing of use of DPVs as proposed by OSU is a recognition that the timing of cable construction timing would be affected by a variety of factors, including seasonal marine conditions, the availability of DPV vessels, and the fact that cable laying cannot be paused once it has begun. OSU estimates that the costs of restricting construction outside the Phase B migration period is $1,500,000.[61] If the Phase B migration period could not be avoided due to some of these factors, OSU proposes to consult with Oregon DFW regarding the timing of such activities. OSU also notes that use of DPVs during connection or disconnection of WECs from transmission cable would be cost-prohibitive and uncommon.

If use of DPVs were to occur during Phase B migration, the resultant noise levels could potentially disrupt mother-calf migration. However, we conclude that the potential effects are limited given OSU's proposal to avoid use of DPVs to the extent practicable during the Phase B migration period, the ability of gray whales to avoid the source of the noise, the short time period whales would be exposed, and the location of the construction site more than 3 nautical miles from the gray whale migration corridor. Any gray whale response to the noise would be expected to be short-term and minor, with minimal effects on their behavior. Further, NMFS concluded that the likelihood of marine mammal take resulting from the project would be so low as to be discountable (letter dated May 30, 2019 included as APEA, Appendix N filed on May 31, 2019). Due to this, OSU's proposal to allow for some flexibility in scheduling cable installation in the unlikely event that use of DPV during Phase B migration cannot be avoided is reasonable. Therefore, because the benefits of Oregon DFW's recommendation do not justify the costs, we do not recommend that the Phase B migration be completely avoided.

[61] OSU estimated a 10 percent contingency for additional costs associated with adding constraints to dynamic positioning vessel scheduling. Limiting the operational window by avoiding the Phase B migration period means the prroject may not be able to take advantage of DPVs that may be in the local area and could then face additional vessel mobilization and demobilization costs.

Modification to Western Snowy Plover Protective Buffer

The western edge of Driftwood parking lot is less than 164 feet (50 meters) from potential suitable habitat for the federally threatened western snowy plover. As part of the proposed BBCS Plan, OSU states that no project equipment or activities, including HDD equipment, would occur on Driftwood beach and that HDD construction equipment or construction activities are expected to be limited to the Driftwood parking lot, at least 164 feet away from any potential suitable habitat for the plover. Although no HDD heavy equipment and construction activities related to proposed HDD installation of the subsea cables and transmission lines would occur within the 164-foot buffer, OSU states that some proposed project equipment and activities would occur this section of the parking lot.

Oregon PRD comments that the 164-foot buffer, consistent with the *Western Snowy Plover Habitat Conservation Plan,* was designed for protection from recreation-related disturbances on the ocean shore (e.g., pedestrians), not potential disturbances associated with heavy-duty equipment. Therefore, because all project-related activities are non-recreational in nature, Oregon PRD recommends they should occur at least 164 feet from potential plover habitat and be approved through consultation with FWS and Oregon PRD.

Oregon DFW recommends (10(j) recommendation 2A) that all activities in the Driftwood parking lot occur at least 164 feet from potential suitable habitat for the plover. However, Oregon DFW does not recommend that all project activities be approved in consultation with Oregon PRD, as Oregon PRD recommends.

In reply comments, OSU agrees to Oregon DFW's recommendation but does not agree to modify the BBCS Plan as recommended by Oregon PRD. OSU states Oregon PRD's recommendation would add to previously agreed upon measures by restricting all proposed project activities, regardless of the activities' noise levels, within 164 feet of potential plover habitat. OSU states that this would prevent a number of project activities from occurring at the western end of the parking lot (e.g., parking, repaving the parking lot after construction, and installing interpretative signs), which OSU would undertake to benefit to the park system as part of the needed easement from Oregon PRD. OSU confirms that proposed HDD construction activities involving heavy equipment are not expected to be closer than 164 feet to suitable plover habitat or potential plover nests.

On October 16, 2019, FWS filed a letter with the Commission concurring with staff's determination that licensing the proposed project is not likely to adversely affect the western snowy plover. FWS's concurrence is based on its review of OSU's project proposal outlined in the license application and the BA. In its letter, FWS notes that, according to OSU's BBCS Plan, all activities and equipment associated with onshore cable landing and HDD will be at least 164 feet from western snowy plover habitat. FWS concurs that sound emitted from the HDD rig is not likely to adversely affect plovers on the beach because the HDD rig will be operated in the eastern half of Driftwood parking lot away from any potential nesting or foraging habitat for snowy plovers. In addition, FWS concludes that after considering OSU's proposal, they anticipate that the proposed project activities in Driftwood would only result insignificant or discountable effects to western snowy plovers as a result of onshore cable installation or due to sound from HDD. However, FWS does not indicate that project activities not involving HDD heavy-duty construction equipment (e.g., sign installation, parking) should also not occur within the proposed 164-foot buffer, as Oregon PRD recommends. Additionally, in its letter providing section 10(j) recommendations, FWS recommends implementation of the BBCS Plan (10(j) recommendation 1) but does not recommend any modifications to the plan related to western snowy plover, including any modifications to the proposed 164-foot buffer.

The additional restriction and consultation recommended by Oregon PRD, to consult on and limit all project activities in Driftwood parking lot to the 164-foot buffer are unnecessary for protection of potential plover habitat. OSU's proposal to apply the buffer in the parking lot to noise producing HDD construction activities would provide adequate protection to minimize effects of the proposed project on the western snowy plover. We have no concerns about the effects on plovers of the other activities proposed for the western edge of the parking lot described above. Therefore, because the benefits of Oregon PRD's and Oregon DFW's recommendation do not justify the costs, we do not recommend that all project activities and equipment in Driftwood parking lot occur at least 164 feet from plover habitat and that all activities be approved in consultation with Oregon PRD.

Modifications to the Bird and Bat Conservation Strategy Plan and Adaptive Measures for Snowy Plover

FWS and Oregon DFW recommends (10(j) recommendation 1 and 2B, respectively) that the BBCS Plan include results from the most recent bat maternity roost surveys conducted in July 2019. In addition, Oregon DFW (10(j) recommendation 2B) also recommends modifying the plan as follows: (1) add records of western snowy plover nests occurring near Driftwood; (2) OSU's worker-awareness program (proposed in the revised BA) to train construction personnel about listed species; and (3) modify the plan in accordance with Oregon DFW's recommendation to install terrestrial cables with a single HDD bore. Oregon PRD recommends that they be consulted on any adaptive management measures necessary for western snowy plovers on the ocean shore.

In its reply comments to the agencies, OSU agreed to all the recommended modifications to the BBCS Plan except for Oregon DFW's recommendation concerning the terrestrial cables. OSU also did not agree with Oregon PRD's recommendation.

Although, Oregon DFW states that survey results for bat maternity roosts informed the selection of environmental measures they do not explain how adding this information to the BBCS Plan would inform any protective measures for bats or what other benefit it may provide. In addition, on February 2, 2020, OSU filed the survey results to the public record for the license proceeding. Likewise, Oregon DFW also does not adequately explain how adding observations of snowy plover nests recorded in 2017, 2018, and 2019 to the plan would be used. Adding additional language to the BBCS Plan regarding the HDD bore is not warranted as discussed above. Therefore, these measures lack substantial evidence, and we do not recommend them.

Response actions for the listed western snowy plover are fully developed in the BBCS Plan and do not require adaptive management. Furthermore, the CWG did not identify snowy plover mitigation measures as appropriate for management under the Adaptive Management Framework. Therefore consultation, as recommended by Oregon PRD, is unnecessary.

5.2 UNAVOIDABLE ADVERSE EFFECTS

The project's WEC test site would be relatively small, consisting of approximately six WECs during the initial development scenario and 20 WECs for the full build-out scenario, and given the location about 6 nautical miles offshore, the overall scale of any adverse effects is expected to be minor. The footprint of the anchors, even under full build-out and using the largest types of anchors, would be about 2 acres total, spread out over the deployment area. Unavoidable adverse effects on the benthic community include placement of anchors on a small area of the seafloor and burial of the subsea cables, which could kill some slow-moving infauna or benthic species, and would temporarily displace some marine organisms.

The project would be located about 3 nautical miles or farther offshore than the average distance gray whales were observed offshore during a monitoring study (Ortega-Ortiz and Mate 2008). However, gray whales were detected as far offshore as 11 nautical miles (Ortega-Ortiz and Mate 2008), so gray whales, as well as other whale species, would be expected to be passing by and through the WEC test site. However, no whale collisions have been detected during operations at PacWave North or at similar projects, such as the Hawaii Wave Energy Test Site and open ocean aquaculture facilities located off of Hawaii and New Hampshire (Section 3.3.2). Lost fishing gear could become entangled on project components. OSU would implement the Organism Interactions Monitoring Plan to detect and remove marine debris at the project, which would minimize the potential for marine mammals to encounter lost fishing gear at the WEC test site and become entangled. Because of the low risk of potential project effects and implementation of comprehensive mitigation measures designed to further minimize the potential for any adverse effects, NMFS has determined that construction and operation of the project is not expected to result in take of marine mammals (letter from NMFS, APEA, Appendix N).

WECs would appear very small when viewed from shore. Lights and navigation aids would be visible at some distance, but are necessary for maritime safety, and the range of visibility would vary depending on time of day and weather conditions.

5.3 FISH AND WILDLIFE AGENCIES RECOMMENDATIONS

Under the provisions of section 10(j) of the FPA, each hydroelectric license issued by the Commission shall include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by the project. Section 10(j) of the FPA states that whenever the Commission finds that any fish and wildlife agency recommendation is inconsistent with the purposes and the requirements of the FPA or other applicable law, the Commission and the agency shall attempt to resolve such inconsistency, giving due weight to the recommendations, expertise, and statutory responsibilities of the agency. In response to our August 29, 2019 notice soliciting comments, recommendations, terms and conditions, and fishway prescriptions, FWS filed 5 section 10(j) recommendations on September 26, 2019, and Oregon DFW filed 10 section 10(j) recommendations on September 30, 2019. The recommendations consisted of multiple components. Table 5.1 lists the section 10(j) recommendations, and whether the measures are recommended by staff. Recommendations that we consider outside the scope of section 10(j) have been considered under section 10(a) of the FPA and are addressed in the specific resource sections of this document and the previous section.

Table 0-1. Analysis of fish and wildlife agency recommendations for the PacWave South Project (Source: staff).

Recommendation	Agency	Within the scope of section 10(j)	Levelized Annual Cost	Adopted?
1. Implement the Bird and Bat Conservation Strategy that includes a range of measures and best management practices designed to protect, mitigate, or enhance bird and bat resources affected or potentially affected by the project.	FWS (recommen-dation 1), Oregon DFW (recommen-dation 2)	Yes	$50,000	Yes
2. Implement Monitoring Plans and related Mitigation Measures proposed by OSU:	FWS (recommen-dation 2) Oregon DFW (recommendati on 1)			
(a) Implement the Benthic Sediments Monitoring Plan and Mitigation		Yes	$114,304	Yes
(b) Implement the Organism Interaction Monitoring Plan and Mitigation		Yes	$69,852	Yes
(c) Implement the Acoustics Monitoring Plan and Mitigation		Yes	$88,903	Yes
(d) Implement the EMF		Yes	$101,603	Yes

Monitoring Plan and Mitigation				
3. Implement the Emergency Response and Recovery Plan	Oregon DFW (recommend-dation 1)	Yes	$50,802	Yes
4. Implement the Adaptive Management Framework	Oregon DFW (recommend-ation 1)	No, the recommendation contemplates as yet un-specified future measures, and such measures do not fall within the scope of 10(j).	$63,502	Yes. See APEA, Appendix J.
5. Implement Navigation Safety Risk Assessment	Oregon DFW (recommend-ation 1)	No, the assessment does not include specific provisions to protect, mitigate, or enhance fish and wildlife resources	$63,502	Yes
6. Implement Operations and Maintenance Plan proposed by OSU	Oregon DFW (recommenda-tion 1)	No, the plan does not include specific provisions to protect, mitigate, or enhance fish and wildlife resources	$1,000,000	Yes

7. Modify measure 19 (Five-Year Reviews), to ensure that the reporting of "monitoring activities and results, and any adaptive management criteria or response actions" include any and all activities relating to natural resources, including mitigation monitoring.	FWS (recommendation 2)	No, agency notification is not a specific measure to protect, mitigate, or enhance fish and wildlife resources	$0	Yes. Measure 19 already includes provisions for monitoring activities for all resources described in the monitoring plans and mitigation measures and results, and any adaptive management criteria or response actions which includes mitigation, that were applied or modified.
8. Modify Fish and Wildlife Emergency Notification, to clarify that if a WEC moves outside of its operational boundary (as described in the Emergency Response and Recovery Plan), that constitutes an emergency under Fish and Wildlife Emergency Notification.	FWS (recommendation 2)	No, agency notification is not a specific measure to protect, mitigate, or enhance fish and wildlife resources	$0[e]	Yes. Agency notification would be required as OSU proposes because a WEC that breaks away from its mooring and moves well beyond its operational boundary would be considered a fish and wildlife emergency. The free-floating device and trailing mooring lines would pose a serious threat to marine mammals (collision and entanglement) and other fish and wildlife (toxic fluid exposure) if WEC grounds into the nearshore bottom substrate or on the beach.

9. Implement Estuary Protection Measures: (a) fabricate project components at existing permitted land-based facilities, allowing all coatings and paint to fully cure prior to deployment into the estuary; (b) use of the estuary to store and stage project components restricted to commercial dockage that has been designed, permitted and is used for dockage, where the docks have been and continue to be dredged. (c) restrict all project use of the estuary to commercial navigation channels, and existing permitted docks and dredged areas (this would include storage and staging of WECS	FWS (recommen-dation 3) Oregon DFW (recommen-dation 5) Oregon DFW (recommendatio n 5) FWS (recommen-dation 3)	Yes Yes Yes	$6,350 $344,000	No for (a), (b), and (c). The potential impacts on the estuary in Yaquina Bay are too attenuated from the Commission's authority over construction and operation of the PacWave South Project to require the recommended measures.
10. Modify Bird and Bat Conservation Strategy to require all activities in the Driftwood parking lot shall occur at least 164 feet (50 meters) from any potentially suitable western snowy plover habitat.	Oregon DFW (recommen-dation 2)	Yes	$0	No. OSU is proposing to conduct some activities within the 164-foot buffer, just not use heavy equipment in that buffer.

11. Modify Bird and Bat Conservation Strategy as follows: (a) Add records of western snowy plovers nesting in 2017, 2018, and 2019 on the beach immediately adjacent to and near Driftwood.	Oregon DFW (recommend-dation 2);	Yes		(a) No, it's unclear how the information would be used to guide implementation of measures in the plan.
(b) If HDD is initiated during the western snowy plover nesting season (March 15 to September 15), prior to operation of the HDD, surveys of suitable nesting habitat would be conducted within 600 feet of the western edge of the parking lot at Driftwood.	Oregon DFW (recommend-dation 2)	Yes		(b) Yes. If the western snowy plover is identified during nesting season, OSU may conduct some activities within the 164-foot buffer.
(c) Construction personnel would participate in a Service-approved worker environmental awareness program on federally listed species and their habitats.	Oregon DFW (recommend-dation 2)	No, such a program not a specific measure to protect, mitigate, or enhance fish and wildlife resources.		(c) No. OSU will implement a range of plans discussed in this EA that will promote the protection, mitigation of damage to, and enhancement of federally listed species and their habitats.
(d) Add results of surveys performed in July 2019 for bat maternity roosts, reported in the PacWave South – Bat Roosting	Oregon DFW (recommend-dation 2); FWS (recommend-	Yes		(d) No, the information is

Habitat Survey Results memorandum dated August 27, 2019. (e) Modify page 17 in accordance with Oregon DFW's recommendation to install terrestrial cables with a single HDD bore beneath the sensitive bog/fen wetland complex associated with Buckley Creek.	dation 1) Oregon DFW (recommend-dation 2)	 Yes		already included in the project record. (e) No, see Oregon DFW Recommendation 17 number (8) below.
12. Modify Acoustic Monitoring Plan to revise the monitoring plan methods to reduce or address "self-noise" and to exclude samples contaminated by "self-noise" from further analysis.	Oregon DFW (recommen-dation 3)	Yes	$0[g]	Yes
13. Modify Habitat Mitigation Plan as follows: (a) develop the revegetation and restoration plan in consultation with and approval of ODFW; (b) use experts to assess and possibly survey kinnikinnick patches delineated within the project area but outside of Driftwood to determine if habitat is suitable for, or	Oregon DFW (recommen-dation 4)	Yes	(a)--$0 (b)--$0 (d)--$0	Adopt (a), (b), and (d); (c) See Oregon DFW Recommendation 16 number (8) below.

occupied by, the seaside hoary elfin butterfly; (c) to minimize risk of inadvertent release of drilling fluid, follow the recommendations outlined in recommended HDD contingency plan (Oregon DFW recommendation 8); and (d) define "temporary" impacts and provide the total acreage of each habitat type in each habitat category considered for potential temporary and permanent impacts.				 (c) See Oregon DFW Recommendation 17 number (8) below.
14. Report detection of aquatic invasive species on or inside a watercraft and provide ODFW with an accurate history of vessels moorage, operating, or storage locations, time out of water, and previous inspection information, as required by state regulations regarding aquatic invasive species.	Oregon DFW (recommendation 6)	No, notification is not a specific fish and wildlife measure.	$0[d]	Yes. OSU proposes (measure 12) to require vessels that OSU charters or contracts with to work on the project comply with all current federal and state laws and regulations regarding aquatic invasive species management.

15. Prepare a revegetation and restoration plan in consultation with ODFW.	Oregon DFW (recommen-dation 7)	Yes.	$50,000	Yes.
16. Limit the number of HDD bores for onshore transmission lines beneath the wetland habitat to no more than 3.	Interior (recommen-dation 4)	Yes	$0[a]	Yes. OSU proposes a maximum of three HDD bores for the onshore transmission lines.
17. Develop a Horizontal Directional Drill (HDD) Plan in consultation with ODFW to include:(1) a description of how OSU would minimize risks of inadvertent return in the marine environment; (2) a description of the HDD locations (both marine and terrestrial), maps, coordinates and spatial dimensions; (3) protocols for locating the depth of the water table and an assessment of the risks of avoiding or drilling through the water table; (4) a description of the HDD laydown area location at Driftwood, the manhole spacing (e.g. 20 feet apart), and the protocols for drill site preparation and set up; (5) a description of the HDD target	Oregon DFW (recommen-dation 8)	Yes	$5,100	Adopted all measures except for (8) No; the benefits of the recommendation to limit the installation of the terrestrial transmission lines in a single HDD bore hole is not worth the cost, because it is not technically necessary to maintain bore hole stability to reduce the likelihood of an inadvertent return. Yes for (1-7) and (9-20), OSU should use these criteria in developing the HDD plan along with Commission guidance for HDD Plan development and

minimum depth beneath dunes, beach, wetland and stream habitat, diameter of the HDD hole, and approximate dimensions (distance, width, depth) of the HDD cable and transmission line corridors; (6) a description of the geotechnical analysis conducted by OSU to ensure successful HDD and reduce the risk of inadvertent return to the maximum extent (e.g. identify vulnerabilities or hazards and how they will be avoided) (7) the HDD methods (e.g. drill and leave); (8) the HDD scope (e.g. five separate marine HDD bores, one large terrestrial HDD bore) to include installation of the terrestrial transmission lines in a single HDD bore hole to increase the likelihood of maintaining bore hole stability and reduce the potential for an inadvertent return; (9) the schedule and timing of HDD installation (e.g. one month per marine borehole, 6-8 months in total); (10) the construction best operating procedures designed to				for Crossings beneath Wetlands to minimize the potential for an inadvertent return to the terrestrial and the marine environment.

minimize the potential for inadvertent return of drilling fluids; (11) a description of anticipated support services such as marine vessels or divers; (12) a description of inspection procedures to facilitate timely detection of inadvertent return or leaks, if any; (13) protocols for monitoring (e.g. drill mud pressure and volume), containment, response recovery and clean-up of inadvertent return, and notification procedures, including notification of Oregon DFW; (14) protocols for storing emergency response equipment on-site during HDD operations; (15) descriptions of alternate or contingency crossing methods should the primary method fail as a successful subsea cable and transmission line installation location; (16) a map of alternative vehicle beach access points and description of consultation procedures with Oregon PRD to inform the public; (17) a map of environmentally sensitive sites				

(e.g. western snowy plover potential habitat, seaside hoary elfin potential habitat, streams, wetlands, dune habitat); (18) approved locations for spoil piles on previously disturbed, paved, areas selected to avoid impacts on habitat; (19) a list of additives used in drilling fluid and procedures and approved disposal sites for spoils and drilling mud; and (20) a description of demobilization procedures for HDD machinery and equipment.				
18. Marine Geological Surveys and Cable Routing: (a) provide refined geological information of the entire subsea cable route; and (b) avoid any rocky habitat by routing subsea cables around any such areas identified by surveys and achieve continuous burial.	Oregon DFW (recommen-dation 9)	Yes	$0[f] $509,300	(a) No. The FLA contains sufficient offshore geophysical and geotechnical information. (b) No. OSU would avoid rock substrate to the extent practicable.
19. (a) Develop a decommissioning plan[c] in consultation with FWS and resource agencies at least three years prior to license expiration and submit a draft	(a) FWS (recommendati on 5) and	No, not a specific licensing measure to protect, mitigate, or enhance fish and wildlife resources.	$0[b]	No. The proposed action is to authorize the construction, operation, and maintenance of the project, not decommission it. Therefore, we make no

decommissioning plan for review and comment no later than two years before the expiration of any license term. (b) Develop a decommissioning plan[c] in consultation with and for approval by ODFW to include: (a) proposed decommissioning schedule; (b) description of removal and containment methods; (c) description of site clearance activities; (d) plans for transporting and recycling, reusing, or disposing of the removed project components, including removal of all anchors and equipment from the water at the time of decommissioning and destination location of appropriate land-based permitted disposal or storage facility; (e) description of those resources, conditions, and activities that could be affected by or could affect the proposed decommissioning activities; (f) results of any recent habitat or biological surveys conducted in the vicinity of the structure; (g)	 (b) Oregon DFW (recommen-dation 10)		 $0[b]	recommendations for decommissioning measures in this EA.

mitigation measures to protect sensitive biological resources during removal activities or subsequently restore habitat features; (h) description of methods that will be used to survey the area after removal to determine any effects on marine life or habitat; (i) description of how the licensee will restore the site to the natural condition that existed prior to the development of the project area; (j) plans to conduct post decommissioning underwater visual surveys to demonstrate that all equipment has been removed and habitat has been returned to its pre-installation state; and (k) plans to provide a report of post-decommissioning survey results.				

[a] OSU stated that the cost to implement this measure is included in the cost of project construction.

[b] No cost estimated—plan would not need to be developed unless the project is decommissioned.

[c] Commission licenses for unconstructed major projects affecting navigable waters and lands of the United States include L-Form 6 with standard article 35 addressing site restoration as part of the surrender of a license with the intent to decommission the project. The elements of a decommissioning plan recommended by FWS and Oregon DFW would be addressed in the decommissioning plan, if the licensee proposes to surrender the license and retire the project.

[d] No cost estimated—costs would be dependent on the frequency and nature of any fish and wildlife emergencies that occur.

[e] OSU did not provide costs for this measure, so we assume that it is included in the project construction capital cost.

[f] OSU stated that there would be no cost unless the plan needs to be implemented at some point in the future and that other costs would be included in routine operation and maintenance costs.

[g] No cost estimated.

5.4 CONSISTENCY WITH COMPREHENSIVE PLANS

Section 10(a)(2) requires FERC to consider the extent to which a project is consistent with federal or state comprehensive plans for developing or conserving a waterway. No inconsistencies with these plans were found.

Federal

- Bureau of Land Management. 1985. A five-year comprehensive anadromous fish habitat enhancement plan for Oregon coastal rivers. Department of the Interior, Portland, Oregon. May 1985.
- Bureau of Land Management. Forest Service. 1994. Standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. Washington, D.C. April 13, 1994.
- Department of the Army, Corps of Engineers. Portland District. 1993. Water resources development in Oregon. Portland, Oregon.
- National Marine Fisheries Service. 2014. Final Recovery Plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unit of Coho Salmon. Arcata, CA.
- National Marine Fisheries Service. 2009. Middle Columbia River steelhead distinct population segment Endangered Species Act recovery plan. Portland, Oregon. November 30, 2009.
- National Marine Fisheries Service, Pacific Fishery Management Council. 1978. Final environmental impact statement and fishery management plan for commercial and recreational salmon fisheries off the coasts of Washington, Oregon, and California commencing in 1978. Seattle, Washington.
- Pacific Fishery Management Council. 1988. Eighth amendment to the fishery management plan for commercial and recreational salmon fisheries off the coasts of Washington, Oregon, and California commencing in 1978. Portland, Oregon.
- Pacific Fishery Management Council. 2000. Amendment 14 to the Pacific Coast salmon plan (1997). Portland, Oregon. [Online] http://www.pcouncil.org/salmon/salfmp/fmpthrua14.pdf.
- Pacific Fishery Management Council. 1999. Appendix A - identification and description of EFH, adverse impacts, and recommended conservation measures for salmon: Amendment 14 to the Pacific coast salmon plan. Portland, Oregon. [Online] http://www.psmfc.org/efh/salmon_efh2.html.
- Pacific Fishery Management Council. Appendix B - Description of the ocean salmon fishery and its social and economic characteristics: Amendment 14 to the Pacific Coast salmon plan. Portland, Oregon. August 1999.
- Pacific Fishery Management Council. Amendment 14 to the Pacific Coast salmon plan (1997). Portland, Oregon. May 2000.

- Pacific Fishery Management Council. 2007. Fishery management plan for U.S. West Coast fisheries for highly migratory species. Portland, Oregon. June 2007.
- U.S. Fish and Wildlife Service. Undated. Fisheries USA: the recreational fisheries policy of the U.S. Fish and Wildlife Service. Washington, D.C.
- U.S. Fish and Wildlife Service. Canadian Wildlife Service. 1986. North American waterfowl management plan. Department of the Interior. Environment Canada. May 1986.

State

- Oregon Global Warming Commission. 2010. Interim Roadmap to 2020.
- Oregon Department of Environmental Quality. 1978. Statewide water quality management plan. Salem, Oregon. November 1978. Seven volumes.
- Oregon Department of Fish and Wildlife. 1982. Comprehensive plan for production and management of Oregon's anadromous salmon and trout: Part I. General considerations. Portland, Oregon. June 1, 1982.
- Oregon Department of Fish and Wildlife. 1982. Comprehensive plan for production and management of Oregon's anadromous salmon and trout: Part II. Coho salmon plan. Portland, Oregon. June 1, 1982.
- Oregon Department of Fish and Wildlife. 1995. Comprehensive plan for production and management of Oregon's anadromous salmon and trout: Part III. Steelhead plan. Portland, Oregon. April 26, 1995.
- Oregon Department of Fish and Wildlife. 1987. The statewide trout management plan. Portland, Oregon. November 1987.
- Oregon Department of Fish and Wildlife. 1987. Warm water game fish management plan. Portland, Oregon. August 1987.
- Oregon Department of Fish and Wildlife. 1987. Trout mini-management plans. Portland, Oregon. December 1987.
- Oregon Department of Fish and Wildlife. 1991. Comprehensive plan for production and management of Oregon's anadromous salmon and trout: Coastal Chinook salmon plan. Portland, Oregon. December 18, 1991.
- Oregon Department of Fish and Wildlife. 2003. Oregon’s elk management plan. Portland, Oregon. February 2003.
- Oregon Department of Fish and Wildlife. 1993. Oregon black bear management plan: 1993-1998. Portland, Oregon.
- Oregon Department of Fish and Wildlife. 1993. Oregon wildlife diversity plan. Portland, Oregon. November 1993.
- Oregon Department of Fish and Wildlife. 2006. Oregon cougar management plan. Roseburg, Oregon. May 2006.
- Oregon Department of Fish and Wildlife. 1995. Biennial report on the status of wild fish in Oregon. Portland, Oregon. December 1995.

- Oregon Department of Fish and Wildlife. 1996. Species at risk: Sensitive, threatened, and endangered vertebrates of Oregon. Portland, Oregon. June 1996.
- Oregon Department of Fish and Wildlife. 1997. Oregon coastal salmon restoration initiative (Oregon Plan). Roseburg, Oregon. March 1997. Five volumes.
- Oregon Department of Fish and Wildlife. 1997. Oregon plan for salmon and watersheds. Salem, Oregon. December 1997.
- Oregon Department of Fish and Wildlife. 2006. Oregon conservation strategy. Salem, Oregon. February 2006.
- Oregon Department of Fish and Wildlife. 2007. Oregon coast Coho conservation plan for the State of Oregon. Salem, Oregon. March 16, 2007.
- Oregon Department of Fish and Wildlife. 2009. 25-year Recreational angling enhancement plan. Salem, Oregon. February 2009.
- Oregon Department of Fish and Wildlife. 2002. An interim management plan for Oregon's nearshore commercial fisheries. Salem, Oregon. October 11, 2002.
- Oregon Department of Fish and Wildlife. 2016. The Oregon nearshore strategy. Newport, Oregon. Available online: http://oregonconservationstrategy.org/oregon-nearshore-strategy/.
- Oregon Department of Fish and Wildlife. 2016. Oregon Forage Fish Management Plan. November 19, 2016. Available online: http://www.dfw.state.or.us/MRP/management/docs/FFMP_2016.pdf.
- Oregon Land Conservation and Development Commission. 1984. Oregon coastal management program. Salem, Oregon.
- Oregon Department of Land Conservation and Development. 2013. Oregon Territorial Sea plan Part Five: Use of the Territorial Sea for the development of renewable energy facilities or other related structures, equipment or facilities. Salem, Oregon. November 2013.
- Oregon Department of State Lands. Oregon natural heritage plan. Salem, Oregon. 2003.
- Oregon State Game Commission. 1963-1975. Fish and wildlife resources - 18 basins. Portland, Oregon. 21 reports.
- Oregon State Parks and Recreation Department. Oregon Outdoor Recreation Plan (SCORP): 2003-2007. Salem, Oregon. January 2003.
- Oregon State Parks and Recreation Department. Oregon shore management plan. Salem, Oregon. January 2005.
- Oregon State Parks and Recreation Division. n.d. The Oregon scenic waterways program. Salem, Oregon.
- State of Oregon. 10-Year Energy Action Plan (2012). Governor John A. Kitzhaber, M.D. Salem, Oregon.
- Oregon Territorial Sea Plan, Part Five: Use of the Territorial Sea for the Development of Renewable Energy Facilities or Other Related Structures,

Equipment or Facilities (2013). Oregon Department of Land Conservation and Development. Salem, OR.
- Oregon Water Resources Commission. 1987. State of Oregon water use program. Salem, Oregon.

Regional

- Northwest Power and Conservation Council. 2010. Sixth Power Plan: Toward a Clean Energy Future. Council Document 2010-01. February 2010.
- Northwest Power and Conservation Council. 2010. The Sixth Northwest conservation and electric power plan. Portland, Oregon. Council Document 2010-09. February 2010.
- State of Idaho. State of Oregon. State of Washington. Confederated Tribes of the Warm Springs Reservation of Oregon. Confederated Tribes of the Umatilla Indian Reservation. Nez Perce Tribe. Confederated Tribes and Bands of the Yakima Indian Nation. 1987. Settlement Agreement pursuant to the September 1, 1983, Order of the U.S. District Court for the District of Oregon in Case No. 68-5113. Columbia River fish management plan. Portland, Oregon. November 1987.

6.0 FINDING OF NO SIGNIFICANT IMPACT

Based on our independent analysis, we find that the issuance of a license for the PacWave South Project, with additional staff-recommended environmental measures, would not constitute a major federal action significantly affecting the quality of the human environment. Preparation of an environmental impact statement is not required.

7.0 LITERATURE CITED

Adams, J., J. Felis, J.W. Mason, and J.Y. Takekawa. 2014. Pacific Continental Shelf Environmental Assessment (PaCSEA): aerial seabird and marine mammal surveys off northern California, Oregon, and Washington, 2011-2012. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2014-003. 266 pp.

Akamatsu, T., D. Wang, K. Wang, and Y. Naito. 2005. Biosonar behavior of free-ranging porpoises", Proc R Soc Biol Sci Ser B 272, 797{801.

Al-Humaidhi, A.W., M.A. Bellman, J. Jannot, and J. Majewski. 2012. Observed and estimated total bycatch of green sturgeon and Pacific eulachon in 2002-2010 U.S. west coast fisheries. West Coast Groundfish Observer Program. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112.

Aikens, C. Melvins, Thomas J. Connolly, and Dennis L. Jenkins. 2011. Oregon Archaeology. Oregon State University Press: Corvallis, Oregon.

Ainley, D.G., K.D. Dugger, R.G. Ford, S.D. Pierce, D.C. Reese, R.D. Brodeur, C.T. Tynan, and J.A. Barth. 2009. The spatial association of predators and prey at frontal features in the northern California Current: Competition, facilitation, or merely co-occurrence? Marine Ecology Progress Series 389:271-294.

Ainley, D., G.E. Porzig, D. Zajanc, and L.B. Spear. 2015. Seabird flight behavior and height in response to altered wind strength and direction. Marine Ornithology. 43:25-36.

Ainley, D.G. 1977. Feeding methods in seabirds: a comparison of polar and tropical communities in the eastern Pacific Ocean, pp. 669-685. In Adaptations within Antarctic Ecosystems (G. A. Llano, ed.). Gulf Publ. Co., Houston.

American Bird Conservancy. 2012. Is rare albatross now colonizing Hawaiʻi? Online [URL]: http://www.abcbirds.org/newsandreports/releases/120417.html (Accessed December 2014).

Ammann, A.A. 2004. SMURFs: Standard Monitoring Units for the Recruitment of Temperate Reef Fishes. Journal of Experimental Marine Biology and Ecology 299:135-154.

Andersson, M.H., I. Lagenfelt, and P. Sigray. 2012. Do ocean-based wind farms alter the migration pattern in the endangered European silver eel (*Anguilla anguilla*) due to noise disturbance? In A.N. Popper and A. Hawkins (eds.). The effects of noise on aquatic life. Advances in Experimental Medicine and Biology 730: DOI 10.1007 978-1-4419-7311_90.

Arkoosh, L., and T.K. Collier. 2002. Ecological Risk Assessment Paradigm for Salmon: Analyzing Immune Function to Evaluate Risk, Human and Ecological Risk Assessment: An International Journal, 8:2, 265-276

Atlantic Marine Aquaculture Center. 2002. UNH OOA Environmental Monitoring Program. Open Ocean Aquaculture Annual Progress Report for the period 1/01/02 through 12/31/02.

Atlantic Marine Aquaculture Center. 2006. Open Ocean Aquaculture Annual Progress Report for the period 1/01/05 through 12/31/05.
Atlantic Marine Aquaculture Center. 2008. About the Atlantic Marine Aquaculture Center. Online [URL]: http://ooa.unh.edu/about/about.html (Accessed July 2008).
Atlantic Marine Aquaculture Center. 2014. About the Atlantic Marine Aquaculture Center. Online [URL]: http://ooa.unh.edu/about/about.html (Accessed December 2014).
Auth, T.D., R.D. Brodeur, and K.M. Fisher. 2007. Diel variation in vertical distribution of an offshore ichthyoplankton community off the Oregon coast. Fishery Bulletin 105:313-326.
Bartol, S.M. 2008. A Review of Auditory Function of Sea Turtles. Bioacoustics 17(1-3):57-59.
Bartol, S., and D.R. Ketten. 2006. Turtle and tuna hearing. *In* Sea Turtle and Pelagic Fish Sensory Biology: Developing Techniques to Reduce Sea Turtle Bycatch in Longline Fisheries, pp. 98-105. Ed. by Y. Swimmer and R. Brill. NOAA Technical Memorandum, NMFS-PIFSC-7.
Bascom, W. 1980. Waves and Beaches. Anchor Press, 366 pp.
Bassett, C., J. Thomson, B. Polagye, and K. Rhinefrank. 2011. Underwater noise measurements of a 1/7 scale wave energy converter. In Proceedings MTS/IEEE Oceans 2011, Waikoloa, 19-22 September, doi:110.1109/OCEANS.2010.5664380.
Beamish, R.J., D. McCaughran, J.R. King, R.M. Sweeting, and G.A. McFarlane. 2000. Estimating the abundance of juvenile coho salmon in the Strait of Georgia by means of surface trawls. North American Journal of Fisheries Management 20(2):369-375.
Beamish, R.J., G.A. McFarlane, J.R. King. 2005. Migratory patterns of pelagic fishes and possible linkages between open ocean and coastal ecosystems off the Pacific coast of North America. Deep-Sea Research II 52 (2005) 739-755.
Beckham, Stephen Dow. 1990. History of Western Oregon Since 1846. In Northwest Coast: Handbook of North American Indians, Volume 7. Wayne Suttles, ed, Smithsonian Institute, Washington D.C.
Bedard, R. 2005. Oregon Offshore Wave Energy Demonstration Project: Bridging the Gap Between the Completed Phase 1 Project Definition Study and the Next Phase – Phase 2 Detailed Design and Permitting. Electrical Power Research Institute Report E2I EPRI-WP-010 OR. Palo Alto, CA.
Bejarano, A.C., J. Michel, J. Rowe, et al. 2013. Environmental Risks, Fate and Effects of Chemicals Associated with Wind Turbines on the Atlantic Outer Continental Shelf. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2013-213; http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5330.pdf (Accessed September 26, 2013).
Benjamins, S., Harnois V., Smith, H.C.M., Johanning, L., Greenhill, L., Carter, C. and Wilson, B. 2014. Understanding the potential for marine megafauna

entanglement risk from renewable marine energy developments. Scottish Natural Heritage Commissioned Report No. 791.

Benson, S.R., Eguchi, T., Foley, D.G., Forney, K.A., Bailey, H., Hitipeuw, C., Samber, B.P., Tapilatu, R.F., Rei, V., Ramohia, P., Pita, J., and Dutton, P.H. 2011. Large-scale movements and high-use areas of western Pacific leatherback turtles, *Dermochelys coriacea*. Ecosphere 2:art84. [doi:10.1890/ES11-00053.1]

Bergstrom, L., F. Sundqvist, and U. Bergstrom. 2013. Effects of an offshore wind farm on temporal and spatial patterns in the demersal fish community. Marine Ecology Progress Series 485:199-210.

Bi, H., R.E. Ruppel, W.T. Peterson, and E. Casillas. 2008. Spatial distribution of ocean habitat of yearling Chinook (*Oncorhynchus tshawytscha*) and coho (*Oncorhynchus kisutch*) salmon off Washington and Oregon, USA. Fisheries Oceanography 17:463-476.

Bishop, J. R. 1980. Experience with scour at the Christchurch Bay Tower. Scour prevention techniques around offshore structures. Proceedings of a one day seminar. 16 December 1980. Society for Underwater Technology. London. 11-22.

Blakely, Joe. 2014. Building Oregon's Coast highway 1936-1966: Straightening Curves and Uncorking Bottlenecks. Groundwaters Publishing, LLC, Lorane, Oregon.

Boehlert, G.W. 1977. Timing of surface-to-benthic migration in juvenile rockfish, *Sebastes diploproa*, off southern California. Fishery Bulletin 75:887-890.

Bodkin, J.L. 1986. Fish assemblages in *Macrocystis* and *Nereocystis* kelp forests off central California. Fishery Bulletin 84:799-808.

Boehlert, G.W. 1977. Timing of surface-to-benthic migration in juvenile rockfish, *Sebastes diploproa*, off southern California. Fishery Bulletin 75:887-890.

Boehlert, G.W, G.R. McMurray, and C.E. Tortorici (eds). 2008. Ecological Effects of Wave Energy Development in the Pacific Northwest. NOAA Technical Memorandum NMFS-F/SPO-92. Northwest Fisheries Science Center. Seattle, WA. October 11-12, 2007.

Bolin, K., and Mats Åbom. 2010. Air-borne sound generated by sea waves. The Journal of the Acoustical Society of America 127:2771. doi.org/10.1121/1.3327815.

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

Bradbury G., M. Trinder, B. Furness, A.N. Banks, R.W.G. Caldow, and D. Hume. 2014. Mapping seabird sensitivity to offshore wind farms. PLoS ONE 9(9): e106366. doi:10.1371/journal.pone.0106366.

Brodeur, R.D. 1990. A synthesis of the food habits and feeding ecology of salmonids in marine waters of the North Pacific. (INPFC Doc.) FRI-UW-9016. Fish. Res. Inst., Univ. Washington, Seattle. 38 pp.

Brodeur R.D., Emmett R.L., Fisher J.P., Casillas E., Teel D.J., Miller, T.W. 2004. Juvenile salmonids distribution, growth, condition, origin, and environmental and

species associations in the northern California Current. Fishery Bulletin 102:25-46.
Brodeur, R.., J. P. Fisher, R.L. Emmett, C.A. Morgan, and E. Casillas. 2005. Species composition and community structure of pelagic nekton off Oregon and Washington under variable ocean oceanographic conditions. Marine Ecology Progress Series 289:41-57.
Brodeur, R. D, E. A. Daly, M.V. Sturdevant, T.W. Miller, J.H. Moss, M.E. Theiss, M. Trudel, L.A. Weitkamp, J. Armstrong, and E.C. Norton. 2007. Regional comparisons of juvenile salmon feeding in coastal marine waters off the West Coast of North America. American Fisheries Society Symposium 57:183-203.
Broughton, K. 2012. Office of National Marine Sanctuaries Science Review of Artificial Reefs. Marine Sanctuaries Conservation Series ONMS-12-05. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Silver Spring, Maryland.
Brownell, R.L., P.J. Clapham, T. Miyashita, and T. Kasuya. 2001. Conservation status of North Pacific right whales. Journal of Cetacean Research and Management, Special Issue 2:269-286.
Bruggeman, J.J., G. Green, R. Grotefendt, and C. Bowlby. 1992. Oregon and Washington Marine Mammal and Seabird Surveys, Final Report. Prepared for Minerals Management Service Pacific OCS Region. OCS Study MMS 91-0093.
Bruton, M.N. 1985. The effects of suspensoids on fish. Hydrobiologia 125: 221-241.
Bull, A.S. 2015. Filling Data Gaps on EMF and Marine Organisms. Bureau of Ocean Energy Management, Pacific Region Tethys Annex IV Environmental Webinar May 7, 2015.
Bureau of Labor Statistics. 2016. Labor Force Statistics from the Current Population Survey. http://www.bls.gov/cps/cps_htgm.htm. Accessed November 2016.
Bureau of Ocean Energy Management (BOEM). 2016. New BOEM report presents findings from power cable observations of EMF and Marine Organisms. October 21, 2016. Available at https://www.boem.gov/BOEM-Science-Note-October-2016/?utm_source=Copy+of+Science+Note%3A+Pacific+EMF+study&utm_campaign=Oct.+2016+Sci+Note%3A+Pacific+EMF+fish+study&utm_medium=email
Bureau of Ocean Energy Management (BOEM). 2015. Virginia Offshore Wind Technology Advancement Project on the Atlantic Outer Continental Shelf Offshore Virginia. Revised Environmental Assessment. Office of Renewable Energy Programs. OCS EIS/EA, BOEM 2015-031. July 2015.
Bureau of Ocean Energy Management (BOEM). 2014. Ocean Wave Energy. Online [URL]: http://www.boem.gov/Renewable-Energy-Program/Renewable-Energy-Guide/Ocean-Wave-Energy.aspx (Accessed December 2014).
Cahill, B. 2014. Wave Measurement and Analysis at the Pacific Marine Energy Center North Energy Test Site (PMEC NETS).
Calambokidis, J., G.H. Steiger, C. Curtice, J. Harrison, M.C. Ferguson, E. Becker, M. DeAngelis, and S.M. Van Parijs. 2015. 4. Biologically important areas for

selected cetaceans within U.S. Waters - West Coast Region. Aquatic Mammals 41(1):39-53.
California State Parks. 2017. Off-Highway Motor Vehicle Recreation. Shorebird Protection. http://ohv.parks.ca.gov/?page_id=22146
Camphuysen, C.J., A.D. Fox, M.F. Leopold, and I.K. Petersen. 2004. Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the UK: A comparison of ship and aerial sampling methods for marine birds, and their applicability to offshore wind farm assessments. Koninklijk Nederlands Instituut voor Onderzoek der Zee Report commissioned by COWRIE.
Carretta, J.V., B.L. Taylor, and S.J. Chivers. 2001. Abundance and depth distribution of harbor porpoise (*Phocoena phocoena*) in northern California determined from a 1995 ship survey. U.S. Fishery Bulletin 99:29-39. *cited in* NOAA 2014d.
Carretta, J.V., K.A. Forney, M.S. Lowry, J. Barlow, J. Baker, D. Johnston, B. Hanson, R.L. Brownell Jr., J. Robbins, D.K.Mattila, K. Ralls, M.M. Muto, D. Lynch, and L. Carswell. 2009. Draft U.S. Pacific Marine Mammal Stock Assessments: 2009. Publications, Agencies and Staff of the U.S. Department of Commerce. Paper 113.
Carretta, J.V., E.M. Oleson, J. Baker, D. W. Weller, A.R. Lang, K.A. Forney, M.M. Muto, B. Hanson, A.J. Orr, H. Huber, M.S. Lowry, J. Barlow, J.E. Moore, D. Lynch, L. Carswell, R.L. Brownell, Jr. 2015. U.S. Pacific Draft Marine Mammal Stock Assessments: 2015. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center. NOAA-TM-NMFS-SWFSC-XXX. Available at https://www.fisheries.noaa.gov/resource/document/us-pacific-marine-mammal-stock-assessments-2015.
Carter, H.R. and S.G. Sealy. 1990. Daily foraging behavior of marbled murrelets. Studies in Avian Biology 14:93-102.
Carter, H.R., and J.L Stein. 1995. Molts and plumages in the annual cycle of the marbled murrelet. *In*: Ecology and conservation of the marbled murrelet (Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, eds.). U.S. Forest Service, Pacific Southwest Research Station, Albany, CA. Gen. Tech. Rep. PSW-GTR-152. p. 99-109.
Carter, A., E. Hague, L. Floyd. 2008. "Benthic Infauna Recovery Following Channel Dredging in the Vicinity of Bogue Inlet, North Carolina." In Proceedings of the 2008 National Conference on Beach Preservation Technology. February 2008.
Caselle, J.E., M.S. Love, C. Fusaro, and D. Schroeder. 2002. Trash or habitat? Fish assemblages on offshore oilfield seafloor debris in the Santa Barbara Channel, California. – ICES Journal of Marine Science, 59: S258-S265.
Caselle, J.E., M.H. Carr, D.P. Malone, J.R. Wilson, and D.E. Wendt. 2010. Can we predict interannual and regional variation in delivery of pelagic juveniles to nearshore populations of rockfishes (genus *Sebastes*) using simple proxies of ocean conditions? CalCOFI Rep. 51: 1-16.

Castro, J.J., J.A. Santiago, and A.T. Santana-Ortega. 2002. A general theory on fish aggregation to floating objects: An alternative to the meeting point hypothesis. Reviews in Fish Biology and Fisheries 11:255-277.

Cato, D.H. 2012. A perspective on 30 years of progress in ambient noise: Source mechanisms and the characteristics of the sound field. AIP Conference Proceedings 242:1495; doi: 10.1063/1.4765918.

Celikkol, B. 1999. Biological assessment of University of New Hampshire open ocean aquaculture demonstration project finfish component. Prepared for U.S. Army Corps of Engineers, New England Division, Concord, Massachusetts.

Center for Whale Research. 2019. Southern Resident Killer Whale Population. Available at https://www.whaleresearch.com/orca-population (Accessed 23 May 2019).

Central Lincoln's People Utility District. 2014. Audit Report, Years Ended June 30, 2014 and 2013. Prepared by Kenneth Kuhns & Co., Salem, OR.

CH2M Hill. 2008. Oregon LNG Terminal and Oregon Pipeline Project. Appendix 9E. Oregon Pipeline Noise Survey and Analysis. Prepared for LNG Development Company, LLC and Oregon Pipeline Company, LLC.

City of San Jose, Environmental Services Department. 2005. Review of the effects of copper on salmonid olfaction. Prepared for the San Francisco Bay Copper Site-Specific Objective Workgroup. April 2005 (as cited by Reedsport OPT Wave Park LLC 2010).

Claisse, J. T., D. J. Pondella II, M. Love, L.A. Zahn, C.M. Wouldiams, J.P. Wouldiams, and A.S. Bull. 2014. Oil platforms off California are among the most productive marine fish habitats globally. Proceedings of the National Academy of Sciences 111:1-6.

Coast Guard (U.S. Coast Guard). 2007. Navigation and Vessel Inspection Circular No. 02-07. Available at: http://www.uscg.mil/hq/cg5/nvic/pdf/2007/NVIC02-07.pdf.

Collie, J.S., Hall, S.J., Kaiser, M.J., and Poiner, I.R. 2000. A quantitative analysis of fishing impacts on shelf-sea benthos. Journal of Animal Ecology 69:785-798.

Cook, A.S. C.P., A. Johnston, L.J. Wright, and N.H.K. Burton. 2012. A review of flight heights and avoidance rates of birds in relation to offshore wind farms. Strategic Ornithological Support Services Project SOSS-02. BTO Research Report Number 618. BTO, Thetford.

Copping, A., Sather, N., Hanna, L., Whiting, J., Zydlewsk, G., Staines, G., Gill, A., Hutchison, I., O'Hagan, A.M., Simas, T., Bald, J., Sparling C., Wood, J., and Masden, E. 2016. Annex IV 2016 State of the Science Report: Environmental Effects of Marine Renewable Energy Development around the World. Available at www.ocean-energy-systems.org and http://tethys.pnnl.gov/publications/state-of-the-science-2016. (Accessed 10 March 2016).

Cryan, P.M., and A.C. Brown. 2007. Migration of bats past a remote island offers clues toward the problem of bat fatalities at wind turbines. Biological Conservation 139:1-11.

Daly, E.A., J.A. Scheurer, R.D. Brodeur, L.A. Weitkamp, B.R. Beckman and J.A. Miller. 2014. Juvenile steelhead distribution, migration, feeding, and growth in the Columbia River Estuary, plume, and coastal waters. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 6:62-80.

Danner, E. M., T.C. Wilson, and R.E. Schlotterbeck. 1994. Comparison of rockfish recruitment of nearshore artificial and natural reefs off the coast of central California. Bulletin of Marine Science 55:333-343.

Davis, A.C.D., R.G. Kvitek, C.B.A. Mueller, M.A. Young, C.D. Storlazzi, and E.L. Phillips. 2013. Distribution and abundance of rippled scour depressions along the California coast. Continental Shelf Research 69:88-100.

Davis, L.G. 2019. Archaeological Assessment of Submerged Cultural Resources in the PacWave South Project Area. Prepared Oregon State University. Corvallis, Oregon. Prepared by Davis Geoarchaeological Research.

Dean Runyan Associates. 2016. Newport Travel Impacts, 1991-2015p. May 2016.

Deane, G.B. 2000. Long time-based observations of surf noise. The Journal of the Acoustical Society of America 107(2):758-770.

Deguchi, T., J. Jacobs, T. Harada, L. Perriman, Y. Watanabe, F. Sato, N. Nakamura, K. Ozaki, and G. Balogh. 2012. Translocation and hand-rearing techniques for establishing a colony of threatened albatross. Bird Conservation International 22:66-81.

Dehnhardt, G., Mauck, B., Hanke, W., and Bleckmann, H. 2001. Hydrodynamic trail following in harbor seals (*Phoca vitulina*). *Science* 293, 102-104.

Dempster, T. and M.J. Kingsford. 2003. Homing of pelagic fish to fish aggregation devices (FADs): The role of sensory cues. Marine Ecology Progess Series 258:213-222.

Department of the Navy. 2003. Environmental Assessment of proposed wave energy technology project, Marine Corps Base Hawaii, Kaneohe Bay, Hawaii. Office of Naval Research. January 2003.

Dernie, K.M., M.J. Kaiser, and R.M. Warwick. 2003. Recovery rates of benthic communities following physical disturbance. Journal of Animal Ecology. 72, 1043-1056.

Desholm, M., and J. Kahlert. 2005. Avian collision risk at an offshore wind farm. Biology Letters 1:296-298.

Dow Piniak, W.E., S.A. Eckert, C.A. Harms, and E.M. Stringer. 2012. Underwater hearing sensitivity of the leatherback sea turtle (*Dermochelys coriacea*): Assessing the potential effect of anthropogenic noise. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Herndon, VA. OCS Study BOEM 2012-01156. 35pp.

EcoNorthwest. 2009. Economic impacts of wave energy to Oregon's economy: A Report to Oregon Wave Energy Trust. Portland, OR. September 7, 2009.

Electricity Innovation Institute. 2004. E2I EPRI Survey and Characterization of Potential Offshore Wave Energy Sites in Oregon. E2I EPRI-WP-003 OR. Electric Power Research Institute. May 17.

Electric Power Research Institute (EPRI). 2011. Mapping and Assessment of the United States Ocean Wave Energy Resource. Report Number 1024637. December 2011.

Elliot-Smith, E., and S.M. Haig. 2007. Western Snowy Plover breeding window survey protocol – final draft. Unpublished report prepared for USFWS.

Emmett, R.L., R.D. Brodeur, and P.M. Orton. 2004. The vertical distribution of juvenile salmon (*Oncorhynchus* spp.) and associated fishes in the Columbia River plume. Fisheries Oceanography 13:392-402.Erickson, D.L. and J.E. Hightower. 2007. Oceanic distribution and behavior of green sturgeon. American fisheries Society Symposium 56:197-211.

Erickson, D.L. and J.E. Hightower. 2007. Oceanic distribution and behavior of green sturgeon. American Fisheries Society Symposium 56:197-211.

Engineering-Environmental Management Inc. 2006. Endangered Species Act Biological Assessment. Appendix D. Final Environmental impact Statement and Environmental Impact Report. Neptune LNG Deepwater Port License Application. November 2006. Available online accessed on 9/25/2018: https://play.google.com/books/reader?id=o-83AQAAMAAJ&hl=en&pg=GBS.SL4-PA21

Engineering Page. 2017. Overall Noise Attenuation by Distance (Point Source). http://www.engineeringpage.com/calculators/noise/distance_dB(A).html

European Marine Energy Centre Ltd (EMEC). 2015. PFOW Enabling Actions project: Sub-sea Cable Lifecycle Study. February 2015. Available: http://www.thecrownestate.co.uk/media/451414/ei-pfow-enabling-actions-project-subsea-cable-lifecycle-study.pdf. (Accessed April 2016).

Fabre, J.P., and J.H. Wilson. 1997. Noise source level density due to surf—Part II: Duck, NC. IEEE Journal of Ocean Engineering 22(3):434-444.

Fang, C., and D. Ling. 2003. Investigation of the noise reduction provided by tree belts. Landscape and Urban Planning 63:187-195.

FCS Group. 2014. Economic Benefits of Oregon Public Ports. May. Available online: http://oregonports.com/documents/memberresources/2014portreport.pdf (Accessed October 2014).

Federal Energy Regulatory Commission (FERC). 2010. Environmental Assessment for Hydropower License. Reedsport OPT Wave Park Project - FERC Project No. 12713-002 Oregon. December 2010.

Federal Energy Regulatory Commission (FERC). 2012. Order issuing original license. Reedsport OPT Wave Park, LLC. Project, No. 12713-002. 81 p.

Federal Energy Regulatory Commission (FERC). 2014. Order issuing pilot project license (minor project). Admiralty Inlet Pilot Tidal Project, No. 12690-005. 85 p.

Federal Energy Regulatory Commission (FERC). 2019. Guidance for Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plans. October 2019. 15 p.

Federal Energy Regulatory Commission (FERC). 2013. Wetland and Waterbody Construction and Mitigation Procedures. May 2013. 20 p.

Ferns, P.N., Rostron, D.M. and H.Y. Siman. 2000. Effects of mechanical cockle harvesting on intertidal communities. Journal of Applied Ecology, 37, 464-474.

Fisher, C., and M. Slater. 2010. Electromagnetic Field Study: Effects of Electromagnetic Fields on Marine Species: A Literature Review. Oregon Wave Energy Trust. 0905-00-001.

Fisher, J., M. Trudel, A. Amman, J.A. Orsi, J. Piccolo, C. Bucher, E. Casillas, J.A. Harding, R.B. MacFarlane, R.D. Brodeur, J.F.T. Morris, and D.W. Welch. 2007. Comparisons of the coastal distributions and abundances of juvenile Pacific salmon from central California to the northern Gulf of Alaska. 2007. Transactions of the American Fisheries Society 57:31-80.

Fisher, J.P., L.A. Weitkamp, D.J. Teel, S.A. Hinton, J.A. Orsi, E.V. Farley Jr., J.F.T. Morris, M.E. Thiess, R.M. Sweeting, and M. Trudel. 2014. Early ocean dispersal patterns of Columbia River Chinook and coho salmon. Transactions of the American Fisheries Society 143:1 252-272.Fisheries Hydroacoustic Working Group (FHWG). 2009. Technical guidance for assessment and final mitigation of the hydroacoustic effects on fish from pile driving noise. Prepared for California Department of Transportation, Sacramento, California. Available at http://www.dot.ca.gov/hq/env/bio/files/Guidance_Manual_2_09.pdf

Fishermen Involved in Natural Energy (FINE). 2011. Commercial Fishing in Oregon. Available Online: http://finecommittee.org/commercial-fishing-in-oregon/ (Accessed October 2014).

Fishermen Involved in Natural Energy (FINE). 2008. Fisheries Discussion and Policy Wave Power Buoy Demonstration Area. February 2008.

Ford, M.J., J. Hempelmann, M.B. Hanson, K.L. Ayres, R.W. Baird, C.K. Emmons, J.I. Lundin, G.S. Schorr, S.K. Wasser, L.K. Park. 2016. Estimation of killer whale (*Orcinus orca*) population's diet using sequencing analysis of DNA from feces. PLoS ONE 11(1):e0144956. doi:10.1371/journal.pone.0144956.

Forney, K.A., J.V. Carretta, and S.R. Benson. 2013. Preliminary estimates of harbor porpoise abundance in Pacific Coast waters of California, Oregon and Washington, 2007-2012. Draft Document PSRG-2013-10 submitted to the Pacific Scientific Review Group, 2-4 April 2013, San Diego, CA. *cited in* NOAA 2014d.

Forsman, E.D., E.C. Meslow, and H.M. Wight. 1984. Distribution and biology of the spotted owl in Oregon. Wildlife Monographs 87:1-64.

Forsman E.D., R.G. Anthony, J.A. Reid, P.J. Loschl, S.G. Sovern, M. Taylor, B.L. Biswell, A. Ellingson, E.C. Meslow, G.S. Miller, K.A. Swindle, J.A. Thraillkill, F.F. Wagner, and D.E. Seaman. 2002. Natal and breeding dispersal of northern spotted owls. Wildlife Monographs 149:1-35.

Furness, R.W., H.M. Wade, A.M.C. Robbins, and E.A. Madsen. 2012. Assessing the sensitivity of seabird populations to adverse effects from tidal stream turbines and wave energy devices ICES Journal of Marine Science 69(8):1466-1479. doi:10.1093/icesjms/fss131.

Gaboury, I., R. Gaboury, M. Zykov, and S. Carr. 2008. Port Dolphin Energy LLC Deep Water Port: Assessment of Underwater Noise. Prepared for CSA International, Inc. by JASCO Research Ltd. 2008. *cited in* NAVFAC 2014.Gallagher, M. B., and S. S. Heppell. 2010. Essential habitat identification for age-0 rockfish along the central Oregon coast. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 2:60-72.

GEI Consultants, Inc. 2015. Exhibit X, Noise. North Mist Expansion Project, November 2015. Prepared for NW Natural Gas.

Geo-Marine, Inc. 2011. Avian radar study for proposed wave energy development off the Oregon Coast. Prepared for Oregon Wave Energy Trust.

Gill, A. 2016. Effects of EMF on Marine Animals from Electrical Cables and Marine Renewable Energy Devices. In Copping, A., Sather, N., Hanna, L., Whiting, J., Zydlewski, G., Staines, G., Gill, A., Hutchison, I., O'Hagan, A., Simas, T., Bald, J., Sparling C., Wood, J., and Masden, E. 2016. Annex IV 2016 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World.

Gill, A. B. 2015. Effects of electromagnetic fields (EMF) on marine animals. Bureau of Ocean Energy Management, Pacific Region Tethys Annex IV Environmental Webinar May 7, 2015.

Gill, A. B., I. Gloyne-Phillips, J. Kimber, and P. Sigray. 2014. Marine renewable energy, electromagnetic (EM) fields and EM-sensitive animals. Pages 61-80 *in* M. A. Shields and A.I.L. Payne (eds.). Marine renewable energy technology and environmental interactions. Springer, Dordrecht, Netherlands.

Green, G.A., J.J. Brueggeman, R.A. Grotefendt, and C.E. Bowlby. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. In Oregon and Washington marine mammal and seabird surveys, J.J. Brueggeman, ed. Minerals Management Service, Pacific OCS Region, U.S. Dept. of Interior, Camarillo CA.

Goldfinger, C., C.Romsos, and B. Black. 2014. Survey and Analysis of the Surficial Geology and Geophysics in the SETS Test Site area and Associated Cable Routes in the Vicinity of Seal Rock Oregon. Draft Final Report, October 29.

Good, T.P., R.S. Waples, and P. Adams (eds.). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-66, 598 p.

Gorzelany, J.F., and Nelson, W.G. 1987. The effects of beach replenishment on the benthos of a subtropical Florida beach. Marine Environmental Research 21:75-94.

Greater Newport Chamber of Commerce. 2009. Seal Rock, Oregon USA. Available Online: http://www.sealrockor.com/ (Accessed October 2014).

Gregory, R.S. 1993. Effect of Turbidity on the Predator Avoidance Behavior of Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 50: 241-246.

Griswold, Harry. 1993. Recollections of electricity coming to Waldport, Oregon. Manuscript On file at Waldport, Oregon Library.

Gustafson, R.G., M.J. Ford, D. Teel, and J.S. Drake. 2010. Status review of eulachon (*Thaleichthys pacificus*) in Washington, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-105, 360 p.

Haikonen, K., J. Sundberg, and M. Leijon. 2013. Characteristics of the Operational Noise from Full Scale Wave Energy Converters in the Lysekil Project: Estimation of Potential Environmental Impacts. Energies 6(5):2562-2582. doi: 10.3390/En6052562. http://tethys.pnnl.gov/publications/characteristicsoperational-noise-full-scale-wave-energy-converterslysekil-project.

Hall, S.J. 1994. Physical disturbance and marine benthic communities: life in unconsolidated sediments. Oceanography and Marine Biology: an Annual Review, 32, 179-239.

Hallermeier, R.J. 1981. Terminal settling velocity of commonly occurring sand grains. Sedimentology, 28, 859-65.

Halvorsen, M.B., T.J. Carlson, and A.E. Copping. 2011. Effects of tidal turbine noise on fish hearing and tissues. Draft Final Report. Environmental Effects of Marine and Hydrokinetic Energy. Pacific Northwest National Laboratory. PNNL-20786. Prepared for U.S. Department of Energy under Contract DE-AC06-76RL01830.

Hanson, M.B., R.W. Baird, J.K.B. Ford, J. Hemplemann-Halos, D.M. Van Doornik, J.R. Candy, C.K. Emmons, G.S. Schorr, B. Gisborne, K.L. Ayres, S.K. Wasser, K.C. Balcomb, K. Balcomb-Bartok, J.G. Sneva, and M.J. Ford. 2010. Species and stock identification of prey consumed by endangered Southern Resident killer whales in their summer range. Endangered Species research 11:69-82.

Hanson, M.B., C.K. Emmons, E.J. Ward, J.A. Nystuen, and M.O. Lammers. 2013. Assessing the coastal occurrence of endangered killer whales using autonomous passive acoustic recorders. Journal of the Acoustical Society of America 134(5):3486-3495.

Harmelink, M.D., and J.J. Hajek. 1973. Highway noise control [abstract only]. Traffic Engineering 43(12):47-53.

Harnois V., Smith, H.C.M., Benjamins, S., Johanning, L. 2015. Assessment of entanglement risk to marine megafauna due to offshore renewable energy mooring systems. International Journal of Marine Energy. 11 (2015) 27-49.

Hastings, M., and Popper, A. 2005. Effects of sound on fish. White Paper. January.

Haswell, R. 1969. Robert Haswell's Log of the First Voyage of the "Columbia" to the Northwest Coast, 1787-1790 and 1790-1793. F.W. Howay, ed. New York: Da Capo Press.

Hatch, S.K., E.E. Connelly, T.J. Divoll, I.J. Stenhouse, K.A. Wouldiams. 2013. Offshore observations of eastern red bats (*Lasiurus borealis*) in the mid-Atlantic United States using multiple survey methods. Plos One. http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0083803

Haxel, J. 2019. Site Characterization Report: Acoustics. Oregon State University, PacWave South. FERC Project No. P-14616. Corvallis, Oregon.

Haxel, J. H., R.P. Dziak and H. Matsumoto. 2011. Obtaining baseline measurements of ocean ambient sound at a mobile test berth site for wave energy conversion off the central Oregon coast. 5 pp.

Haxel, J.H., R.P. Dziak and H. Matsumoto. 2013. Observations of shallow water marine ambient sound: The low frequency underwater soundscape of the central Oregon coast. Journal of the Acoustical Society of America 133(5):2586-2596.

Hays, Marjorie. 1976. The land that kept its promise: A History of South Lincoln County, Oregon. Lincoln County historical Society, Newport, OR.

HDR. 2017. Wetlands and Waterbodies Delineation Report – Pacific Marine Energy Center South Energy Test Site. FERC Project No. P-14616. December 2017.

HDR. 2018. Cultural Resoruces Terrestrial Study Report; Pacific Marine Energy Center South Energy Test Site (FERC No. 14616); Lincoln County, Oregon. Prepared for Oregon State University, Corvallis, Oregon. Prepared by HDR Engineering, Inc. Sacramento, California.

HDR. 2019. Cultural Resources Summary Report for the PacWave South project. FERC No 14616, Lincoln County Oregon and offshore of Newport, Oregon. August 2019.

Hecht, S.A., D.H. Baldwin, C.A. Mebane, T. Hawkes, S.J. Gross and N.L. Scholz. 2007. An overview of sensory effects on juvenile salmonids exposed to dissolved copper: Applying a benchmark concentration approach to evaluate sublethal neurobehavorial toxicity.

Henkel, S. 2011. Characterization of benthic conditions and organisms on the South Oregon Coast: A rapid evaluation of habitat characteristics and benthic organisms at the proposed Reedsport Wave Energy Park. Oregon Wave Energy Trust, 31 p.

Henkel, S. 2016a. Site Characterization Report – Benthic. Pacific Marine Energy Center – South Energy Test Site.

Henkel, S. 2016b. Site Characterization Report – Crabs. Pacific Marine Energy Center – South Energy Test Site. Henkel, S. K., and D. C. Hellin. 2016. Pacific Marine Energy Center North Energy Test Site Annual Operations & Monitoring Report 2015. Prepared for the Adaptive Management Committee by Northwest National Marine Renewable Energy Center.

Henkel, S., J. Haxel, A. Schultz, A. Hofford, S. Moran, K. Hildenbrand, and D. Hellin. 2013. Pacific Marine Energy Center North Energy Test Site Annual Operations & Monitoring Report 2013. Prepared for the Adaptive Management Committee by Northwest National Marine Renewable Energy Center.

Henkel, S.K. 2017. Seasonal variability in green sturgeon presence and duration on the Oregon central coast. Twelfth Annual Ocean Renewable Energy Conference. September 13-14, 2017. Portland, Oregon.

Henkel, S.K., and D.C. Hellin. 2016. Pacific Marine Energy Center North Energy Test Site Annual Operations & Monitoring Report 2015. Prepared for the Adaptive Management Committee by Northwest National Marine Renewable Energy Center.

Henkel, S.K., R.M. Suryan, and B.A. Lagerquist. 2014. Marine renewable energy and environmental interactions: baseline assessments of seabirds, marine mammals, sea turtles, and benthic communities on the Oregon shelf. Chapter 8 in M. A. Shields and A. I. L. Payne, Editors. Marine renewable energy and environmental interactions. Springer, New York.

Henkel, S., L. Torres, and A. Holdman. 2016. Site Characterization Report – Marine Mammals. Pacific Marine Energy Center – South Energy Test Site.

Hildebrand, J.A. 2009. Anthropogenic and natural sources of ambient noise in the ocean. Marine Ecology Progress Series 395:5-20.

Holt, M.M., Noren, D.P., Dunkin, R.C., and Wouldiams, T.M. 2015. Vocal performance affects metabolic rates in dolphins: implications for animals communicating in noisy environments. Journal of Experimental Biology 218:1647-1654, doi:10.1242/jeb.122424.

Huddart, L. 1990. The use of vegetation for traffic noise screening. Transport and Road Research Laboratory; Research Report 238.

Huff, D.D., S.T. Lindley, P.S. Rankin, E.A. Mora. 2011. Green sturgeon physical habitat use in the coastal Pacific Ocean. PLoS One 6: e25156.

Huff D.D., Lindley S.T., Wells B.K., and Chai F. 2012. Green Sturgeon Distribution in the Pacific Ocean Estimated from Modeled Oceanographic Features and Migration Behavior. PLoS ONE 7(9): e45852. doi:10.1371/journal.pone.0045852.

Hyrenbach, K.D. 2001. Albatross response to survey vessels: implications for studies of the distribution, abundance, and prey consumption of seabird populations. Marine Ecology Progress Series 212:283-295.Israel J. A., and A. P. Klimley. 2006. Life history conceptual model for North American green sturgeon (*Acipenser medirostris*). California Department of Fish and Game, Delta Regional Ecosystem Restoration and Implementation Program.

ICFa International. 2010. Habitat Conservation Plan for the Western Snowy Plover. Prepared for Oregon Parks and Recreation Department, Salem, Oregon.

ICF International. 2010b. Western Snowy Plover Habitat Conservation Plan Final Environmental Impact Statement Volume 1: Report. Prepared for U.S. Fish and Wildlife Service. Israel J.A., Klimley A.P. Life history conceptual model for North American green sturgeon (*Acipenser medirostris*). California Department of Fish and Game, Delta Regional Ecosystem Restoration and Implementation Program. 2006. Page 12 has a summary of what is known about their prey in bays.

Interagency Special Status/Sensitive Species Program (ISSSSP). 2005. Species Fact Sheet—Incisalia polia maritima, Seaside Hoary Elfin. <https://www.fs.fed.us/r6/sfpnw/issssp/planning-documents/species-guides.shtml>. Accessed November2018.

Johnsgard, P.A. 1987. Diving Birds of North America. Lincoln, Nebraska: University of Nebraska Press.

Johnson, F.G., and R.R. Stickney (editors). 1989. Fisheries. Kendall/Hunt Publishing Company. Dubuque, Iowa.

Johnson, K.R., C.H. Nelson, and J.H. Barber. 1983. Assessment of gray whale feeding grounds and sea floor interaction in the northeastern Bering Sea. U.S. Geological Survey Open-File Report 83-727.
Jones, M.K. and T. Mulligan. 2014. Juvenile rockfish recruitment in Trinidad Bay, California, Transactions of the American Fisheries Society, 143:543-551.
Kaiser, M.J. 1998. Significance of bottom fishing disturbance. Conservation Biology 12:1230-1235.
Kagan, J.S., J.C. Hak, B. Csuti, C.W. Kiilsgaard, and E.P. Gaines. 1999. Oregon Gap Analysis Project Final Report: A geographic approach to planning for biological diversity. Oregon Natural Heritage Program, Portland, Oregon. 72 pp. + appendices. Available at https://www.pdx.edu/sites/www.pdx.edu.pnwlamp/files/GAP_FNL_RPT.PDF.
Kogan, I., C.K. Paull, L.A. Kuhnz, E.J. Burton, S. Von Thun, H.G. Greene, and J.P. Barry. 2006. ATOC/Pioneer Seamount cable after 8 years on the seafloor: Observations, environmental impact. Continental Shelf Research 26:771-787.
Konstantinou, I.K., and T.A. Albanis. 2004. Worldwide occurrence and effects of antifouling paint booster biocides in the aquatic environment: a review. Environment International 30:235-248.
Kostow, K. 1995. Biennial report on the status of wild fish in Oregon. Oregon Department of Fish and Wildlife Report. 217 p.
Kot, B.W., Sears, R., Anis, A., Nowacek, D.P., Gedamke, J. and Marshall, C.D. 2012. Behavioral responses of minke whales (*Balaenoptera acutorostrata*) to experimental fishing gear in a coastal environment. Journal of Experimental Marine Biology and Ecology, 413, 13-20. *cited in* Benjamins et al. 2014
Kramer, S.H., C.D. Hamilton, G.C. Spencer, and H.D. Ogston. 2015. Evaluating the potential for marine and hydrokinetic devices to act as artificial reefs or fish aggregating devices, Based on analysis of surrogates in tropical, subtropical, and temperate U.S. West Coast and Hawaiian Coastal Waters. OCS Study BOEM 2015-021. U.S. Department of Energy, Energy Efficiency and Renewable Energy, Golden, Colorado.
Krone, R., L. Gutow, T. Brey, J. Dannheim, and A. Schroder. 2013. Mobile demersal megafauna at artificial structures in the German Bight - Likely effects of offshore wind farm development. Estuarine, Coastal and Shelf Science 125:1-9.
Kropp R.K. 2013. Review of recent literature relevant to the environmental effects of marine and hydrokinetic energy devices; Task 2.1.3: effects on aquatic organisms - Fiscal Year 2012 Progress Report. PNNL-21846, Pacific Northwest National Laboratory, Richland, WA.
Krutzikowsky, G.K., K. Adkisson, C. Braby, D. Fox, M. Sommer, T. Swearingen, I. Kuletz, and S. Rumrill. 2016. The Oregon Nearshore Strategy. Oregon Department of Fish and Wildlife, Salem. <http://oregonconservationstrategy.org/media/The-Oregon-Nearshore-Strategy.pdf>. Accessed October 2018.

Kuhnz, L.A., J.P. Barry, B.K. Buck, and P.J. Whaling. 2011. Potential Impacts of the Monterey Accelerated Research System (MARS) Cable on the Seabed and Benthic Faunal Assemblages. Monterey Bay Aquarium Research Institute.

Lacy, R.C., R. Wouldiams, E. Ashe, K.C. Balcomb III, L J.N. Brent, C.W. Clark, D.P. Croft, D.A. Giles, M. MacDuffee, and P.C. Paquet. 2017. Evaluating anthropogenic threats to endangered killer whales to inform effective recovery plans. Scientific Reports 7:14119 DOI:10.1038/s41598-017-14471-0

LaHaye, W.S., and R.J. Gutierrez. 1999. Nest sites and nesting habitat of the northern spotted owl in northwestern California. Condor 101:324-330.

Laird, J. 2006. Effect of water clarity on the distribution of marine birds in nearshore waters of Monterey Bay, California. Field Ornithology 77:151-156.

Landry, M.R., Postel, J.R., Peterson, W.K., and Newman, J. 1989. Broad-scale patterns in the distribution of hydrographic variables. In M.R. Landry and B.M. Hickey. Coastal Oceanography of Washington and Oregon. Elsevier Press. Amsterdam.

Langhamer, O., D. Wilhelmsson, and J. Engstrom. 2009. Artificial reef effect and fouling impacts on offshore wave power foundations and buoys - A pilot study. Estuarine, Coastal and Shelf Science 82:426-432.

Laurinollo, M.H., C.D.S. Tollefson, S.A. Carr, and S.P. Turner. 2005. Assessment of the Effects of Underwater noise from the Proposed Neptune LNG Project. Part (3): Noise Sources of the Neptune Project and Propagation Modeling of Underwater Noise. Prepared by JASCO Research Ltd. for LGL Ltd. LGL Report TA4200-3.

Lauten, D.J., K.A. Castelein, J.D. Farrar, A.A. Kotaich, E. Krygsman, and E.P. Gaines. 2017. The Distribution and Reproductive Success of the Western Snowy Plover along the Oregon Coast - 2017. Oregon Biodiversity Information Center, Institute for Natural Resources, Portland State University, Oregon.

Lavendar, A.L., S.M. Bartol, and I.K. Bartol. 2012. Hearing capabilities of loggerhead sea turtles (*Caretta caretta*) throughout ontogeny. Pp. 89-92 *In* A. N. Popper and A. D. Hawkins (eds.). The effects of noise on aquatic life. Springer Science + Business Media, LLC, New York.

Leonhard, S.B., C. Stenberg, and J. Stottrup, editors. 2011. Effect of the Horns Rev 1 offshore wind farm on fish communities: Follow-up seven years after construction. DTU Aqua, National Institute of Aquatic Resources, DTU Aqua Report No 246-2011.

Lenarz, W.H., D.A. VenTresca, W.M. Graham, F. B. Schwing & F. Chavez, 1995. Explorations of El Niño events and associated biological population dynamics off central California. CalCOFI Reports 36: 106-119.

Lenhardt, M.L. 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (Caretta caretta). In Proceedings of the fourteenth annual symposium on sea turtle biology and conservation (K.A. Bjorndal, A.B. Bolten, D.A. Johnson & P.J. Eliazar, eds.) NOAA Technical Memorandum, NMFS-SEFC-351, National Technical Information Service, Springfield, Virginia, 238-241.

Light, J.T., C.K. Harris, and R.L. Burgner. 1989. Ocean distribution and migration of steelhead (Oncorhynchus mykiss, formerly Salmo gairdneri). (Document submitted to the International North Pacific Fisheries Commission.) 50 pp. FRI-UW-8912. Fisheries Research Institute, University of Washington, Seattle.

Lincoln County. 2014. About Lincoln County. Available Online: http://www.co.lincoln.or.us/about.html#facts (Accessed October 2014).

Lindley, S.T., M.L. Moser, D.L. Erickson, M. Belchik, D.W. Welch, E. Rechisky, J.T. Kelly, J. Heublein, and A.P. Klimley. 2008. Marine Migration of North American Green Sturgeon. Transactions of the American Fisheries Society 137:182-194.

Lindley, S. T., D. L. Erickson, Daniel, M. L. Moser, G. Wouldiams, O. P. Langness, B. W., McCovey Jr., M. Belchik, D. Vogel, W. Pinnix, J. T. Kelly, J. C. Heublein, and A. P. Klimley. 2011. Electronic tagging of green sturgeon reveals population structure and movement among estuaries. Transactions of the American Fisheries Society 140:108-122.

Lomeli, M.J.M. and W.W. Wakefield. 2014. Examining the potential use of artificial illumination to enhance Chinook salmon escapement out a bycatch reduction device in a Pacific hake midwater trawl. NMFS Northwest Fisheries Science Center Report, 15 pp. Available at http://www.psmfc.org/bycatch/documents/LomeliWakefield2014Chinook.pdf.

Love, M.S., M.M. Nishimoto, S. Clark, and A.S. Bull. 2016. Renewable Energy in situ Power Cable Observation. U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study 2016-008. 86 pp.

Love M.S., and Schroeder D.M. 2006. Ecological performance of OCS platforms as fish habitat off California. MMS OCS Study 2004-005. Santa Barbara (CA): Marine Science Institute, University of California, Santa Barbara. MMS Cooperative Agreement No. 1435-01-03-CA- 72694.

Love, M.S., and M. Yoklavich. 2006. Deep rock habitats. Pages 253-268 in L. G. Allen, D. J. Pondella II, and M. H. Horn (Editors), The Ecology of Marine Fishes, California and Adjacent Waters. University of California Press, Berkeley and Los Angeles, California.

Love, M.S., M.M. Nishimoto, and D.M. Schroeder. 2010. Fish Assemblages Associated with Platforms and Natural Reefs in Areas Where Data are Non-existent or Limited. Bureau of Ocean Energy Management, Regulation and Enforcement, Camarillo, CA. BOEMRE OCS Study 2010-012.

Love, M.S., M. Nishimoto, S. Clark, and D.M. Schroeder. 2012. Recruitment of young-of-the-year fishes to natural and artificial offshore structure within central and southern California waters, 2008-2010. Bulletin of Marine Science 88:863-882.

Love, M.S., M.M. Nishimoto, S. Clark, and A. Scarborough Bull. 2015. Identical response of caged rock crabs (genera *Metacarcinus* and *Cancer*) to energized and unenergized undersea power cables in southern California, USA. Bulletin of the Southern California Academy of Sciences 114(1):33-41.

Love, M.S., M.M. Nishimoto, S. Clark, and A.S. Bull. 2016. Renewable Energy in situ Power Cable Observation. U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study 2016-008. 86 pp.

Lower Columbia Fish Recover Board (LCFRB). 2010. Washington Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan.

Marin Jarrin, J.R., A.L. Shanks, and M.A. Banks. 2009. Confirmation of the presence and use of sandy beach surf-zones by juvenile Chinook salmon. Environmental Biology of Fishes 85:119-125.

Marshall, D.B., M.G. Hunter, and A.L. Contreras, Eds. 2006. Birds of Oregon: a general reference. Oregon State University Press, Corvallis, OR. 768 pp.

Masden, E.A., D.T. Haydon, A.D. Fox, R.W. Furness, R. Bullman, and M. Desholm, 2009. Barriers to movement: impacts of wind farms on migrating birds. ICES Journal of Marine Science 66:746-753.

Matthews, K.R. 1985. Species similarity and movement of fishes on natural and artificial reefs in Monterey Bay, California. Bulletin of Marine Science 37:252-270.

Maurer, D., R.T. Keck, J.C. Tinsman, and W.A. Leathem. 1982. Vertical migration and mortality of benthos in dredged material: Part III – polychaeta. Marine Environmental Research. 6:49-68.

McCauley, R.D., Fewtrell, J. Duncan, A.J., Jenner, C. Jenner. M.N., Penrose, J.D. Prince. R.I.T., Adhitya, A. Murdock, J. and McCabe, K. 2000. Marine seismic surveys: a study of environmental implications. APPEA Journal, 40:692-708.

McShane, C., T. Hamer, H. Carter, G. Swartzman, V. Friesen, D. Ainley, R. Tressler, K. Nelson, A. Burger, L. Spear, T. Mohagen, R. Martin, L. Henkel, K. Prindle, C. Strong, and J. Keany. 2004. Evaluation report for the 5-year status review of the marbled murrelet in Washington, Oregon, and California. Unpublished Report. EDAW, Inc., Seattle, WA. Prepared for the U.S. Fish and Wildlife Service, Region 1. Portland, OR.

Miles, W., S. Money, R. Luxmoore, and R.W. Furness. 2010. Effects of artificial lights and moonlight on petrels at St. Kilda. Bird Study 57:244-251.

Miller, S.L., C.B. Meyer, and C.J. Ralph. 2002. Land and seascape patterns associated with marbled murrelet abundance offshore. Waterbirds 25:100-108.

Mills, F.H.J. and Renouf, D. 1986. Determination of the vibration sensitivity of harbour seal Phoca vitulina (L.) vibrissae. J. Exp. Mar. Biol. Ecol. 100, 3-9.

Minerals Management Service (MMS). 2007. Record of Decision. Programmatic Environmental Impact Statement: Establishment of an OCS Alternative Energy and Alternate Use Program. MMS, Washington, DC. 20 p.

Minor, Rick. 2008. Archaeological Monitoring and Testing at the Alsea Village of łkú•huyu•/Old Town Waldport, Lincoln County, Oregon. Heritage Research Associates Report No. 326.

Mitchell, C.T., and J.R. Hunter. 1970. Fishes associated with drifting kelp, *Macrocystis pyrifera*, off the coast of southern California and northern Baja California. California Fish and Game 56:288-297.

Montevecchi, W.A. 2006. Influences of artificial light on marine birds. Chapter 5 in C. Rich and T. Longcore, Editors. Ecological consequences of artificial night lighting. Island Press, Washington, D.C.

Mooney, James. 1928. The Aboriginal Population of American North of Mexico. *Smithsonian Miscellaneous Collections* 80(7). Washington.

Morris, J.F.T., M. Trudel, M.E. Thiess, R.M. Sweeting, J. Fisher, S.A. Hinton, E.A. Fergusson, J.A. Orsi, E.V. Farley, Jr., and D.W. Welch. 2007. Stock-specific migrations of juvenile coho salmon derived from coded-wire tag recoveries on the continental shelf of western North America. American Fisheries Society Symposium 57:81-104.

Moyle, P.B. 2002. Inland fishes of California. University of California Press, Berkeley, CA. 502 pp.

Munoz, N.J., A.P. Farrell, J.W. Heather, and B.D. Neff. 2014. Adaptive potential of a Pacific salmon challenged by climate change. Nature Climate Change 5(2015):163-166.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grand, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-35, 443 p.

National Conference of State Legislatures Available. 2014. Federal and State Recognized Tribes. Last Updated April 2014. Available online: http://www.ncsl.org/research/state-tribal-institute/list-of-federal-and-state-recognized-tribes.aspx#or (Accessed October 2014).

National Marine Fisheries Service (NMFS). 2008. Draft Environmental Impact Statement for Proposed Authorization of the Makah Whale Hunt. NOAA. May 2008.

National Marine Fisheries Service (NMFS). 2009b. North Atlantic right whale (*Eubalaena glacialis*): Western Atlantic Stock. Stock assessment report. December 2009. Available at http://www.nmfs.noaa.gov/pr/sars/species.htm.

National Marine Fisheries Service (NMFS). 2010a. Proposed rule to revise the critical habitat designation for the endangered leatherback sea turtle. 75 FR 319.

National Marine Fisheries Service (NMFS). 2010b. Recovery plan for the sperm whale (*Physeter macrocephalus*). National Marine Fisheries Service, Silver Spring, MD. 165 pp.

National Marine Fisheries Service (NMFS). 2011. Final Recovery Plan for the Sei Whale (*Balaenoptera borealis*). National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD. 108 pp.

National Marine Fisheries Service (NMFS). 2011e. North-Central California Coast Recovery Domain. 5-Year Review: Summary and evaluation of California

Coastal Chinook salmon ESU, Central California Coast coho salmon ESU. National Marine Fisheries Service. Southwest Region, Long Beach, CA.

National Marine Fisheries Service (NMFS). 2012b. Endangered Species Act Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Reedsport Ocean Power Technologies (OPT) 10-PowerBuoy Wave Park, 2.5 miles offshore of Reedsport, Oregon in the Eastern Pacific Ocean (FERC Docket No. P-12713-002). June 7, 2012.

National Marine Fisheries Service (NMFS). 2012c. Endangered Species Act Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Department of Energy's Northwest national marine Renewable Energy Center and Oregon State University Wave Energy Test Facility project Funding and US Army Corps of Engineers Nationwide Permit #5 for 2012-2013 WET-NZ Wave Energy Test project in the Northwest National Marine Renewable Energy Center Test Site. August 2, 2012.

National Marine Fisheries Service (NMFS). 2013a. Lower Columbia River salmon and steelhead ESA Recovery Plan.

National Marine Fisheries Service (NMFS). 2013b. Species Profile: Sperm Whale, Office of Protected Resources, May 2014. Available online: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/spermwhale.htm (Accessed November 2014).

National Marine Fisheries Service (NMFS). 2013c. Biological Report on the Designation of Marine Critical Habitat for the Loggerhead Sea Turtle, Caretta. Available online at http://www.nmfs.noaa.gov/pr/pdfs/criticalhabitat/loggerhead_criticalhabitat_biological.pdf (Accessed August, 2017).

National Marine Fisheries Service (NMFS). 2014. Species Profile: Blue Whale, Office of Protected Resources, May 2014. Available online: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/bluewhale.htm (Accessed November 2014).

National Marine Fisheries Service (NMFS). 2015. Endangered Species Act Section 7 Consultation Biological Opinion. Deepwater Wind: Block Island Wind Farm and Transmission System. NER-2015-12248.

National Marine Fisheries Service (NMFS). 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 p.

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

National Marine Fisheries Service (NMFS). 2017. The 5 year review: North Pacific Right Whale (*Eubalaena japonica*) Five-Year Review: Summary and Evaluation.

National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS and FWS). 1998. Recovery Plan for U.S. Pacific populations of the leatherback turtle (*Dermochelys coriacea*).

National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS and FWS). 2013. Leatherback sea turtle (*Dermochelys coriacea*) 5-Year Review: Summary and evaluation. Available at http://www.nmfs.noaa.gov/pr/listing/5yearreview_leatherbackturtle.pdf National Oceanic and Atmospheric Administration (NOAA). 2018. Biologically Important Areas, Interactive BIA MAP. Online [URL]: https://cetsound.noaa.gov/important (Accessed September 4, 2018).

National Oceanic and Atmospheric Administration (NOAA). 2017. 2016 West Coast Entanglement Summary. *Available online* at: http://www.westcoast.fisheries.noaa.gov /mediacenter/WCR%202016%20Whale%20Entanglements_3-26-17_Final.pdf. March 2017.

National Oceanic and Atmospheric Administration (NOAA). 2016. 2015 Whale Entanglements off the West Coast of the United States. *Available online* at: http://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/cetaceans/whale_entanglement_fact_sheet.pdf. March 2016.

National Oceanic and Atmospheric Administration (NOAA). 2014b. Leatherback Turtle (*Demochelys coriacea*). Available online: http://www.nmfs.noaa.gov/pr/species/ turtles/leatherback.htm (Accessed October 2014).

National Oceanic and Atmospheric Administration (NOAA). 2014c. Kelp Forest. Available online: http://www.westcoast.fisheries.noaa.gov/habitat/habitat_types/kelp_forest_info/kelp_forest_habitat_types.html (Accessed October 2014).

National Oceanic and Atmospheric Administration (NOAA). 2014d. Marine Mammal Stock Assessment Reports (SARs) by Species/Stock. Available online at: http://www.nmfs.noaa.gov/pr/sars/species.htm. (Accessed October 2014).

National Oceanic and Atmospheric Administration (NOAA). 2007. Community Profiles for West Coast and North Pacific Fisheries, Washington, Oregon, California, and other U.S. States. Available Online: http://www.nwfsc.noaa.gov/assets/25/499_01082008_153910_CommunityProfilesTM85WebFinalSA.pdf?CFID=43717503&CFTOKEN=78931119&jsessionid=8430ec2bd87d7bd127227326376614406 92a (Accessed October 2014).

NERC (North American Electric Reliability Corporation). 2019. Long-Term Reliability Assessment; December 2019.

NOAA Fisheries West Coast Region and Washington Department of Fish and Wildlife. 2018. Southern Resident killer whale priority Chinook stocks report. June 22, 2018. Accessed on 11/1/2018 at https://www.westcoast.fisheries.noaa.gov/publications/protected _species/marine_mammals/killer_whales/recovery/srkw_priority_chinook_stocks_conceptual_model_report___list_22june2018.pdf.

National Research Council (NRC). 2003. Ocean noise and marine mammals. National Academy.

National Resources Conservation Service (NRCS). 2016. Web Soil Survey. Online Resource. Available online at: http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm. (Accessed May 27, 2016).

Naughton, M.B., D.S. Pitkin, R.W. Lowe, K.J. So, and C.S. Strong. 2007. Catalogue of Oregon Seabird Colonies. BTP-R1009-2007, U.S. Fish and Wildlife Service, Portland.

Naval Facilities Engineering Command. (NAVFAC). 2014. Wave Energy Test Site Final Environmental Assessment. Naval Facilities Engineering Command, Pacific Naval Facilities Engineering and Expeditionary Warfare Center, Marine Corps Base, Hawaii.

Navy. Barking Sands Underwater Range Expansion Refurbishment; Final Record of Categorical Exclusion/Overseas Environmental Assessment. 2008. cited in NAVFAC 2014.

Nedwell, J.R., and B. Edwards. 2004. A review of measurements of underwater man-made noise carried out by Subacoustech Ltd, 1993-2003. Report 534R0109 submitted to Chevron Texaco, et al.Neilson, J.L., Gabriele, C.M., Jensen, A.S., Jackson, K., and Straley, J.M. 2012. Summary of Reported Whale-Vessel Collisions in Alaskan Waters. Journal of Marine Biology. 2012: 1-18.

Nelson, K. 1997. Marbled murrelet (*Brachyramphus marmoratus*). *In*: Birds of North America, No. 276 (Poole, A. and G. Gill, eds.). The Academy of Natural Sciences and The American Ornithologists' Union, Washington, D.C.

Nelson, P.A. 2003. Marine fish assemblages associated with fish aggregating devices (FADs): effects of fish removal, FAD size, fouling communities, and prior recruits. *Fishery Bulletin* 101: 835-850.

Neo, Y.Y., J. Seitz, R.A. Kastelein, H.V. Winter, C. ten Cate, H. Slabbekoorn. 2014. Temporal structure of sound affects behavioural recovery from noise impact in European seabass. Biological Conservation 178:65-73.

Neptune LNG LLC. 2007. Revised application for incidental harrassment authorization and letter of authorization for the non-lethal taking of marine mammals resulting from the construction and operation of the Neptune LNG Deepwater Port, Massachusetts Bay. December 2007.

Newcombe, C.P. and J.O. Jensen. 1996. Channel suspended sediment and fisheries: A synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. 16:693-727, 1996.

Newell, R.C., L.J. Seiderer, N.M. Simpson, and J.E. Robinson. 2004. "Impacts of Marine Aggregate Dredging on Benthic Macrofauna off the South Coast of the United Kingdom." Journal of Coastal Research. 20(1): 115-125.

Nielsen, T.P., Wahlberg, M., Heikkilä, S., Jensen, M., Sabinsky, P., and Dabelsteen, T. 2012. Swimming patterns of wild harbour porpoises *Phocoena* show detection and avoidance of gillnets at very long ranges. Marine Ecology Progress Series, 453, 241-248. Cited in Benjamins et al. (2014).

Normandeau Associates Inc, Exponent Inc, T. Tricas, and A. Gill. 2011. Effects of EMFs from Undersea Power Cables on Elasmobranchs and other Marine Species. U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, California. OCS Study BOEMRE 2011-09.

Northwest National Marine Renewable Energy Center (NNMREC). 2015a. Annual Operations & Monitoring Report 2014. Prepared for the Adaptive Management Committee by NNMREC. February 6, 2015 Revised April 14, 2015.

Northwest National Marine Renewable Energy Center (NNMREC). 2015b. Adaptive Management Framework for the Pacific Marine Energy Center South Energy Test Site.

Northwest Power and Conservation Council. 2016. Seventh Northwest Conservation and Electric Power Plan. document 2016-02. February 25, 2016. Available online at https://www.nwcouncil.org/energy/powerplan/7/plan/.

Ocean Observatories Initiative (OOI). 2011. Finding of No Significant Impact Pursuant to the National Environmental Policy Act (NEPA) 42 U.S.C. 4321, *et seq.*

Oregon Bird Records Committee (OBRC). 2016. The records of the Oregon Bird Records Committee through April 2014. Available: http://www.orbirds.org/obrcrecordsaugust2016.pdf. (Accessed October 2016).

Oregon Department of Energy (ODOE). 2015. 2015-17 State of Oregon Biennial Energy Plan. Salem, OR. Available at https://www.oregon.gov/energy/docs/reports/legislature/2015/Energy_Plan_2015-17.pdf.

Oregon Department of Environmental Quality (ODEQ). 2011. Reedsport OPT Wave Park Evaluation and Findings Report. FERC Project No. 12713, Portland, OR.

Oregon Department of Environmental Quality (ODEQ). 2012. Water Quality Assessment – Oregon's 2010 Integrated Report Assessment Database and 303(d) List. Updated December 14, 2012. Available online: online: http://www.deq.state.or.us/wq/assessment/rpt2010/search.asp.

Oregon Department of Fish and Wildlife (ODFW). 2011. Marine Mammal Research Program: Species Information. Available at: http://www.dfw.state.or.us/MRP/mammals/species.asp.

Oregon Department of Fish and Wildlife (ODFW). 2015. Bat Call Recordings at Tami Wagner Wildlife Area, Fall 2015. Unpublished Data.

Oregon Department of Fish and Wildlife (ODFW). 2016. Sensitive Species List. <https://www.dfw.state.or.us/wildlife/diversity/species/docs/2016_Sensitive_Species_List.pdf>. Accessed October 2018.

Oregon Department of Fish and Wildlife (ODFW) 2017. Oregon's Ocean Commercial Fisheries. Available online:

https://www.dfw.state.or.us/MRP/docs/Backgrounder_Comm_Fishing.pdf (Accessed April 2019).

Oregon Department of Fish and Wildlife (ODFW). 2018. Threatened , Endangered, and Candidate Fish and Wildlife Species. Last Updated June 2018. Available Online: http://www.dfw.state.or.us/wildlife/diversity/species/threatened_endangered_candidate_list.asp. (Accessed May 2019).

Oregon Department of Fish and Wildlife (ODFW). 2019. 2018 Final Pounds and Values of Commercially Caught Fish and Shellfish Landed in Oregon in Newport. Available online: http://www.dfw.state.or.us/fish/commercial/landing_stats/2018/NEWPORT.pdf. (Accessed May 2019).

Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife (ODFW and WDFW). 2014. Studies of eulachon smelt in Oregon and Washington. Prepared for the National Oceanic and Atmospheric Administration, Washington, D.C., by the Oregon Department of Fish and Wildlife and the Washington Department of Fish and Wildlife. Grant No.: NA10NMF4720038.

Oregon Department of Land Conservation and Development (DLCD). 2001. A Citizen's Guide to the Oregon Coastal Management Plan. Available Online: http://www.oregon.gov/LCD/docs/publications/citzngid.pdf (Accessed October 2014).

Oregon Department of Land Conservation and Development. 2013. Oregon Territorial Sea Plan, Part Five: Use of the Territorial Sea for the Development of Renewable Energy Facilities or Other Related Structures, Equipment or Facilities. Salem, OR.

Oregon Employment Department. 2014. Unemployment Rates. Available Online: http://www.qualityinfo.org/olmisj/AllRates (Accessed October 2014).

Oregon Natural Heritage Information Center (ONHIC) and The Wetlands Conservancy. 2009. Oregon Wetlands Cover. October 2009.

Oregon Parks and Recreation Department (OPRD). 2018. Oregon Parks and Recreation Department: Grants Programs. Online [URL]: https://www.oregon.gov/oprd/GRANTS/pages/lwcf.aspx (Accessed November 8, 2018).

Oregon Parks and Recreation Department (OPRD). 2014. Driftwood Beach State Recreation Site. Available Online: http://www.oregonstateparks.org/index.cfm?do=parkPage.dsp_parkHistory&parkId=144 (Accessed October 2014).

Oregon Public Ports Association. 2014. Port of Newport. http://www.portofnewport.com/ (Accessed October 2014).

Oregon Secretary of State. 2014. Oregon's Economy: Overview. Online [URL]: http://bluebook.state.or.us/facts/economy/economy01.htm (Accessed March 2015).

Oregon State University. 2020. Oregon State University's Federal Consistency Certification submission to Oregon Department of Land Conservation and

Development for the PacWave South Project (FERC No. 14616). Filed February 27, 2020 (accession no. 20200227-5219).

Oregon State University and Institute for Natural Resources (OSU and INR). 2014. Wildlife Viewer. [Online] URL: http://oe.oregonexplorer.info/Wildlife/wildlifeviewer/. (Accessed October 2014)

Oregon Watershed Enhancement Board (OWEB). 2008. Summary of Watershed Health Indicators for the Oregon Coast Coho ESU 2007. Available online: https://www.oregon.gov/OWEB/docs/pubs/rest_priorities/or_coastcohoesu_priorities.pdf.

Oregon Wave Energy Trust (OWET). 2014. The Oregon Advantage. Online [URL]: http://oregonwave.org/information/oregon-advantage/ (Accessed December 2014).

Ormsbee P.C., L. Risdal, and A.H. Hart. 2010. The Bat Database: A compilation of bat species detections and related attributes spanning 1883 to 2010 collected in the Pacific Northwest. (Unpublished database).

Ortega-Ortiz, J., B. Mate. 2008. Distribution and Movement Patterns of Gray Whales Migrating by Oregon: Shore-Based Observations Off Yaquina Head, Oregon, December 2007-May 2008. Oregon State University Marine Mammal Institute. October 2008.

Oshima, T., and M. Li. 2013. Field measurements on wind effects to propagation of road traffic noise over open and flat ground. Applied Acoustics 74(1):141-149.

Pacific Fishery Management Council. 2014. Letter to FERC commenting on Scoping Document 1 for PMEC-SETS, July 8, 2014.

Pacific Fishery Management Council. 2013. Habitat and Communities: Habitat. Available Online: http://www.pcouncil.org/habitat-and-communities/habitat/ (Accessed on October 2014).

Panzer, D. 2014. BOEM's Renewable Energy Program Marine Hydrokinetic Update. Presented at the Ocean Renewable Energy Conference IX. 24-25 September 2014. Bureau of Ocean Energy Management, Pacific OCS Region.

Parker, P. and T. King. 1998. Guidelines for Evaluating and Documenting Traditional Cultural Properties. Department of the Interior National Park Service National Register, History and Education National Register of Historic Places.

Payne, J., D.L. Erickson, M. Donnellan, and S.T. Lindley. 2015. Migration and habitat use of green sturgeon (*Acipenser medirostris*) near the Umpqua River Estuary. On behalf of Oregon Wave Energy Trust. March 2015. Available at http://oregonwave.org/oceanic/wp-content/uploads/2015/04/Green-Sturgeon-Study_-Website_FINAL.pdf.

Pemberton, G. and J.A. MacEachern. 1997. The ichnological signature of storm deposits: The use of trace fossils in event stratigraphy. Pages 73-109 in C.E. Brett and G.C. Baird, editors. Paleontological events: stratigraphic, ecological, and evolutionary implications. Columbia University Press, New York. *cited in* NMFS 2012c.

Peterson, W.T., and J.E. Keister. 2003. Interannual variability in copepod community composition at a coastal station in the northern California Current: a multivariate approach. Deep Sea Research Part II: Topical Studies in Oceanography.

Peterson, W.T., C.A. Morgan, J.P. Fisher, and E. Casillas. 2010. Ocean distribution and habitat associations of yearling coho (*Oncorhynchus kisutch*) and Chinook (*O. tshawytscha*) salmon in the northern California Current. Fisheries Oceanography 19:508-525.

Plonczkier, P. and I.C. Simms. 2012. Radar monitoring of migrating pink-footed geese: behavioural responses to offshore wind farm development. Journal of Applied Ecology. doi: 10.1111/j.1365-2664.2012.02181.x.

Poot, H., B.J. Ens, H. de Vries, M.A.H. Donners, M.R. Wernand, and J.M. Marquenie. 2008. Green light for nocturnally migrating birds. Ecology and Society 13(2):47. http://www.ecologyandsociety.org/vol13/iss2/art47/.

Popper, A.N. 2003. Effects of anthropogenic sound on fishes. Fisheries 28:24-31.

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

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, et al. 2014. ASA S3/SC1. 4 TR-2014. Sound exposure guidelines for fishes and sea turtles: a technical report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. New York, NY: Springer.

Porquez, J.M. 2016. Spatiotemporal drivers of seabird distribution at the Pacific Marine Energy Center off Newport, Oregon. Master's thesis. Oregon State University, Corvallis, Oregon.

Port of Newport. 2013. Strategic Business Plan and Capital Facilities Plan. January.

Purser, J. and A.N. Radford. 2011. Acoustic noise induces attention shifts and reduces foraging performance in three-spined sticklebacks (*Gasterosteus aculeatus*). PLoS One 6:1-8.

Putman, N.F., Endres, C.S., Lohmann, C.M.F. and Lohmann, K.J. 2011. Longitude perception and bicoordinate magnetic maps in sea turtles. Current Biology, 21: 463-466.

Putman, N.F., M.M. Scanlan, E.J. Billman, J.P. O'Neil, R.B. Couture, T.P. Quinn, K.J. Lohmann, and D.L.G. Noakes. 2014. An inherited magnetic map guides ocean navigation in juvenile Pacific salmon. Current Biology 24:446-450.

Quinn TP. 2005. The behavior and ecology of Pacific salmon and trout. Seattle (WA): University of Washington Press.

Radtke, L.D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento–San Joaquin Delta with observations on food of sturgeons. Pp. 115-119. In: J.L. Turner & D.W. Kelley (eds.), Ecological Studies of the Sacramento–San Joaquin Estuary, Part II. California Department of Fish Game Fish Bulletin 136.

Rance, P.J. 1980. The potential for scour around large objects. Scour Prevention Techniques Around Offshore Structures. Proceedings of a one day seminar. 16 December 1980. Society for Underwater Technology. London. 41-53.

Reedsport OPT Wave Park, LLC. 2010. Reedsport OPT Wave Park, FERC Project 12713. FERC License Application, Applicant Prepared Environmental Assessment, Volume II of IV. January 2010.

Reubens, J.T., S. Degraer, and M. Vincx. 2014. The ecology of benthopelagic fishes at offshore wind farms: A synthesis of 4 years of research. Hydrobiologia 727:121-136.

Richardson, W.J., C.R Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise. Academic Press, New York, NY.

Roegner, G.C., and S.A. Fields. 2015. Mouth of the Columbia River Beneficial Sediment Deposition Project: Benthic Impact Study 2014. Report of the National Marine Fisheries Service to the U.S. Army Corps of Engineers. Portland, Oregon.

Ross, Richard. 1990. Prehistory of the Oregon Coast. In Northwest Coast: Handbook of North American Indians, Volume 7. Wayne Suttles, ed, Smithsonian Institute, Washington D.C.

Sachs, G., J. Traugott, A.P. Nesterova, G. Dell'Omo, F. Kümmeth, W. Heidrich, A. L. Vyssotski, and F. Bonadonna. 2012. Flying at no mechanical energy cost: disclosing the secret of wandering albatrosses. PLoS ONE;7(9):e41449. doi:10.1371/journal.pone.0041449.

Science Applications International Corporation (SAIC). 2011. Final Summary Report: Environmental Science Panel for Marbled Murrelet Underwater Noise Injury Threshold. July 27-29. Prepared for U.S. Navy NAVFAC Northwest. Available: http://www.fws.gov/wafwo/pdf/MAMU_ConferenceSummaryReport_090711.pdf Siemens.

Schiff, K., J. Brown, D. Diehl, and D. Greenstein. 2007. Extent and magnitude of copper contamination in marinas of the San Diego region, California, USA. Marine Pollution Bulletin, Volume 54, Issue 3, March 2007, Pages 322-328.

Schultz, A. 2013. Electric and magnetic field measurements at the Northwest National Marine Renewable Energy Center Ocean Test Facility. Attachment 4; Pages 99-117 Cited in Northwest National Marine Renewable Energy Center North Energy Test Site: 2012 Annual operations and monitoring report.

Schusterman, R.J., and R.F. Ballet. 1970. Visual acuity of the harbor seal and the Steller sea lion under water Nature 226: 563-564.

Scottish Executive. 2007. Scottish Marine Renewables SEA, Environmental Report. March 2007. Available online http://www.scotland.gov.uk/Publications/2007/03/seawave.

Sealy, S.G. 1974. Breeding phenology and clutch size in the marbled murrelet. Auk 91:10-23.

Siemens & Associates. 2019. Technical Services for Terrestrial Seismic Survey and Evaluation. Data Report: Results of Geophysical Exploration.

Siemens & Associates. 2018. PacWave: HDD Path on the Pacific Ocean, near Waldport, Oregon. Data Report: Results of Geophysical Exploration.

Siemens & Associates. 2017. Pacific Marine Energy Center South Energy Test Site, near Waldport, Oregon. Data Report: Results of Geophysical Exploration.

Siemens. 2011. Siemens Debuts HVDC PLUS with San Francisco's Trans Bay Cable. Available online: http://www.energy.siemens.com/hq/pool/hq/energy-topics/living-energy/issue-5/livingenergy_05_hvdc.pdf. (Accessed February 2015).

Simpson, S.D., A.N. Radford, S.L. Nedelec, M.C.O. Ferrari, D.P. Chivers, M. I. McCormick, and M.G. Meekan. 2015. Anthropogenic noise increases fish mortality by predation. Nature Communications DOI: 10.1038/ncomms10544.

Sims, N.A. 2013. Kona Blue Water Farms case study: permitting, operations, marketing, environmental impacts, and impediments to expansion of global open ocean mariculture. *In* A. Lovatelli, J. Aguilar-Manjarrez & D. Soto, eds. Expanding mariculture farther offshore: Technical, environmental, spatial and governance challenges. FAO Technical Workshop, 22-25 March 2010, Orbetello, Italy. FAO Fisheries and Aquaculture Proceedings No. 24. Rome, FAO. pp. 263-296. Available online: ftp://ftp.fao.org/fi/Cdrom/P24/i3530e/root/14.pdf.

Slabbekoorn, H., N. Bouton, I. van Opzeeland, A. Coers, C. ten Cate, and A.N. Popper. 2010. A noisy spring: the impact of globally rising underwater sound levels on fish. Trends in Ecology and Evolution 25:419-427. doi: 10.1016/j.tree.2010.04.005.

Slater, M., A. Schultz, and R. Jones. 2010a. Electromagnetic Field Study: Estimated Ambient Electromagnetic Field Strength in Oregon's Coastal Environment. Oregon Wave Energy Trust. 0905-00-002.

Slater, M., A. Schultz, and R. Jones. 2010b. Electromagnetic Field Study: The Prediction of Electromagnetic Fields Generated by Wave Energy Converters. Oregon Wave Energy Trust. 0905-00-003.

Slater, M., R. Jones, and A. Schultz. 2010c. Electromagnetic Field Study: The Prediction of Electromagnetic Fields Generated by Submarine Power Cables. Oregon Wave Energy Trust. 0905-00-007.

Slotte, A., K. Hansen, J. Dalen, and E. Ona. 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast Fisheries Research 67 (2004) 143-150.

Snelgrove, P.V.R., and C.A. Butman, 1994. Animal-sediment relationship revisited: cause versus effect. Oceanogr. Mar. Biol. Ann. Rev.

Soulsby, R. 1997. Dynamics of marine sands – A manual for practical applications. HR Wallingford.

Sound and Sea Technology. Wave Energy Technology Project (WET) Environmental Impacts of Selected Components. Prepared for Belt Collins Hawaii. 2002. *Appendix F* in Navy 2003.

Sound & Sea Technology. 2009. Advanced anchoring and mooring study. Prepared for the Oregon Wave Energy Trust. Portland, OR. November 30, 2009.

Southall, B.L. 2005. Final report of the NOAA International Symposium: "Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology," 18-19 May, 2004, Arlington, VA, U.S.A.

Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, R., Greene, C. Jr., Kastak, D.,Ketten, D., Miller, J., Nachtigall, P., Richardson, W., Thomas, J., Tyack, P. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Available at http://sea-inc.net/assets/pdf/mmnoise_aquaticmammals.pdf.
Sovern, S.G., E.D. Forsman, B.L. Biswell, D.N. Rolph, and M. Taylor. 1994. Diurnal behavior of the spotted owl in Washington. Condor 96:200-202.
Spromberg, J.A., and J.P. Meador. 2006. Relating chronic toxicity responses to population-level effects: A comparison of population-level parameters for three salmon species as a function of low-level toxicity. Ecological Modelling 199:240-252.
Stephens, J.S., Jr., R.J. Larson, and D.J. Pondella. 2006. Rocky reefs and kelp beds. Pages 227-252 in L. G. Allen, D. J. Pondella II, and M. H. Horn (Editors), The Ecology of Marine Fishes, California and Adjacent Waters. University of California Press, Berkeley and Los Angeles, California.
Strachan, G., M. McAllister, and C.J. Ralph. 1995. Marbled murrelet at-sea and foraging behavior. *In*: Ecology and conservation of the marbled murrelet (Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, eds.). U.S. Forest Service, Pacific Southwest Research Station, Albany, CA. Gen. Tech. Rep. PSW-GTR-152. p. 247-254.
Stratton, E. 2015. Wave power: Company hopes to harness the motion of the ocean at Camp Rilea. The Daily Astorian, October 29, 2015. Available online: http://www.dailyastorian.com/Local_News/20151029/wave-power-company-hopes-to-harness-the-motion-of-the-ocean-at-camp-rilea (Accessed 7 July 2016).
Strong, C. S. 2009. Seabird abundance and distribution during summer off the Oregon and southern Washington coast. Crescent Coastal Research, Crescent City, CA.
Surfrider Foundation et al. 2011. Non-consumptive Ocean Recreation in Oregon: Human Uses, Economic Impacts, & Spatial Data. March 3, 2011.
Sumer, B.M., and J. Fredsoe. 2002. The mechanics of scour in the marine environment: Advanced series on ocean engineering – Volume 17. World Scientific. 536 p.
Suryan, R.M., K.S. Dietrich, E.F. Melvin, G.R. Balogh, F. Sato, and K. Ozaki. 2007. Migratory routes of short-tailed albatross: use of exclusive economic zones of North Pacific Rim countries and spatial overlap with commercial fisheries in Alaska. Biological Conservation 137: 450-460.
Suryan, R.M., D.J. Anderson, S.A. Shaffer, D.D. Roby, Y. Tremblay, D.P. Costa, P.R. Sievert, F. Sato, K. Ozaki, G.R. Balogh, and N. Nakamura. 2008. Wind, waves, and wing loading: Morphological specialization may limit range expansion of endangered albatrosses. PLoS ONE 3:e4016. doi:4010.1371/journal.pone.0004016.
Suryan, R.M., E.M. Phillips, K.J. So, J.E. Zamon, R.W. Lowe, and S.W. Stephensen. 2012. Marine bird colony and at-sea distributions along the Oregon coast: Implications for marine spatial planning and information gap analysis. Northwest National Marine Renewable Energy Center Report no. 2. Corvallis: NNMREC. 26 pp.

Suryan, R.M., and J. Porquez. 2016. Site Characterization Report- Seabirds. Pacific Marine Energy Center-South Energy Test Site.

Tagging of Pacific Pelagics (TOPP). 2010. Data for a migratory leatherback sea turtle. Available at http://las.pfeg.noaa.gov/TOPP/.

Tanaka, S., and B. Shiraishi. 2008. Wind effects on noise propagation for complicated geographical and road configurations. Applied Acoustics 69(11):1038-1043.

Taylor, T. 2018. Oregon Parks and Recreation Department letter to Kimberly Bose, Federal Energy Regulatory Commission on the Draft License Application for PMEC-SETS, FERC Docket number P-14616-000. July 20, 2018.

TEC Inc. 2011. Site-Specific Environmental Assessment for the Ocean Observatories Initiative – Final. National Science Foundation, Division of Ocean Sciences, Arlington, Virginia.

TerraSond. 2019. PMEC-SETS marine Geophysical and Geotechnical Surveys. May 3, 2019.

Terracon. 2020. Geotechnical Survey Report for Terrestrial HDD Route. Project No. 82195049. January 13, 2020.

Tetra Tech. 2012a. Block Island Wind Farm and Block Island Transmission System Environmental Report / Construction and Operations Plan. Appendix H, Sediment Transport Analyses. Prepared by RPS ASA for Deepwater Wind. September 2012.

Tetra Tech. 2012b. Block Island Wind Farm and Block Island Transmission System In-Air Acoustic report. Appendix N-1. Prepared for Deepwater Wind Block Island, LLC and Deepwater Wind Block Island Transmission, LLC. September 2012.

Tetra Tech. 2013. Appendix M-1. In-Air Acoustic Modeling Report. Virginia Offshore Wind Technology Advancement Project (VOWTAP). Prepared for Dominion. December 2013.

3U Technologies LLC. 2013. Draft cable routing desktop study for power cables near Newport, Oregon. Prepared for NNMREC, PMEC, OSU. December 2013.

Thomson J., B. Polagye, C. Bassett (2012) Noise Measurements of Columbia Power Technologies 1/7 Scale Prototype (SeaRay). Report prepared by Northwest National Marine Renewable Energy Center,University of Washington for Columbia Power Technologies, Inc. 7 pp.

Thomas, J.W., E.D. Forsman, J.B. Lint, E.C. Meslow, B.R. Noon, and J. Verner. 1990. A conservation strategy for the northern spotted owl. Interagency committee to address the conservation of the northern spotted owl. U.S. Department of Interior, Portland, OR.

Thompson, L.C., and Kinkade, M.D. 1990. Languages. Pp 30-51. In Northwest Coast: Handbook of North American Indians, Volume 7. Wayne Suttles, ed, Smithsonian Institute, Washington D.C.

Tollefsen, C., and B. Byrne. 2011. Dependence of airborne surf noise on wave height. Canadian Acoustics 39(3):210-211.

Trudel, M., J. Fisher, J.A. Orsi, J.F.T. Morris, M.E. Theiss, R.M. Sweeting, S. Hinton, E.A. Fergusson, and D.W. Welch. 2009. Distribution and migration of juvenile

Chinook salmon derived from coded wire tag recoveries along the continental shelf of western North America. Transactions of the American Fisheries Society 138:1369-1391.

Tynan, C.T., D.G. Ainley, J.A. Barth, T.J. Cowles, S.D. Pierce, and L.B. Spear. 2005. Cetacean distributions relative to ocean processes in the northern California Current System. Deep-Sea Research II 52 (2005) 145-167.

U.S. Army Corp of Engineers (USACE). 2012. Corps seeks comments on ocean disposal sites near Yaquina Bay. Available online: http://www.nwp.usace.army.mil/Media/NewsReleases/tabid/1888/Article/492034/corps-seeks-comments-on-ocean-disposal-sites-near-yaquina-bay.aspx. (Accessed October 2014).

U.S. Army Corps of Engineers (USACE), Portland District, and U.S. Environmental Protection Agency (EPA) Region 10. 2001. Yaquina Bay Ocean Dredged Material Disposal Site Evaluation Study and Environmental Assessment. Final Report. July 2001. 46 pp plus appendices.

U.S. Army Corps of Engineers (USACE) and U.S. Environmental Protection Agency (EPA). 2012. Yaquina Bay, Oregon Ocean Dredged Material Disposal Sites Evaluation Study and Environmental Assessment. USACE, Portland District and EPA, Region 10.

U.S. Army Corps of Engineers (USACE), U.S. Environmental Protection Agency, Washington Department of Ecology, Washington Department of Natural Resources, Oregon Department of Environmental Quality, Idaho Department of Environmental Quality, National Marine Fisheries Service, U.S. Fish and Wildlife Service. 2009. Sediment Evaluation Framework for the Pacific Northwest. Available at http://www.nwp.usace.army.mil/Portals/24/docs/environment/sediment/2009_SEF_Pacific_NW.pdf.

U.S. Army Corps of Engineers (USACE), Portland District, and U.S. Environmental Protection Agency (EPA) Region 10. 2008. Umpqua River, Oregon Ocean Dredged Material Disposal Site Evaluation Study and Environmental Assessment. Final Report. November 2008. 46 pp.

U.S. Census Bureau (USCB). 2014. State & County Quick Facts, Lincoln County Oregon. Available online: http://quickfacts.census.gov/qfd/states/41/41041.html. (Accessed October 2014).

U.S. Census Bureau (USCB). 2016a. ACS Demographics and Housing Estimates., American Fact finder – Community Facts. Available Online: http://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml (Accessed November 2016).

U.S. Census Bureau (USCB). 2016b. Foreign Trade - State Exports from Oregon. http://www.census.gov/foreign-trade/statistics/state/data/or.html (Accessed November2016).

U.S. Department of Energy (DOE). 2009. Report to Congress on the potential environmental effects of marine and hydrokinetic energy technologies. Prepared in response to the Energy and Independence and Security Act of the 2007, Section

633(B). Wind and Hydropower Technologies Program. U.S. Department of Energy. December, 2009.
U.S. Department of Energy (DOE). 2011. Final Environmental Assessment for University of Maine's deepwater offshore floating wind turbine testing and demonstration project, Gulf of Maine. DOE/EA-1792. September 2011.
U.S. Department of Energy (DOE). 2012. Oregon State University and Northwest National Marine Renewable Energy Center Wave Energy Test Project Final Environmental Assessment. DOE/EA-1917, Golden Field Office, Golden, CO.
U.S. Department of the Interior (DOI). 1989. Gray Whale Monitoring Study Final Report. Prepared for Minerals Management Service, Pacific OCS Region. Prepared by: MBC Applied Environmental Sciences. OCS Study MMS 88-0075. 70 pgs.
U.S. Environmental Protection Agency (USEPA). 2011. Site Designation of the Ocean Dredged Material Disposal Site Offshore of Yaquina Bay, Oregon: Biological Assessment and Essential Fish Habitat Assessment. Region 10, Seattle, WA.
U.S. Environmental Protection Agency (USEPA). 2009. Rogue River, Oregon Ocean Dredged Material Disposal Site Evaluation Study and Environmental Assessment. April. 40 pp.
U.S. Environmental Protection Agency (USEPA). 2008. Umpqua River, Oregon Ocean Dredged Material Disposal Site Evaluation Study and Environmental Assessment. Final Report. November 2008. 46 pp.
U.S. Energy Information Administration (EIA). 2016. Annual Energy Outlook 2016 with projections to 2040. DOE/EIA-0383(2016) August 2016. Available online: https://www.eia.gov/forecasts/aeo/pdf/0383(2016).pdf.
U.S. Fish and Wildlife Service (FWS). 1983. California Brown Pelican Recovery Plan. Portland, Oregon. 179 pp.
U.S. Fish and Wildlife Service (FWS). 2007a. Recovery plan for the Pacific Coast population of the western snowy plover (*Charadrius alexandrinus nivosus*). 274 pp. + appendices.
U.S. Fish and Wildlife Service (FWS). 2007b. National Bald Eagle Management Guidelines. http://www.fws.gov/northeast/ecologicalservices/pdf/NationalBaldEagleManagementGuidelines.pdf.
U.S. Fish and Wildlife Service (FWS). 2008. Short-tailed Albatross Recovery Plan. Anchorage, AK, 105 pp.
U.S. Fish and Wildlife Service (FWS). 2010. Unpublished data. Oregon WSP Window Survey Results 1990-2010. Newport, Oregon.
U.S. Fish and Wildlife Service (FWS). 2011. Revised recovery plan for the northern spotted owl (*Strix occidentalis caurina*). U.S. Fish and Wildlife Service, Portland, OR.
U.S. Fish and Wildlife Service (FWS). 2013. Sea Otters - Population History in Washington State. Available online: http://www.fws.gov/wafwo/sea_otters_history.html. Accessed October 2014.

U.S. Fish and Wildlife Service (FWS). 2014a. 5-Year Review: Summary and Evaluation. Short-tailed Albatross. Anchorage Fish and Wildlife Field Office. Anchorage, AK.

U.S. Fish and Wildlife Service (FWS). 2014b. Monitoring for marbled murrelets during marine pile driving – Certification training. Port Townsend Marine Science Center, June 16, 2014. PowerPoint Presentation.

U.S. Fish and Wildlife Service (FWS). 2014c. Oregon Islands National Wildlife Refuge. Available online: http://www.fws.gov/oregoncoast/oregonislands/ (Accessed October 2014).

U.S. Fish and Wildlife Service (FWS). 2018. Pacific Coast winter window survey results, western snowy plover. https://www.fws.gov/arcata/es/birds/WSP/documents/2018%20Pacific%20Coast%20Winter%20Window%20Survey.pdf (Accessed on November 2, 2018).

Van Renterghem, T., D. Bottledooren, and K. Verheyen. 2012. Road traffic noise shielding by vegetation belts of limited depth. Journal of Sound and Vibration 331:2404-2425.

Van Renterghem, T., J. Forssen, K. Attenborough, P. Jean, J. Defrance, M. Hornikx, and J. Kang. 2015. Using natural means to reduce surface transport noise during propagation outdoors. Applied Acoustics 93:86-101.

Van Rijn, L.C. 1984. Sediment Transport: part I: bed load transport; part II: suspended load transport; part III: bed forms and alluvial roughness. J. Hydraul. Div., Proc. ASCE, 110 (HY10), 1431-56; HY11, 1613-41; HY12, 1733-54.

Vize, S., C. Adnitt, R. Staniland, J. Everard, A. Sleigh, R. Cappell, S. McNulty, M. Budd, I. Bonnon, and J. Carey. 2008. Review of Cabling Techniques and Environmental Effects Applicable to the Offshore Wind Farm Industry - Technical Report. January. Prepared for Department for Business Enterprise and Regulatory Reform, in association with defra. Prepared by Royal Kaskoning and BOMEL.

Wade, P.R., A. Kennedy, R. LeDuc, J. Barlow, J. Carretta, K. Shelden, W. Perryman, R. Pitman, K. Robertson, B. Rone, J.C. Salinas, A. Zerbini, R.L. Brownell, and P.J. Clapham. 2011. The Worlds smallest shale population? Biology Letters 7:83-85.

Wahlberg, M. and H. Westerberg. 2005. Hearing in fish and their reactions to sound from offshore wind farms. Marine Ecology Progress Series 288:295-309.

Ward, E.J., E.E. Holmes, and K.C. Balcomb. 2009. Quantifying the effects of prey abundance on killer whale reproduction. Journal of Applied Ecology 46:632-640.

Walker, R.V., Sviridov, V.V., Urawa, S., and Azumaya, T. 2007. Spatio-temporal variation in vertical distributions of Pacific salmon in the ocean. North Pacific Anadromous Fish Commission Bulletin 4:19-201.

Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife (WDFW and ODFW). 2001. Washington and Oregon Eulachon Management Plan. October 2001.

Washington State Department of Fisheries and Western Washington Treaty Indian Tribes. 1993. 1992 Washington State Salmon and Steelhead Sock Inventory (SASSI). Washington State Department of Fish and Wildlife, Olympia, Washington.

Washington Department of Transportation (WSDOT). 2014. Biological Assessment Preparation for Transportation projects - Advanced Training Manual, Chapter 7 Noise Impact Assessment. Available at http://www.wsdot.wa.gov/Environment/Biology/BA/BAguidance.htm.

Weitkamp, L.A., R.C. Wissmar, C. A. Simenstad, K.L. Fresh, and J.G. Odell. 1992. Gray whale foraging on ghost shrimp (*Callianassa californiensis*) in littoral sand flats of Puget Sound, U.S.A. Canadian Journal of Zoology 70:2275-2280.

Weitkamp, L.A. 2010. Marine distributions of Chinook salmon from the west coast of North America determined by coded wire tag recoveries. Transactions of the American Fisheries Society 139:147-170.

Weitkamp, L., and K. Neely. 2002. Coho salmon (*Onchorhynchus kisutch*) ocean migrations patterns: insight from marine coded-wire tag recoveries. Canadian Journal of Fisheries and Aquatic Sciences 59:1110-1115.

Wenz, G.M. 1962. Acoustic ambient noise in the ocean: spectra and sources. Journal of the Acoustical Society of America 34:1946-1956.

West, M., F. alkden, and R.A. Sack. 1989. The acoustic shadow produced by wind speed and temperature gradients close to the ground. Applied Acoustics 27(3):239-260.

Whitehouse, R. 1998. Scour at marine structures: A manual for practical applications. Thomas Telford. xix + 198.

Wilhelmsson, D., T. Malm, and M.C. Ohman. 2006. The influence of offshore windpower on demersal fish. ICES Journal of Marine Science 63:775-784.

Wilhelmsson, D., and O. Langhamer. 2014. The influence of fisheries exclusion and addition of hard substrate on fish and crustaceans. Pages 49-60 *in* M. A. Shields and A.I.L. Payne (Editors), Marine Renewable Energy Technology and Environmental Interactions. Springer, New York, New York.

Wilson, B., P.A. Lepper, C. Carter, and S.P. Robinson. 2014. Rethinking underwater sound-recording methods to work at tidal-stream and wave-energy sites. Chapter 8 *in* M. A. Shields and A. I. L. Payne, Editors. Marine renewable energy and environmental interactions. Springer, New York.

Wilson, O.B., M.S. Stewart, J.H. Wilson, and R.H. Bourke. 1997. Noise source level density due to surf—Part I: Monterey Bay, CA. IEEE Journal of Ocean Engineering 22(3):425-433.

Woodruff, D.L., V.I. Cullinan, A.E. Copping, and K.E. Marshall. 2012. Effects of Electromagnetic Fields on Fish and Invertebrates. U.S. Department of Energy. PNNL-22154.

Woodson C.B., McManus M.A., Tyburczy J.A., Barth J.A., Washburn L., Caselle J.E., Carr M.H., Malone D.P., Raimondi P.T., Menge B.A., Palumbi S.R. 2012. Coastal fronts set recruitment and connectivity patterns across multiple taxa, Limnology and Oceanography 57: doi: 10.4319/lo.2012.57.2.0582.

Wursig, B. and G.A. Gailey. 2002. Marine mammals and aquaculture: conflicts and potential resolutions. In Stickney, R.R. and J.P. McVay (Eds.) *Responsible Marine Aquaculture*. CAP International Press, New York, pp. 45-59.
Wysocki, L. E., J.W. Davidson, III, and M.E. Smith. 2007. Effects of aquaculture production noise on hearing, growth, and disease resistance of rainbow trout *Onchorhynchus mykiss*. Aquaculture 272:687-697.
Yamashina Institute of Ornithology. 2011. Short-tailed albatross band recoveries through August 2011. Spreadsheet. 2pp.
Zamon, J.E., Phillips, E.M., and Guy, T.J. 2014. Marine bird aggregations associated with the tidally-driven plume and plume fronts of the Columbia River. Deep Sea Research Part II: Topical Studies in Oceanography 107:85-95.
Zenke, Henery. 1990. Alseans. Pp 568-571 In Northwest Coast: Handbook of North American Indians, Volume 7. Wayne Suttles, ed, Smithsonian Institute, Washington D.C.

8.0 LIST OF PREPARERS

Alan Mitchnick – Marine Mammals, Terrestrial Resources, Threatened and Endangered Species (Environmental Biologist; M.S., Wildlife and Fisheries Sciences)

Quinn Emmering – Marine Birds, Terrestrial Resources, Threatened and Endangered Species (Wildlife Biologist; Ph.D., Zoology)

Khatoon Melick – Socioeconomics, Need for Power, Developmental Analysis (Environmental Engineer; Ph.D., Civil Engineering)

Jim Hastreiter – Project Coordinator, Geology and Soils, Aquatic Resources (Fisheries Biologist; M.S., Natural Resources)

Evan Williams – Recreation, Land Use, Navigation, Aesthetics (Outdoor Recreation Planner; B.S., Recreation Management)

Frank Winchell – Cultural Resources (Archaeologist; B.A., M.A., Ph.D., Anthropology)