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

August 2, 2012

Laura Margason
Department of Energy
Golden Field Office
1617 Cole Boulevard
Golden, CO. 80401-3393

Debra Henry
US Army Corps of Engineers,
Portland District
PO Box 2946
Portland, OR 97208

RE: Endangered Species Act Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the 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 Engineers Nationwide Permit #5 for 2012-2013 WET-NZ Wave Energy Test Project at the Northwest National Marine Renewable Energy Center Test Site.

Dear Ms. Margason and Ms. Henry:

The enclosed document contains a biological opinion (opinion) prepared by National Marine Fisheries Service (NMFS) pursuant to Section 7(a)(2) of the Endangered Species Act (ESA) on the effects of the Department of Energy's funding for the Northwest National Marine Renewable Energy Center and Oregon State University Wave Energy Test Facility Project and US Army Corps Engineers Nationwide Permit #5 authorization for the 2012-2013 WET-NZ Wave Energy Test Project at the Northwest National Marine Renewable Energy Center Test Site.

In this opinion, NMFS concludes that the proposed action is not likely to jeopardize the continued existence of Lower Columbia River, Upper Willamette River, Upper Columbia River spring-run, Snake River spring/summer, Snake River fall, California Coastal, Sacramento River winter-run, or Central Valley spring-run Chinook salmon; Lower Columbia River, Oregon Coast, Southern Oregon/Northern California Coast, or Central California Coast coho salmon; Southern Distinct Population Segment (DPS) of North American green sturgeon; Southern DPS eulachon; Southern Resident killer whales; Steller sea lions; or humpback whales, or result in the destruction or adverse modification of their respective designated critical habitats. NMFS also concluded that the proposed action is not likely to adversely affect Snake River, Upper Columbia River, Middle Columbia River, Lower Columbia River, Upper Willamette River, South-Central California Coast, Central California Coastal, Northern California, or California Central Valley steelhead; Snake River sockeye or Columbia River chum salmon; Sei, blue, fin, or sperm whales; leatherback sea turtles or their critical habitat, or green, olive Ridley or loggerhead, sea turtles.

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

This Opinion also includes the results of our analysis of the actions likely effects on essential fish habitat (EFH) pursuant to Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA). NMFS does not have any MSA conservation recommendations as we have not identified any potential adverse effects on EFH.

Please direct questions regarding this opinion to Kim Hatfield, NMFS FERC and Water Diversions Branch of the Northwest Region Hydropower Division at 503-231-2315 or Kim.Hatfield@noaa.gov.

We appreciate the efforts the U.S. Department of Energy, US Army Corps of Engineers and NNMREC have made to work with NMFS on the development of the open ocean test program which will further research and development of alternative energy sources such as wave energy.

Sincerely,

Bruce K for

William W. Stelle, Jr.
Regional Administrator

cc: (Sent electronically, unless noted as "hard copy")
Belinda Batten, NNMREC
Meleah Asford, NNMREC
Justin Klure, NWEI
Therese Hampton, PEV
Chris Moelter, ICF
Delia Kelley, ODFW
Jeff Everett, USFWS

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Section 7(a)(2) "Not Likely to Adversely Affect" Determination, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation

Department of Energy's Northwest National Marine Renewable Energy Center and Oregon State University Wave Energy Test Facility Project Funding and US Army Corps Engineers Nationwide Permit #5 for 2012-2013 WET-NZ Wave Energy Test Project at the Northwest National Marine Renewable Energy Center Test Site.

NMFS Consultation Number: *F/NWR/2012/02531*

Action Agencies: *United States Department of Energy*
United States Army Corps of Engineers

Affected Species and Determinations:

ESA-Listed Species	**Status**	**Is Action Likely to Adversely Affect Species or Critical Habitat?**	**Is Action Likely To Jeopardize the Species?**	**Is Action Likely To Destroy or Adversely Modify Critical Habitat?**
Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No
Upper Willamette River (UWR) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
Upper Columbia River (UCR) Chinook salmon (*O. tshawytscha*)	Endangered	Yes	No	No
Snake River (SR) spring/summer (spr/sum) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
Snake River (SR) fall Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
California Coastal (CC) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
Sacramento River (SAC) winter-run Chinook salmon (*O. tshawytscha*)	Endangered	Yes	No	No
Central Valley (CV) spring-run Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
LCR coho salmon (*O. kisutch*)	Threatened	Yes	No	No
Oregon Coast (OC) coho salmon (*O. kisutch*)	Threatened	Yes	No	No
Southern Oregon/Northern California Coasts (SONCC) coho salmon (*O. kisutch*)	Threatened	Yes	No	No
Central California Coast (CCC) coho salmon (*O. kisutch*)	Threatened	Yes	No	No
SR steelhead *(O. mykiss)*	Threatened	No	No	No
UCR steelhead *(O. mykiss)*	Threatened	No	No	No
Middle Columbia River (MCR)	Threatened	No	No	No

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
steelhead *(O. mykiss)*				
LCR steelhead *(O. mykiss)*	Threatened	No	No	No
UWR steelhead *(O. mykiss)*	Threatened	No	No	No
South-Central California Coast (SCCC) steelhead *(O. mykiss)*	Threatened	No	No	No
Central California Coastal (CCC) steelhead *(O. mykiss)*	Threatened	No	No	No
Northern California (NC) steelhead *(O. mykiss)*	Threatened	No	No	No
California Central Valley (CCV) steelhead *(O. mykiss)*	Threatened	No	No	No
SR sockeye *(O. nerka)*	Endangered	No	No	No
Columbia River (CR) chum *(O. keta)*	Threatened	No	No	No
Southern distinct population segment (DPS) of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	No
Southern distinct population segment (DPS) of eulachon (*Thaleichthys pacificus*)	Threatened	Yes	No	No
Southern Resident killer whale (*Orcinus orca*)	Endangered	Yes	No	No
Steller sea lion (*Eumatopius jubata*)	Threatened	Yes	No	No
Humpback whale (*Megaptera novaeangliae*	Endangered	Yes	No	N/A
Sei Whale (*Balaenoptera borealis*)	Endangered	No	No	No
Blue Whale *(B. musculus)*	Endangered	No	No	No
Fin Whale (*B.physalus)*	Endangered	No	No	No
Sperm Whale (*Physeter macrocephalus)*	Endangered	No	No	No
Leatherback Sea Turtle *(Dermochelys coriacea)*	Endangered	No	No	No
Green Sea Turtle (*Chelonia mydas)*	Threatened	No	No	No
Olive Ridley Sea Turtle *(Lepidochelys olivacea)*	Endangered	No	No	No
Loggerhead Sea Turtle *(Caretta caretta)*	Threatened	No	No	No

Fishery Management Plan that Describes EFH in the Action Area	Would the action adversely affect EFH?	Are EFH conservation recommendations provided?
Pacific Coast Salmon	No	No
Pacific Coast Groundfish	No	No
Coastal Pelagic Species	No	No
Highly Migratory Species	No	No

Consultation Conducted By:National Marine Fisheries Service, Northwest Region

Issued By: Barry A. Thom

FOR William W. Stelle, Jr.
Regional Administrator

Date: 8/2/2012

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LIST OF ACRONYMS

AC..................Alternating Current
AIS.................automatic identification system
AMC ....Adaptive Management Committee
AMP...............Adaptive Mitigation Plan
A/P ....Abundance and Productivity
B.....................Magnetic
BA..................Biological Assessment
BC..................British Columbia
CC..................California Coastal
CCC................Central California Coast
CCV ....California Central Valley
CFR................Code of Federal Regulations
CHART..........Critical Habitat Analytical Review Team
Corps..............U.S. Army Corps of Engineers
CR..................Columbia River
CV..................Central Valley
CVSR.............Central Valley Spring-run Chinook
CWA..............Clean Water Act
CWT...............Coded Wire Tags
DAS................data acquisition systems
dB...................Decibel
dBrms.............Decibel root mean square
DOE ...............U.S. Department of Energy
DPS................Distinct Population Segment
DQA...............Data Quality Act
E.....................Electric
EA..................Environmental Assessment
EFH................Essential Fish Habitat

EEZ ....Exclusive Economic Zone

EFH................Essential Fish Habitat

EMF ....Electromagnetic field

EPA................U.S. Environmental Protection Agency

ERRP.............Emergency Response and Recovery Plan

ESA ....Endangered Species Act

ESU................Evolutionarily Significant Unit

FAD................Fish Attraction Device

FERC.............Federal Energy Regulatory Commission

FINE...............Fisherman Involved in Natural Energy

FR...................Federal Register

GLOBE ....CGlobal Ocean Ecosystems Dynamics

HMSC............Hatfield Marine Science Center

Hz...................Hertz

HUC...............Hydraulic Unit Code

IALA..............International Association of Lighthouse Authorities

IC....................Interior Columbia

iE....................Induced electric

IHA ....Incidental Harassment Authorization

ITS..................Incidental Take Statement

JPA.................Joint Permit Application

KW.................Killer Whales

kW..................Kilowatt

LC ....Lower Columbia

LCR................Lower Columbia River

MCR...............Middle Columbia River

MMPA ....Marine Mammal Protection Act

MMS ....Minerals Management Service

MPG...............Major Population group

MSA...............Magnuson-Stevens Fishery Conservation and Management Act

MW ....Megawatt

NNMREC ......Northwest National Marine Renewable Energy Center

NAMF............NNMREC Test Facility (test center) Adaptive Management Framework

NC..................Northern California

NLAA ....Not Likely to Adversly Affect

NMFS.............National Marine Fisheries Service

NOMAD .....Navy Oceanographic Meteorological Automatic Device

NWEI ....Northwest Energy Innovations, Inc

NWFSC..........Northwest Fisheries Science Center

NWP...............US Army Corps of Engineers Nationwide Permit

OC..................Oregon Coast

ODEQ ....Oregon Department of Environmental Quality

ODFW............Oregon Department of Fish and Wildlife

O&M..............Operation and Maintenance

Opinion ....Biological Opinion

OPT................Ocean Power Technologies

Oregon DEQ ..Oregon Department of Environmental Quality

OSU................Oregon State University

PCE ....Primary constituent elements

PEV................Pacific Energy Ventures

PFMC.............Pacific Fishery Management Council

PM&E ....Protection, Mitigation and Enhancement

PVA................Population Viability Analysis

Re: 1µPa.........Reference 1 MicroPascal

RMS...............Root Mean Squared

RPA................Reasonable and prudent alternative

RPM...............Reasonable and prudent measure

SA ....Settlement Agreement

SAC................Sacramento River

SCCC ....South-Central California Coast

SONCC ....Southern Oregon/Northern California Coasts

SPCC..............Spill Prevention, Control and Countermeasures

SR...................Snake River

SRB................Snake River Basin

SS/D...............Spatial structure and Diversity

SSF.................Sub–Surface Float

TBT................Tributyltin

TL...................Total Length

TRT................Technical Review Team

UCR...............Upper Columbia River

USFWS..........U.S. Fish & Wildlife Service

U.S.C..............United States Code

UWR..............Upper Willamette River

VSP................Viable Salmonid Population

WAMP...........WET-NZ Adaptive Mitigation Plan

WEC...............Wave energy converter

WET-NZ ....Wave Energy Technology-New Zealand

WLC...............Willamette/Lower Columbia

1. INTRODUCTION

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

1.1 Background

The US Department of Energy (DOE) is the lead agency for this consultation, and proposes to fund the Oregon State University's (OSU) Northwest National Marine Energy Research Center (NNMREC) for the 10-year operation of an open ocean test center (test center) for wave energy conversion devices (WECs) described in the proposed action. DOE is responsible for ensuring that all actions related to the 10-year operation and management of the test center are carried out as described in the proposed action, with any additional requirements from the incidental take statement's (ITS) reasonable and prudent measures (RPM) and terms and conditions.

The US Army Corps of Engineers (Corps) is also an action agency and proposes to authorize the WET-NZ test under Section 10 of the Rivers and Harbors Act and Nationwide Permit #5. The Corps is responsible for ensuring that all actions related to the proposed WET-NZ device test are carried out as described in the proposed action, with any additional requirements from the ITS reasonable and prudent measures and the terms and conditions.

As the recipient of the DOE funding, NNMREC is undertaking the actions described in the proposed action for the 10-year operation of the proposed test center. As the permittees for the Corps Nationwide Permit (NWP) # 5, NNMREC and the WET-NZ developer are jointly undertaking the actions described in the proposed WET-NZ test.

National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and ITS portions of this document in accordance with the Endangered Species Act (ESA) (16 U.S.C. 1531 et seq.), and implementing regulations at 50 CFR 402 Subpart B.

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

The opinion, ITS, and EFH conservation recommendations are each in compliance with the Data Quality Act (DQA)(44 U.S.C. 3504(d)(1) et seq.) and they underwent pre-dissemination review.

1.2 Consultation History

This opinion is based on information provided in the May 21, 2012 DOE biological assessment (BA), the March 27, 2012 Corps NWP #5 Joint Permit Application (JPA), telephone discussions and meetings noted below, additional information response received from OSU on June 15, 2012. OSU's response to comment submitted by the State of Oregon dated June 14, 2012 and other sources of information provided in the References section. A complete record of this consultation is on file at NMFS, Northwest Regional Office, Hydropower Division, and Portland, Oregon.

Coordination with NMFS and other agencies occurred in the following:

- April 8, 2010: conference call to present project overview, attended by representatives of DOE, OSU, NNMREC and NMFS.
- May 4, 2010: call between representatives of ICF International (ICF) and US Fish and Wildlife Service (USFWS) to establish USFWS jurisdictional species to be addressed.
- May 17, 2010: call between representatives of ICF and NMFS to discuss NMFS jurisdictional species to be addressed.
- May 26, 2010: NMFS provided DOE via electronic submission a list, dated May 26, 2010, of NMFS ESA listed species to be addressed.
- January 11, 2012: DOE submitted a BA for the Proposed Project, January 11, 2012, to USFWS and NMFS pursuant to Section 7 of the Endangered Species Act, and for consultation under the MSA. The BA was accompanied by letters requesting concurrence with DOE's determination of effects on species and habitat under ESA, Marine Mammal Protection Act (MMPA), and the MSA.
- February 21, 2012: DOE received preliminary comments from NMFS regarding the BA.
- March 19, 2012: Conference call between representatives of ICF, Pacific Energy Ventures (PEV), NNMREC, and NMFS to discuss comments on the January 2012 BA.
- March 29, 2012: Conference call between representatives of ICF, PEV, NNMREC, and NMFS to discuss development of monitoring plans and an adaptive management framework for the Proposed Project.
- April 12, 2012: Meeting at ICF's office in Portland, Oregon, where Principle Investigators from OSU presented their monitoring plans to NMFS. Attended by representatives of ICF, PEV, NNMREC, OSU, and NMFS.
- May 8 and 9, 2012: Conference calls between representatives of ICF, PEV, NNMREC, and NMFS to finalize the monitoring plans and adaptive management framework for the Proposed Project.
- May 21, 2012: DOE submitted to NMFS the Revised Biological Assessment (ICF 2012), dated May 2012, and requested concurrence with their not likely to adversely affect (NLAA) determination for ESA-listed species and designated critical habitat as well as for no adverse effect for EFH.
- June 7, 2012: Conference call between representatives of PEV, NNMREC, and NMFS regarding NMFS request for additional information necessary to initiate Consultation under Section 7(a)(2) of the ESA.
- June 8, 2012: The Corps submitted a letter dated June 8, 2012, to NMFS requesting concurrence with its determinations of NLAA for ESA-listed species and critical habitat and no adverse effect for EFH for the JPA under NWP #5 (PEV 2012).
- June 8, 2012: NMFS submitted a letter to DOE and the Corps, dated June 7, 2012, requesting additional information required to initiate consultation.
- June 15, 2012: DOE and the Corps submitted additional information (OSU 2012) dated June 14, 2012, in response to the request by NMFS on June 8, 2012.

- June 21, 2012: NMFS submitted a letter to DOE and to the Corps, dated June 21, 2012, informing both agencies that the additional information required to initiate consultation had been received and formal ESA consultation was initiated on June 18, 2012.
- July 10, 2102: OSU submitted a revised NNMREC Adaptive Management Framework and WET-NZ Adaptive Mitigation Plan (AMP), dated July 1, 2012, in response to comments received from the State of Oregon.
- July 23, 2010: OSU submitted another revised NNMREC Adaptive Management Framework and WET-NZ AMP, dated July 23, 2012, in response to comments received from the State of Oregon and comments received by DOE on the draft environmental assessment.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies. (50 CFR 402.02). Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. NMFS has not identified any interrelated or interdependent actions.

The proposed action for purposes of this ESA Section 7 consultation is comprised of two Federal agency actions.

Department of Energy Proposed Action

The first is the DOE's proposed authorization and funding for NNMREC's test center, including a monitoring program and equipment to evaluate WEC devices at the proposed location where testing would occur for a period of ten years. The test center program would be limited to evaluating the effects of off-grid WEC devices (i.e., devices that do not have a cable connection to the onshore electrical grid) on the environment, and how well the devices perform and withstand open ocean conditions. The test center would not include any permanent structures and consists of designating and operating an open ocean wave energy test site (test site) about 3.4-km^2 (1-square-nautical-mile) centered about 3 km (2 miles) off the Oregon coast near the city of Newport, Oregon (**Figure 1**) where WEC devices and instrumentation test buoys would be moored during short-term (a few months per device) tests. Up to two WEC devices could be tested at the same time, and both would be deployed within the test site. The coordinates marking the four corners of the test site are presented in Table 1.

Table 1. Test Site Coordinates**.** (ICF 2012

Test Site Corner	**Latitude**	**Longitude**[1]
Northwest	N44.697	W124.146
Northeast	N44.699	W124.123
Southeast	N44.682	W124.122
Southwest	N44.681	W124.145

[1] Lambert Conformal Conic NAD83.

While all WEC devices, the Ocean Sentinel and the TRIAXYS™ buoy would be deployed within the boundary of the test site as described above and shown in Figure 1. The action area (detailed in Section 1.4) comprises a 9.3-km radius from the proposed test site boundary, within which some temporary monitoring equipment (e.g. hydrophones mounted on a lander) may be deployed (Figure 2).

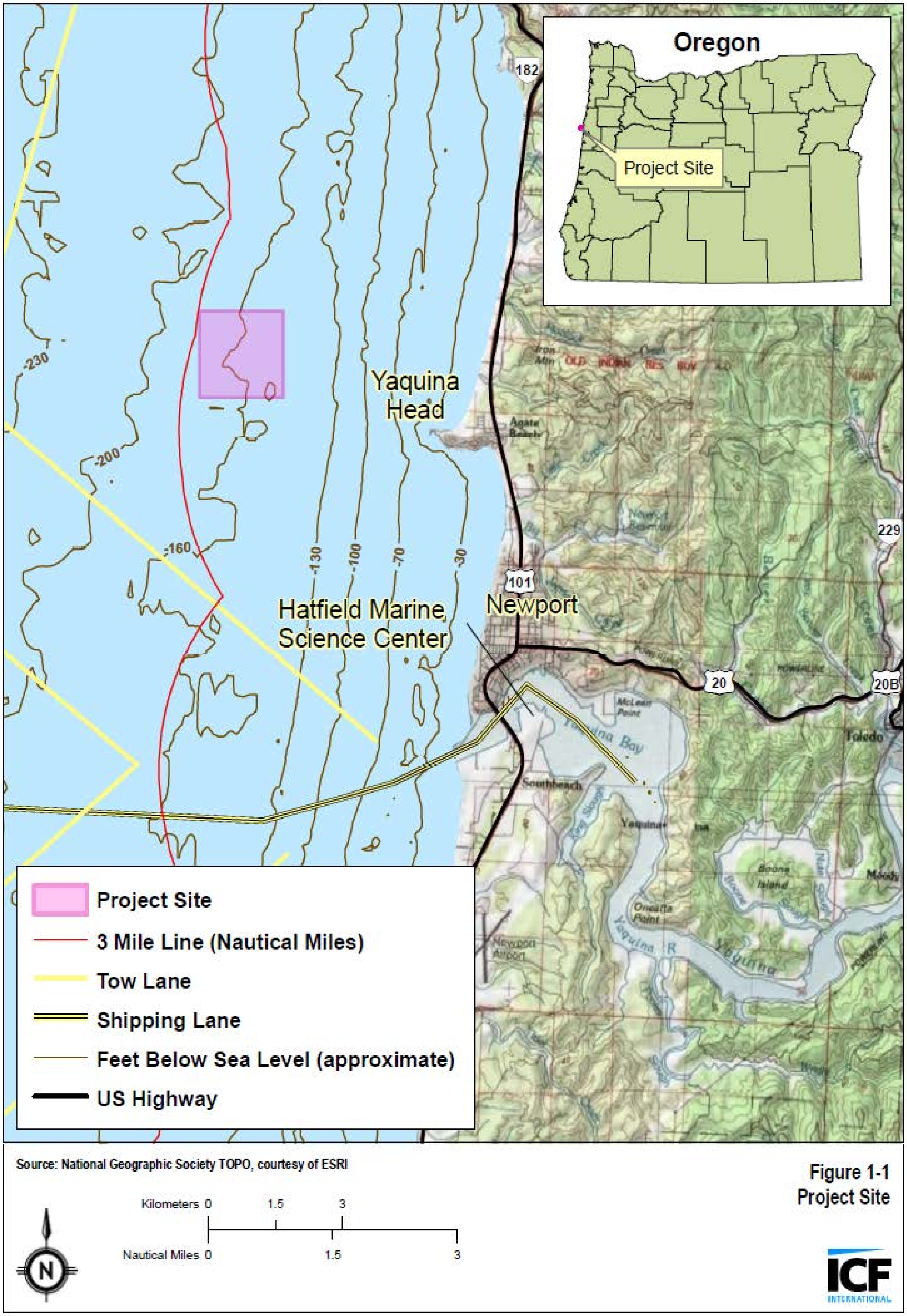


Figure 1. NNMREC open ocean test center Test Site location

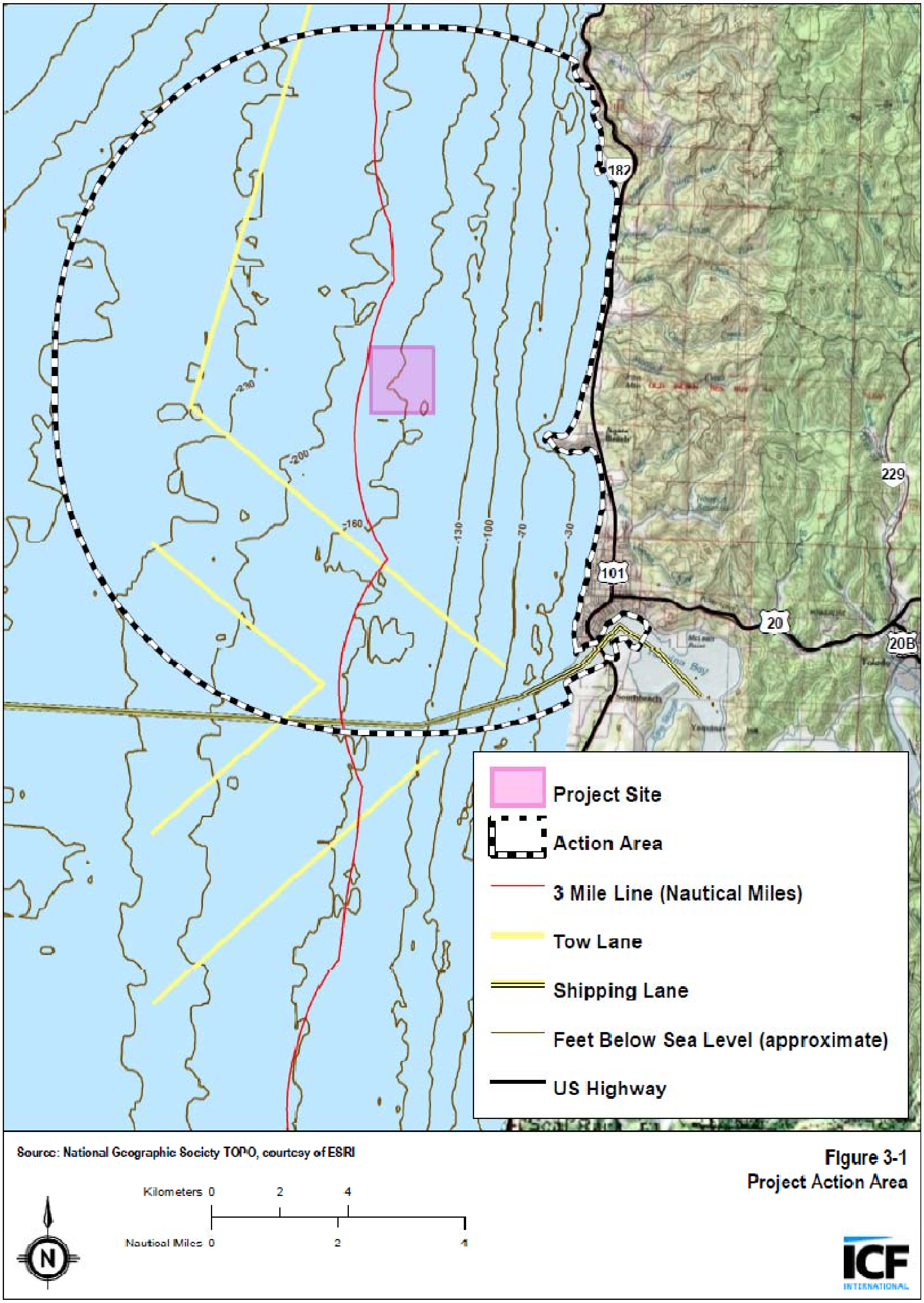


Figure 2: Action area. (ICF 2012

The proposed funding provided by DOE would support the design, construction, deployment, operation, removal, and decommissioning of up to two Ocean Sentinel test buoys and deployment of a TRIAXYS™wave measurement buoy and other instrumentation used in studies to characterize and monitor a number of environmental conditions within and near the test site during WEC tests. A summary of NNMREC activities supported by DOE financial assistance are listed below.

- Scientific and public outreach efforts to select a location for the testing facility (test site).
- Design and construction of testing equipment (the Ocean Sentinel instrumentation buoy).
- Various studies to characterize and monitor environmental conditions in the action area (during baseline, test, and post-testing timeframes) including benthic monitoring, underwater acoustics, and electromagnetic fields.
- Mooring, deployment, operation, and recovery of Ocean Sentinel instrumentation buoys for system testing and to test WEC devices, as needed, for the 10-year operation of the test center. The proposal is for two instrumentation systems, such that two WEC devices could be tested simultaneously.

A number of WEC devices may be tested during the 10-year operation of the test center. The specific WEC device prototypes and models that would be tested as part of the proposed action are not presently known, with the exception of the WET-NZ device, which has a planned deployment at the test site, as described below.

US Army Corps of Engineers Proposed Action

The proposed action also includes the Corps' authorization under the Clean Water Act (CWA) (NWP) #5 for the installation of the WET-NZ wave energy conversion (WEC) device, an Ocean Sentinel instrumentation buoy, a power and communications cable, a TRIAXYS™ wave measurement buoy, and associated mooring systems to collect environmental, technical and energy resource information, the WET-NZ Adaptive Mitigation Plan and all monitoring associated with the WET-NZ test deployment. The Corps will incorporate the WET-NZ AMP and all monitoring plans associated with the WET-NZ test into the conditions of the NWP authorization. The footprint of the devices associated with the WET-NZ test is about 0.085 km^2 or 2% of the proposed test site. The project components for the WET-NZ test would be deployed for about 3 months during the summer of 2012 and about 3 months during the summer of 2013. The anchors and mooring systems would remain in place for the duration of the WET-NZ test's Corps NWP #5 authorization expected to be about 2 years.

Over the 10-year lifetime of test center operations, the Corps is likely to receive requests for permits to test a number of WEC devices. Due to the uncertain nature of any future installations, we are able to consider only their general effects on listed marine organisms in this opinion. In each case, NNMREC and the WEC developer interested in testing at the site would apply to the Corps and other agencies for permits to moor, deploy, and test at the test site, and thus NMFS will evaluate the specific effects of each test would be considered in future Section 7 consultations.

All future deployments of the Ocean Sentinel, TRIAXYS™ wave monitoring buoy and other equipment not associated with the WET-NZ test would be required to obtain the necessary permits and authorizations (e.g. Corps Nationwide or individual permit and any other applicable state andFederal authorizations). Effects of deployment of the Ocean Sentinel, TRIAXYS™ wave monitoring buoy and other equipment beyond the scope of the WET-NZ test are not considered in this opinion.

1.3.1 Proposed WEC Project Facilities

There will be a number of different WEC devices tested at the test facility over the 10 years it will be in operation. At this time, we only have information on the first WEC device to be tested in 2012-2013, the WET-NZ device. The WET NZ information is detailed in the sections below.

Due to the uncertain nature of any future installations, we are able to consider only their general effects on listed marine organisms in this opinion. General WEC device designs that are reasonably expected as part of the proposed action, include pitching/surging/heaving/sway devices, point absorber devices, and oscillating water column devices capable of operating in water depths of about 55 meters (180 feet) as described below in Section 1.3.5.1 (see also ICF 2012).

1.3.1.1Project Components for the 2012–2013 WET-NZ Test

Components for this test would include the Ocean Sentinel instrumentation buoy, a half scale WET-NZ WEC device, the power and communications cable between these buoys, a TRIAXYS™ wave measurement buoy, and associated mooring systems. The test equipment would not be connected to the electric grid; power generated by the WET-NZ device would be transported through the power and communications cable to the Ocean Sentinel to be dissipated in resistors. The testing would take place during two short-term deployments, the first of which is planned for 2012. Upon conclusion of testing in 2012, the devices would be removed and taken to a land-based storage facility for the winter. In 2013, the devices would be redeployed for a second round of testing. Upon conclusion of testing in 2013 and in compliance with the Corps NWP #5 authorization for the WET-NZ test, all project components, including the devices and mooring systems, would be removed. The total footprint for the WET-NZ device test is about 0.085 km^2, or two percent of the 3.4 km^2 test site.

Ocean Sentinel

The Ocean Sentinel has an aluminum hull with steel/aluminum/composite instruments. The Ocean Sentinel measures 21.25 feet long, 10.5 feet wide and 24 feet high with about 15 feet from the mean water line to the antenna locations (Figure 3). Including fuel and equipment, the Ocean Sentinel has a displacement of 19,600 pounds. The hull of the Ocean Sentinel would be coated with an antifouling compound to resist growth and colonization of marine organisms. The antifouling compound used for the Ocean Sentinel would be free of tributyltin (TBT) and copper.

Fiber optic cables integrated in the umbilical cable would provide communications between the WEC device under test and the Ocean Sentinel. Connectivity between the Ocean Sentinel and the shore station would be provided via wireless telemetry. Both systems would be capable of providing real-time continuous monitoring of the WEC device and Ocean Sentinel.

Because WEC devices would not be connected to the electrical grid, resistive load banks may be used as the electrical load for the WEC devices under test. A 100-kilowatt, air-cooled load bank would be installed on deck, high enough above the waterline to avoid significant seawater spray penetrating the load bank enclosures or housed below deck in one of the buoy bulkheads, depending on the size and cooling capacity of the load bank.

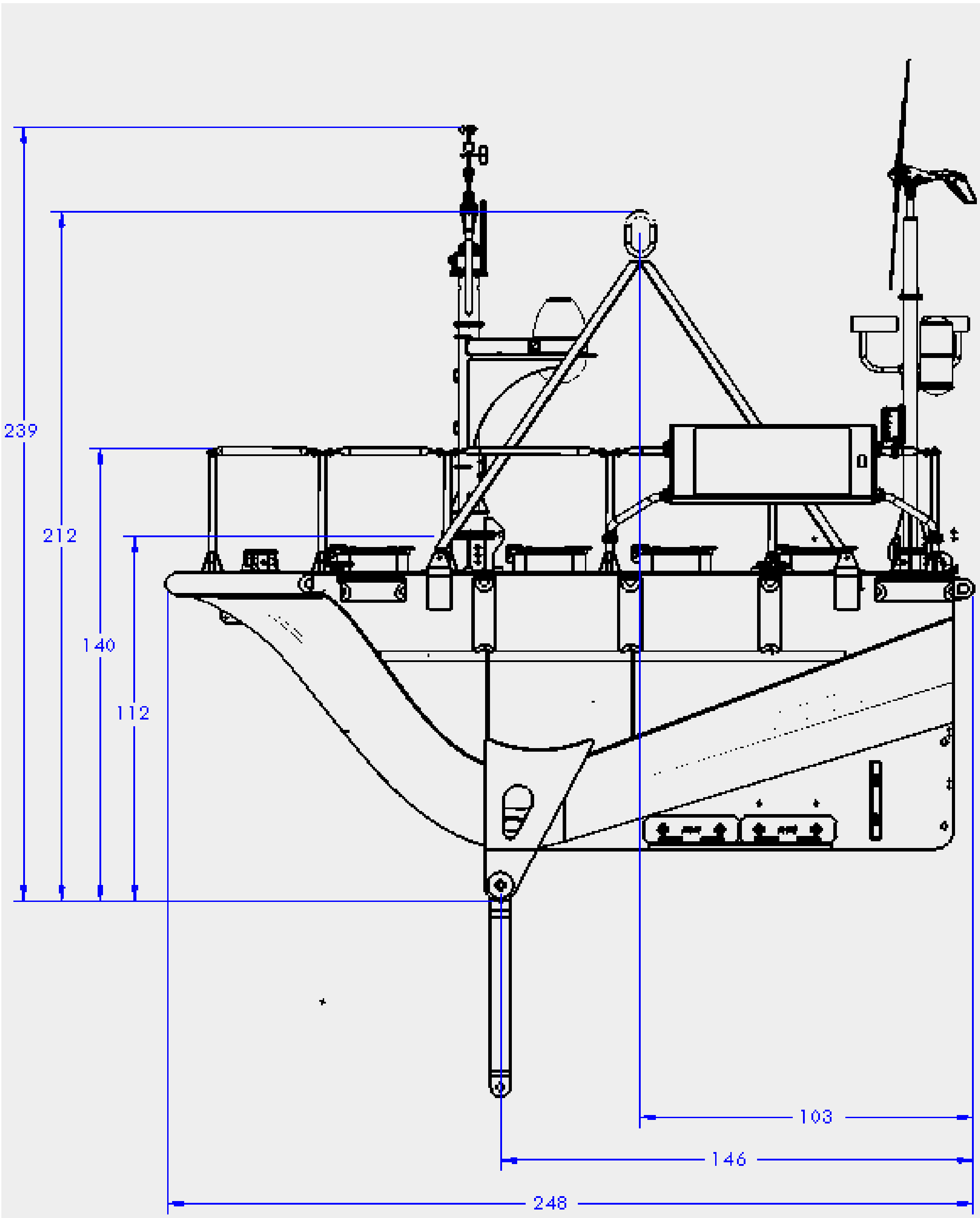


Figure 3. Ocean Sentinel Instrumentation Buoy External Dimensions (inches) (ICF 2012)

The Ocean Sentinel would have the capacity to independently generate power to operate all onboard systems by a combination of deck-mounted solar panels, wind generation, and a bio-diesel fuel generator. The Ocean Sentinel would contain up to 240 gallons of bio-diesel fuel in three baffled aluminum tanks. These tanks would be tested pursuant to the requirements outlined in *33 CFR 183.510*. The battery would be designed to meet all applicable U.S. Coast Guard and environmental requirements.

Other components that are likely to be included in the Ocean Sentinel as part of the proposed action are described below.

- **Bilge pumps**. Bilge pumps would address minor leaks. Two pumps could be independently equipped with a level alarm and activated by a level float. The wireless communications system would activate and transmit an alarm to NNMREC and any identified party, allowing for immediate action. The pumps would be powered by marine-grade batteries, which would be completely sealed to prevent hydrogen buildup.
- **Markers and auxiliary sensors.** Components to increase the visibility of the Ocean Sentinel would include a marine-grade beacon light, radar reflector, and Global Positioning System (GPS). The Ocean Sentinel would also include an indication, warning, and alarm subsystem designed to monitor system status, provide warnings for negative trends, and provide alarms for conditions requiring operator intervention. On-board video cameras would be mounted on the deck of the Ocean Sentinel. Using a low frame rate, they would monitor the deck and water immediately surrounding the Ocean Sentinel. The cameras could be monitored remotely and in real time with their signal broadcast to the shore-side station through the telemetry system.
- **Automatic identification system (AIS).** An AIS transmitter would provide navigation assistance for locating the Ocean Sentinel under moorage and in the unlikely event, the Ocean Sentinel breaks free from its mooring. The AIS would provide other vessels with the location and identity of the Ocean Sentinel at all times. The AIS would also be configured to communicate the location and identity of other components of the project including the WEC device, the wave-measurement buoy, and any surface or marker buoys.
- **Cable interface.** A cable interface would be made using a marine-grade connector(s) designed to withstand harsh marine environments. This style of connector would allow the submarine power cable to couple to the Ocean Sentinel quickly and efficiently on the deck, without the need to access the inner watertight compartments. An input disconnect protective device would enable the complete electrical disconnection of the Ocean Sentinel from the cable that could be operated without entering any compartment of the Ocean Sentinel containing energized devices. The interface would be constructed of steel or other metal so that marine life could not become exposed to electrical current by chewing, gnawing, or pecking through the cable.
- **Associated monitoring equipment.** Associated monitoring equipment would be deployed to support the Ocean Sentinel and collect data to be used in physical and environmental studies. Most monitoring equipment would be deployed within the 3.4 km2 test site. This equipment may include acoustic wave and current profilers, acoustic Doppler current profilers, waveriders (wave-measurement buoy accelerometers), seafloor

mapping devices, echosounders, sub-bottom profilers, acoustics data logger recovery devices, acoustic hydrophones, plankton-collection plates, water quality monitoring devices (e.g., dissolved oxygen, temperature, salinity), fish tag receivers, and electromagnetic frequency monitoring equipment. However, some equipment (e.g. hydrophones mounted on a lander) may be deployed outside of the test site within the action area (a 9.3-km radius from the test site) to collect reference samples for comparative analyses. In all cases, equipment either would be resting on the sea floor or held in place by a single, temporary anchor and line. Wave-measurement buoys would be located sufficiently close to the Ocean Sentinel to allow them to transmit data to the Ocean Sentinel via wireless telemetry. Other monitoring equipment may or may not have this capability. Specific identification of the equipment that would be used as part of the monitoring associated with the proposed action is included as Appendix A.

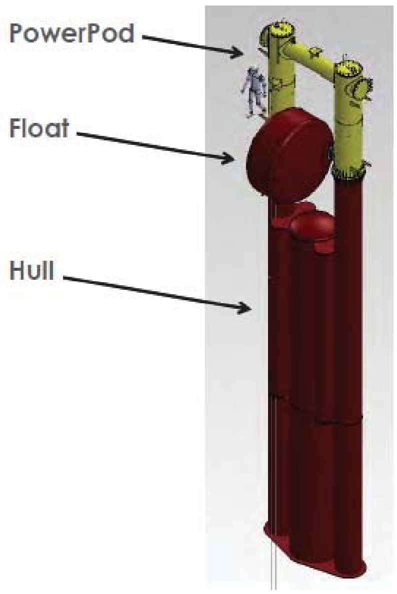
- **Umbilical cable.** An umbilical cable consisting of a copper conductor, steel armor, and polyethylene insulation would carry power and data signals between the WEC device and the Ocean Sentinel. The umbilical cable connecting the Ocean Sentinel and the WEC under test would measure about 200 meters (656 feet) long and 50 centimeters (1.6 feet) in diameter. Power generated by the WEC device would be transmitted through this cable to the Ocean Sentinel for monitoring, recording, and dissipation. The cable would be suspended beneath the surface by floats. Marking and lighting would be provided as directed by the U.S. Coast Guard. The cable would be about 2.5 to 7.5 centimeters (1 to 3 inches) in diameter enabling the Ocean Sentinel and the WEC under test to be about 100 meters (328 feet) apart.

TRIAXYS™ Wave Measurement Buoy

A TRIAXYS™ wave measurement buoy supplied by AXYS Technologies would be used for ocean wave and current measurements. This buoy is constructed of stainless steel and polycarbonate and contains instrumentation to measure and record the size and strength of wave activity at the site and transmit data wirelessly to the Ocean Sentinel. It weighs about 440 pounds, including batteries, and measures 3 feet in diameter. When deployed in the water, the top of the spherical buoy extends about 1.5 feet above water line. The TRIAXYS™ wave buoy would be moored about 100 meters in the prevailing wave direction from the WEC device under test, and would transmit wave and current data to the Ocean Sentinel via radio telemetry.

WET-NZ Wave Energy Converter

The WET-NZ device (Figure 4) is a point absorber with some special characteristics that enable it to extract energy from passing waves. The device is floating but the majority of it is submerged so that as much of it as possible interacts directly with the wave energy. The WET-NZ device is designed to operate in transitional / deep water waves (20 to 100 meters [67 to 328 feet]) and is designed to extract as much energy as possible from more than one type of motion. The device to be deployed in the test site is nominally half scale with a rated energy output of 20 kilowatts. The hull is about 18 meters (59 feet) long and 3.5 meters (11.5 feet) wide. Wet mass of the hull (flooded) is nominally 50 metric tons (110,231 pounds) and displacement volume is around 95% (i.e. the structure is almost fully immersed – the water line is nominally at the axle center). The float weighs 4 metric tons (8,818 pounds) with a displacement volume of 50% (Figure 4). The wetted surface of the WET-NZ device would be treated with a copper-based antifouling coating. The antifouling coating would be free of TBT.



Hull Height/Draft:	15.0 meters
Hull Width:	3.8 meters
Float Diameter:	2.4 meters
Main Tube Diameter:	1.5 meters
Side Tube Diameter:	0.7 meters
Draft (ballasted):	12.8 meters
Displacement (unballasted):	30 metric tons
Displacement (ballasted):	50 metric tons
Rated output:	20 kW

Figure 4. WET-NZ Wave Energy Converter (ICF 2012

Anchors and Mooring Systems

For the proposed WET-NZ test the Ocean Sentinel, WET-NZ device, and TRIAXYS™ Wave Monitoring Buoy would each have their own mooring system, detailed in the following sections. The maximum footprint of the Ocean Sentinel and TRIAXYS™ Wave Monitoring buoy and their mooring systems is 800 feet by 625 feet (equivalent 500,000 square feet or 0.046km2). Moorings and associated lines would be maintained under tension to reduce the creation of loops in the lines (OSU 2012). The WET-NZ device would be moored about 490 feet from the Ocean Sentinel, and the footprint of the WET-NZ and its mooring system is about 700 feet by 700 feet (equivalent to about 490,000 square feet or 0.045 km2). The project components would have a combined footprint of about 820 feet by 1,148 feet. The total impact area would be about 941,000 square feet or 0.085 km^2 or 2% of the proposed 3.4 km^2 test site. The deployed configuration of devices for the 2012–2013 WET-NZ test is illustrated in Figure 5.

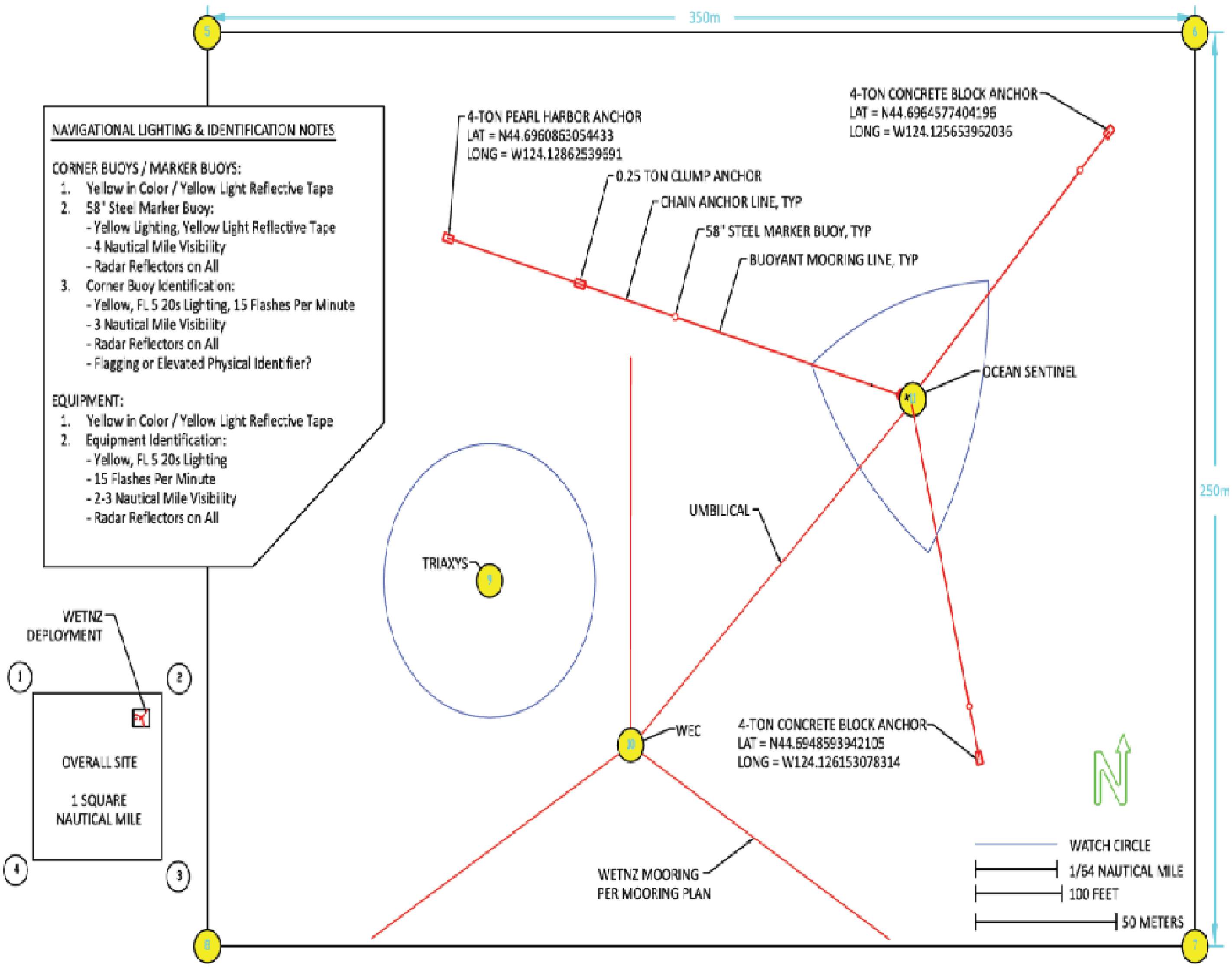


Figure 5. WET-NZ Test Mooring Configuration, Plan View (ICF 2012)

WET-NZ Mooring System
The WET-NZ device would use a three-point mooring system that has a combination of drag anchors. Drag anchors are common in the industry, having broad use experience and reliable holding capacity. In addition, very large size and capacity drag anchors are available for use in sand bottom types like the test site. A drag anchor is similar to an inverted “kite” that is placed on the seafloor and dragged laterally until the anchor fluke trips and then penetrates the seafloor to a depth that depends on load, anchor weight, anchor configuration and seafloor properties. In addition to their ease of installation and removal, mooring line connections on drag anchors are easy to inspect and service. In the three-point mooring system designed for the WET-NZ, each mooring leg would consist of an embedment anchor, a clump anchor, a subsurface float, and wire and synthetic mooring lines. A multi-leg mooring spread using drag anchors alone requires a large footprint on the seafloor, but the use of clump weights with the drag anchors allows for a shorter line scope and, therefore, a smaller impact area on the seabed. In the WET-NZ mooring system, 12,000-pound drag anchors would function as the primary mooring points. Each drag anchor would be secured to an 8,000-pound Navy Stockless anchor functioning as a clump weight. The EELS drag anchors and Navy Stockless anchors would be connected by a steel wire rope between 164 feet and 246 feet long (final lengths would be determined by exact water depth at time of deployment). The footprint of the WET-NZ and its mooring system is about 700 feet by 700 feet (equivalent to about 490,000 square feet or 0.045 km^2).The mooring configuration and components are illustrated in Figure 6.

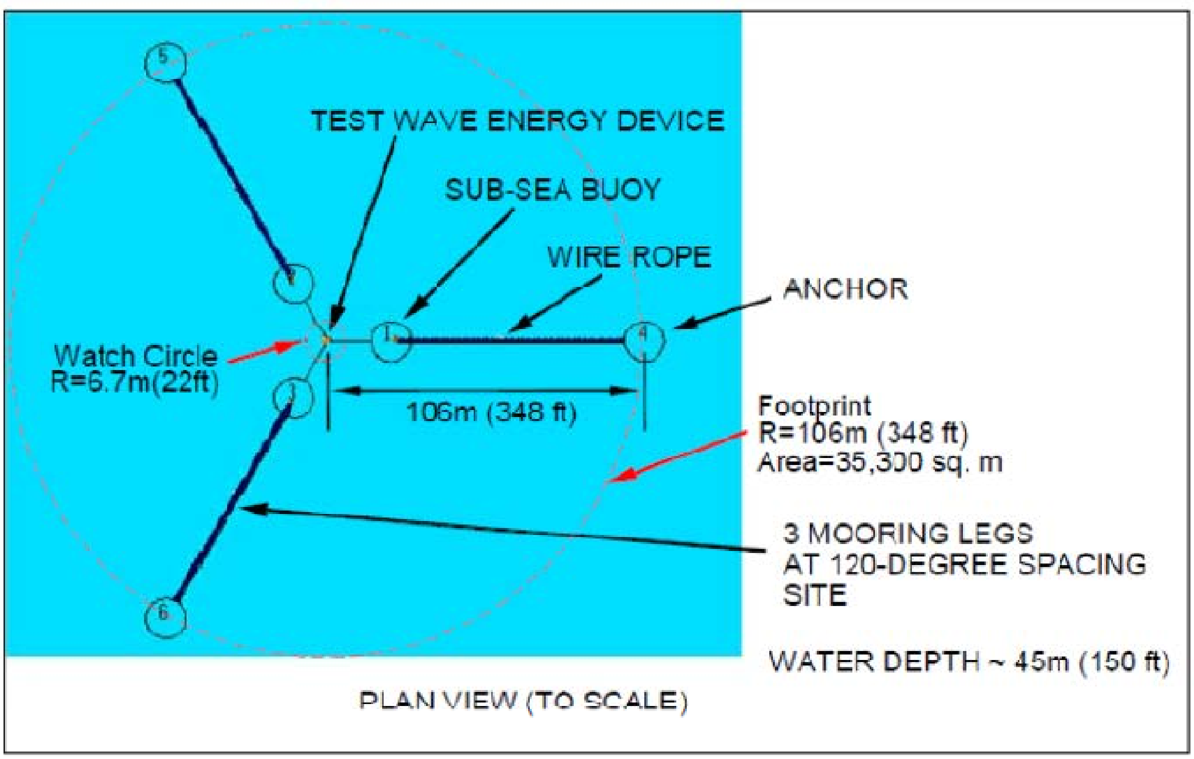
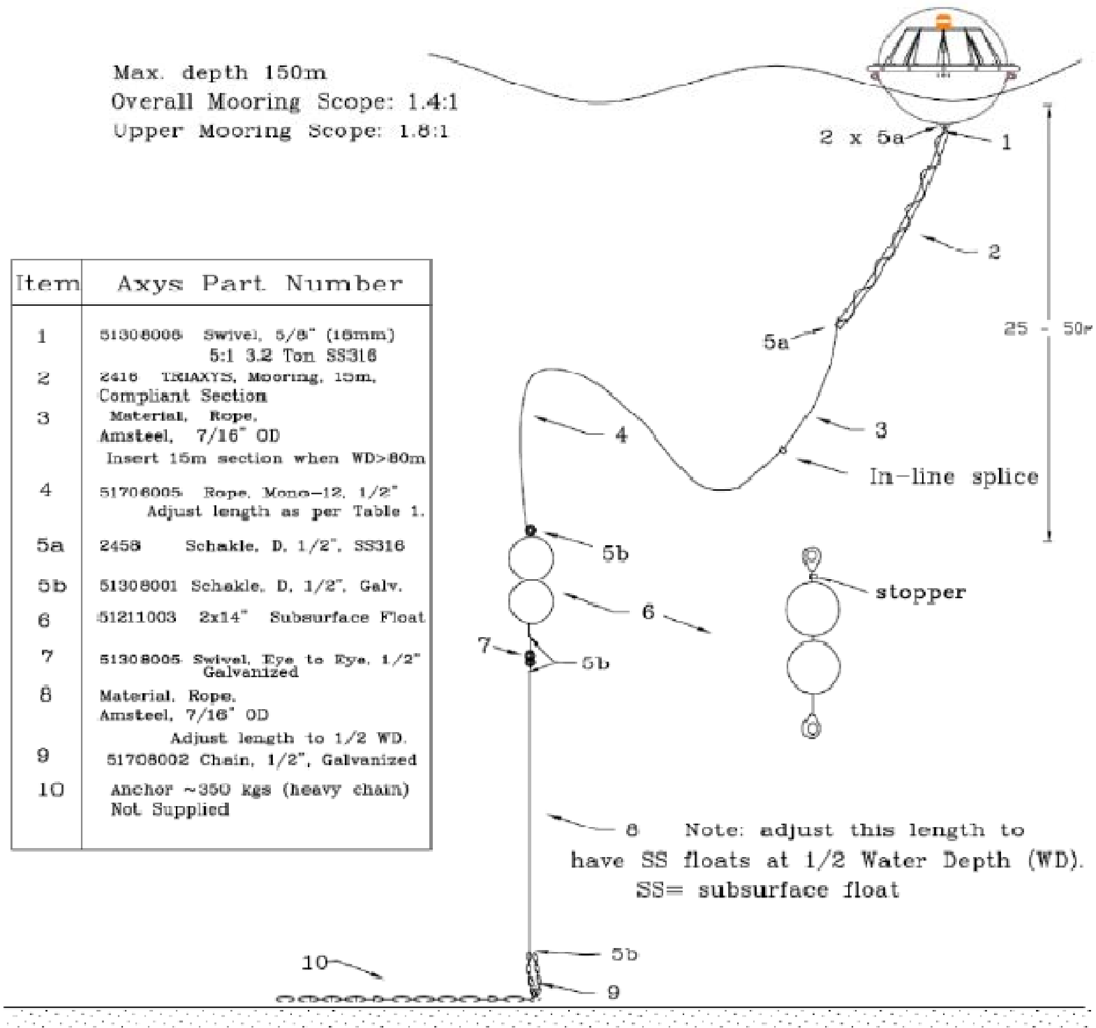


Figure 6:WET-NZ Mooring Plan view

TRIAXYS™ Wave Measurement Buoy Mooring System

The mooring line for the TRIAXYS™ Buoy is a 49.2-foot rubber bungee cord that attaches directly underneath the buoy to allow compliant wave following. The bungee cord would terminate to a synthetic Amsteel rope extending to the anchor system. The TRIAXYS™ anchor is a heavy steel chain with an approximate in water weight of 800 pounds (Figure 7).



Item	Axys Part Number
1	51308006 Swivel, 5/8" (16mm) 5:1 3.2 Ton SS316
2	2416 TRIAXYS, Mooring, 15m, Compliant Section
3	Material, Rope, Amsteel, 7/16" OD Insert 15m section when WD>80m
4	51706005 Rope, Mono-12, 1/2" Adjust length as per Table 1.
5a	2458 Schakle, D, 1/2", SS316
5b	51308001 Schakle, D, 1/2", Galv.
6	51211003 2x14" Subsurface Float
7	51308005 Swivel, Eye to Eye, 1/2" Galvanized
8	Material, Rope, Amsteel, 7/16" OD Adjust length to 1/2 WD.
9	51708002 Chain, 1/2", Galvanized
10	Anchor ~350 kgs (heavy chain) Not Supplied

***Figure 7**:TRIAXYS™ Wave Measurement Buoy Mooring Plan—Side View (ICF 2012)*

Ocean Sentinel Mooring System

The Ocean Sentinel will use a three-point mooring system that consists of two, 4-ton concrete block anchors—each on independent mooring lines—and a 500-pound clump anchor and 4-ton Pearl Harbor deadweight anchor on a third mooring line. The mooring lines would be positioned 120 degrees apart around a center position with a radius of about 100 meters (328 feet).

For the two aft mooring lines, the Ocean Sentinel would be tethered with 328-foot-long, 1.5-inch diameter Samson RP-12, which would connect to two 58-inch spherical surface mooring buoys, each of which is made of steel and has a total buoyancy of about 3,000 pounds. The Samson RP-12 is a polyester rope with a minimum breaking strength of 58,000 pounds; it has a specific gravity of 1.38 (sinking line). At both ends, these lengths of rope will have a short pendant section with a shackle assembly, which would enable them to be easily attached or detached from the mooring buoys and the Ocean Sentinel, at sea, in the case of deployment or towing, respectively. The mooring buoys would be attached with 1-inch-stud link chain to their respective anchors on the seabed. The anchors would be constructed of concrete according to International Association of Lighthouse Authorities (IALA) standards, at least 28 days prior to deployment and would be cured to full strength (to prevent leaching). Attached to each anchor would be two shots (90 feet each) of 1-inch-stud link chain, each of which would run to its corresponding mooring buoys and be attached to the padeye on the mooring buoy. A profile view of an Ocean Sentinel's mooring line is depicted in Figure 8.

The mooring line connected to the bow of the Ocean Sentinel would be a buoyant mooring line connecting the mooring yoke of the Ocean Sentinel to a 58-inch spherical surface mooring buoy with a total buoyancy of about 3,000 pounds. From there, the bowline would consist of chain anchor line leading to a 500-pound clump anchor and additional chain anchor line terminating in a 4-ton Pearl Harbor deadweight anchor.

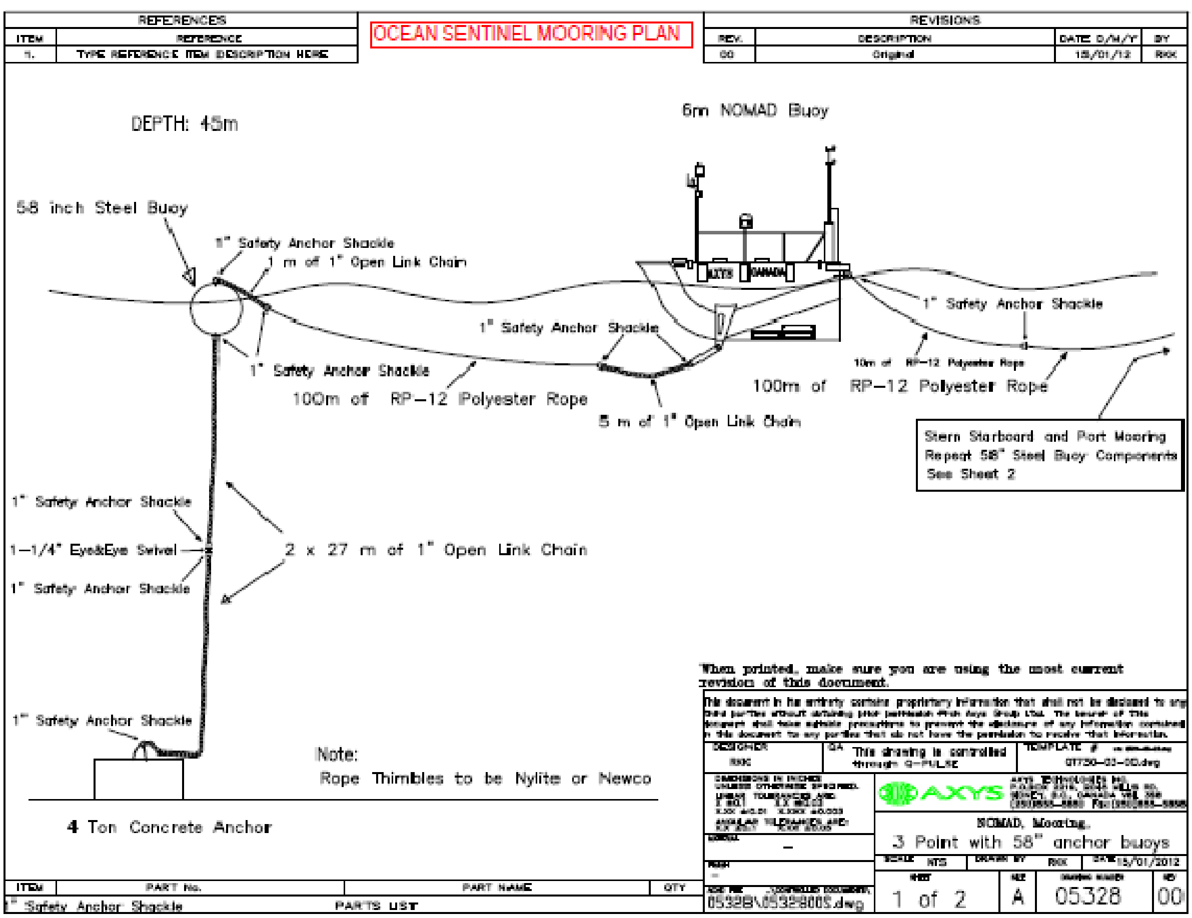


Figure 8: Ocean Sentinel Instrumentation Buoy Mooring Plan—Side View (ICF 2012)

1.3.2 Construction and Installation for the 2012–2013 WET-NZ Test

No on-site construction activities would be associated with this proposed action. All project components would be constructed at land-based facilities prior to being installed at the test site. Hatfield Marine Science Center (HMSC), in Newport, would serve as the mobilization site. The Ocean Sentinel, WET-NZ, and TRIAXYS™ wave measurement buoys, as well as all mooring materials, would be staged at this site for the installation vessels to pick up and transport to the test site.

Installation of the Ocean Sentinel and its mooring system is described in detail in the NOMAD Buoy and Mooring Deployment Procedures developed by AXYS Technologies Inc. detailed in the Corps permit application (PEV 2012). Each mooring leg consists of a concrete block anchor, a steel buoy and synthetic mooring lines. The Ocean Sentinel will be transported to the test site by a tugboat, where it would be attached to its mooring system. The Oceanus4[1], a mid-sized research vessel which accommodates a crew of 12 and a scientific party of 19 for up to 30 days at sea, is the candidate vessel for deploying the mooring system. First, an anchor would be lowered over the side, lowered to the seafloor, and set into location. The associated mooring line and possible subsurface buoy would follow attached to the anchor. A surface buoy would be used to secure the mooring line to the surface. This would be repeated for the two remaining mooring legs.

For the WET-NZ mooring system, deployment would be in two phases: deploy two seaward mooring legs and then deploy the single leeward leg. Each mooring leg would consist of a drag anchor, a clump anchor, a subsurface float, and wire and synthetic mooring lines. The same vessels and marine engineers would be contracted for the deployment of the WET-NZ mooring system. The WET-NZ device would be transported to the site by a tugboat, turned upright, and attached to its mooring system. The Seacor Quest, a 160-foot vessel out of Astoria, is the candidate vessel for deploying the mooring system. The deployment vessel would facilitate the connection of the Ocean Sentinel with its moorings, likely assisted by a smaller work skiff. The WET-NZ deployment would be accomplished in one workday.

1.3.3 Operations and Maintenance for the 2012–2013 WET-NZ Test

Continuous on-shore monitoring of the Ocean Sentinel and WET-NZ devices would commence immediately after deployment. NNMREC would maintain a dedicated staff person to be in charge of daily monitoring of the instrumentation for the deployed equipment. This person would also respond to alarms and initiate emergency response, if required. The staff person would monitor a prearranged set of WET-NZ and Ocean Sentinel device parameters either directly through the umbilical cable or through an external Internet-based interface into the Ocean Sentinel's monitoring computer. A remote telemetry system would be used for this data monitoring. The data stream would be available for local and remote monitoring, data analysis, and reporting.

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[1] Complete vessel specifications can be found at <http://ceoas.oregonstate.edu/research/vessels/oceanus/>.

Prior to deployment, the WEC developer would be required by NNMREC develop a detailed alarm response manual as part of the monitoring plan. The alarm response manual would provide a series of decision trees to assist the Ocean Test Facilities Manager, or Monitoring Engineer, in determining the next step, logging procedures, and points of contact. All alarms would be logged by the system. Alarm logs, periodically reviewed to assist in determining faulty sensors or problematic systems. WET-NZ representatives shall monitor their alarms and would advise the Ocean Sentinel monitoring engineer that they have received, acknowledge, and addressed their alarm in accordance with the WET-NZ alarm response manual. WET-NZ-specific alarm manual would be prepared and submitted by the WET-NZ developer, reviewed and approved by NNMREC, then incorporated into the WET-NZ-specific deployment.

During the 2012–2013 WET-NZ test, visual inspections, maintenance operations, and safety checks of the project devices would be performed every 4 weeks, and weekly visits may be conducted initially. This would include retrieving data storage devices, replacing batteries, and conducting any other corrective maintenance as needed. Visual inspections of the devices above and below water line would be made for signs of premature wear or excessive biofouling. Aids to navigation would also be visually inspected during these visits. In addition, associated monitoring equipment would be periodically installed and recovered (depending on the parameters being monitored, battery life, and data storage capacity of the devices).
The Ocean Sentinel would be inspected visually through the deck-mounted video camera and through regular maintenance trips on the predetermined schedule. The inspection would determine maintenance requirements. NNMREC would conduct both announced and unannounced safety inspections. If pier-side, this inspection may include internal wiring and ground system.

Prior to removal of the deployment, appropriate inspection techniques would be used to view underwater components of the project, including looking for any accumulation of derelict fishing gear. All inspections would be carried out with consideration for safety of personnel and weather permitting. This inspection would be logged and would help to gain a greater understanding of system component aging.

Scheduled maintenance is done based on length of operational use or at predetermined intervals of time. The results of the maintenance would provide an understanding of future maintenance requirements. A list of the basic maintenance items includes:

- Solar panel cleaning,
- Anemometer and wind bird inspection,
- Inspection and cleaning of marine growth buildup,
- Evidence of bird or marine mammal presence,
- Hull inspection following manufacturer’s recommendations,
- Load element inspection,
- Mooring lines,
- Umbilical cable connection point and integrity, and
- Many other items compiled in maintenance plan.

The WET-NZ device and the Ocean Sentinel itself could undergo specific maintenance, which could include:

- Retrieval for on-shore inspection. The WET-NZ device and Ocean Sentinel would be disconnected electrically, detached from their moorings, and taken to port for inspection and refurbishment as required. This maintenance may include the change of load elements, rerouting of electrical wires, etc. When the devices are removed from the mooring systems for maintenance, the mooring lines would be connected to each other as if the device were still on station and supported with an additional subsurface float (SSF). The SSF maintains tension on the mooring system so there is no slack introduced into the mooring system.
- On-shore inspection and refurbishment. When the devices are removed from moorings at the end of the deployment period, they would be taken out of water and cleaned, after which an external visual inspection would be carried out. Full internal inspections would also be performed, including replacement of worn or damaged components. The lid seals, hydraulic cylinder seals, and bearing pads would all be replaced as appropriate based on their condition. The hydraulic fluid would be tested and replaced, if required.
- Redeployment after inspection. The devices would be towed out from port, reconnected electrically, attached to all moorings, and the test would resume.
- Corrective maintenance would occur when required and may be between scheduled maintenance. The change in schedule could be due to:
- Failure of equipment or hardware,
- Predicted failure during an inspection, or
- Accelerated maintenance to be available during a specific time frame, when normal maintenance would be done.

In addition to the above, maintenance that can be done while in the moor would be identified as well as maintenance that must be done pier-side and in dry-dock identified.

Any unscheduled maintenance would be completed as necessary, with consideration for safety of personnel and protection of the environment. During operation, either the Ocean Sentinel or the WET-NZ device may require removal from the mooring. A vessel of opportunity would be employed to travel to the site, disconnect each mooring line, and transport the Ocean Sentinel or WET-NZ device back to Newport. The Ocean Sentinel or WET-NZ device would be repaired, serviced, or modified as needed; it would be subsequently tested, and once validated, towed back to the site for reinstallation. When removed from the test site mooring, there may be a need for dockside mooring in Newport for the WET-NZ device. These moorings would occur at existing piers and docks in the Port of Newport and in agreement with the owner and in accordance with existing uses and authorizations.

A number of formal plans and procedures have been developed or would be developed prior to the deployment of the 2012–2013 WET-NZ test. These include an Installation and Removal Plan, Ocean Sentinel Mooring Plan, WET-NZ Mooring Plan, Operations and Maintenance Plan, Decommissioning Plan, Spill Contingency and Emergency Response Plan, Emergency Response and Recovery Plan, Safety Management Plan, Navigational Lighting Plan, a number of environmental monitoring plans, and an Adaptive Management Framework. Both NNMREC and WET-NZ would have plans to address the major types of emergency conditions that could occur during normal operation and maintenance activities for the WET-NZ test, identify lines of communication with regulatory agency personnel, and establish response actions for emergencies. Implementation of procedures in their plans would minimize the potential for adverse effects in the event an emergency was to occur.

Upon conclusion of testing in 2012, the Ocean Sentinel, WET-NZ, and TRIAXYS™ devices would be removed and taken to a land-based storage facility for the winter. The anchoring and mooring systems for the Ocean Sentinel would remain in place until the summer of 2013, at which time the devices would be redeployed for a second round of testing. The WET-NZ anchoring and mooring system may also remain in place between the summer tests. Upon conclusion of testing in the summer of 2013 and within the NWP #5 authorization period, all project components, including the devices and mooring systems, would be removed.

1.3.4 Removal and Decommissioning for the 2012–2013 WET-NZ Test

When the WET-NZ developer has completed the testing in 2013, the device would be locked down and the umbilical cable would be divorced from the WET-NZ. The cable could be staged temporarily on hang-off buoys after disconnection from the WET-NZ. With the umbilical cable disconnected from the WET-NZ, the WET-NZ and all associated mooring components would be removed from the test site. The Ocean Sentinel moorings would be removed at the end of the authorization period for the 2012– 2013 WET-NZ test, at which time the mooring lines and anchors would be recovered by a vessel of opportunity.

During decommissioning of the 2012–2013 WET-NZ test, all project components would be removed from the test site and action area, including the Ocean Sentinel, WET-NZ device, TRIAXYS™ wave measurement buoy, anchors, mooring lines, subsurface floats, and the shore station, and associated telemetry antennas. A vessel of opportunity would be used to disconnect and recover the umbilical cable and would recover each component using a winch and/or A-frame to bring each component to the surface and locate on the deck.

1.3.5 Future Tests of Wave Energy Conversion Devices

As stated in the description of the Corps Proposed Action above, over the 10-year lifetime of the test center operation, the Corps is likely to receive requests for permits to test a number of WEC devices. The Corps will be required to conduct ESA Section 7 for all future device deployments at the NNMREC test site. Due to the uncertain nature of any future installations, we are able to consider only their general effects on listed marine organisms in this opinion. In each case, NNMREC and the WEC developer would apply to the Corps and other agencies for permits to moor, deploy, and test at the test site, and thus the specific effects of each test would be considered in future Section 7 consultations.

1.3.5.1 Future Wave Energy Conversion Technologies

Because wave energy generation is in the early stages of development, a wide variety of technology designs are being conceptualized, designed, and tested. DOE's Marine and Hydrokinetic Technology Database include over 250 different technologies including tidal, current, and thermal devices[2]. WEC devices which may potentially be tested at the test center can be grouped into the following categories.

- Pitching/surging/heaving/sway devices. Pitching/surging/heaving/sway devices are any of several device designs that capture wave energy directly without a collector by using relative motion between a float, flap, or membrane and a fixed reaction point. The float, flap, or membrane oscillates along a given axis depending on the device and mechanical energy is extracted from the relative motion of the body part relative to its fixed reference.
- Oscillating water columns. Oscillating water columns are partially submerged structures in which water enters a chamber through a subsurface opening. Wave action causes the captured water column to move up and down like a piston. This action forces the air trapped above the water column to move through an opening connected to a turbine. No water travels through the turbine blades during operation of this type of WEC device. There are shore-based and floating models.
- Point absorbers. Point absorbers are floating or submerged structures with components that capture energy from the vertical motion of waves. This motion drives electromechanical or hydraulic generators. Point absorbers may be fully or partly submerged, they may be floating or rigidly anchored, and they are relatively small 1.3.5.2 Scenarios for Future Wave Energy Conversion Tests

Any of the three following possible testing scenarios could be implemented in the test site during the 10-year operation:

1. Future WEC developers could deploy WEC devices and monitor their power generation using equipment contained within their device. Such deployments would typically last at least several months and could continue for as long as 12 months, thus, allowing WEC developers to observe how their devices handle the severe winter storms that affect this region. No more than two WEC devices would be tested at any given time under this scenario. NNMREC may help developers with the design and construction of the internal testing equipment.
2. The WEC devices could be monitored using test equipment deployed on a powered and manned vessel. In this case a WEC device would be connected to the vessel by a floating or in-water electrical cable at a distance of about 150 meters (492 feet). The vessel would be manned at all times and located using its own anchor. Due to the expense of keeping a manned vessel on site, such tests would not be expected to last more than 10 days. The WEC devices might remain on site for a longer period of time to demonstrate

[2] The DOE Marine Hydrokinetic Technology Database is available online at : http://www1.eere.energy.gov/water/hydrokinetic/default.aspx

the survivability of the device. In this case, the power generation unit would either be taken off line, or directed toward test equipment on-board the WEC device itself.

3. Up to two WEC devices could be monitored using test equipment deployed on up to two Ocean Sentinel instrumentation buoys. The Ocean Sentinels would have their own mooring system that would consist of a three-point mooring configuration and would be connected to the WEC devices at a distance of about 150 meters (492 feet) by an umbilical cable carrying power and data signals. A TRIAXYS™ wave measurement buoy would be located nearby. Wave data recorded by the TRIAXYS™ wave measurement buoy would also be transmitted to the Ocean Sentinel or directly to shore, via wireless telemetry. The Ocean Sentinels would be unmanned during the test Tests would run for 1 to 6 months during the months of May to October, although the WEC device itself might remain on site for longer.

As described above, future testing of WEC devices at the test site could follow a variety of deployment and testing scenarios. The following is intended to generally describe the potential project components, mooring systems and installation scenarios, which may be associated with Future Tests.

Deployment and configuration scenario for Future Wave Energy Conversion Tests
The deployed configuration of the Ocean Sentinels (or manned testing vessel), and the TRIAXYS™ wave measurement buoy would be nearly identical to that proposed for the Ocean Sentinel and TRIAXYS™ wave measurement buoy during the 2012–2013 WET-NZ test. Deployments may be located in different locations within the 3.4 km^2 test site, the physical footprint of the test may be different, and the standoff distances may differ, and watch circles may be larger or smaller dependent on the specific equipment used and the precise location of the test. However, NNMREC expects that the configuration would closely approximate those employed for the 2012–2013 WET-NZ test. Based on the data provided for the WET-NZ test the approximate footprint for a future WEC test would be 0.085km^2 or two-percent or the proposed test site. If two WEC device tests were conducted concurrently in the future the combined footprint would be about 0.17km^2 or five-percent of the proposed test site.

Testing Vessel for monitoring WEC devices in Future Tests
As described above, future WEC tests could be monitored using test equipment mounted on a manned vessel. The vessel would likely be OSU's research vessel, the *R/V Pacific Storm*, which is a 26-meter (84-foot), steel hulled, converted fishing vessel. The vessel has berthing for up to 12 people (crew and scientists). It is equipped with a knuckle boom with a 5,443-kilogram (6-ton) lifting capacity and a 9-meter (30-foot) reach mounted to the back of the living area for loading/unloading supplies, boats, etc. The aft deck area measures 7 meters (24 feet) long by 6.7 meters (22 feet) wide. The vessel is powered by a Caterpillar 3412 engine enabling the vessel to reach a top speed of 9.5 knots. The vessel also has a 300 horsepower hydraulic engine and two electrical generators that provide 110 and 220-volt power. The vessel can carry a maximum of 56,781 liters (15,000 gallons) of fuel, 10,599 liters (2,800 gallons) of fresh water, 379 liters (100 gallons) of lube oil, and 1,514 liters (400 gallons) of hydraulic oil (ICF 2012).

Anchoring and Mooring Systems for WEC Devices in Future Tests
In addition to the 2012–2013 WET-NZ deployment, other potential WEC device designs may be tested over the 10-year operation of the test center. In future tests, up to two WEC devices may be tested simultaneously in the test site. For tests of two WEC devices, the Ocean Sentinel would be coupled to one of the WEC devices. The manned testing vessel or a second Ocean Sentinel would be coupled to the second WEC device under test during this time. One or two TRIAXYS™ wave measurement buoys would also be deployed in future tests.

Ocean Sentinel Instrumentation Buoy Mooring System for WEC Devices in Future Tests
In future test deployments, the Ocean Sentinel would use anchoring and mooring equipment and a configuration that is nearly identical to the one that would be used during the 2012–2013 WET-NZ tests. Subtle differences (e.g., anchor line length) may occur to optimize the anchoring and mooring configuration based upon the specific conditions of the precise deployment location. However, because the physical and environmental parameters within the test site are relatively uniform, it is not likely that anchoring and mooring configurations for future deployments of the Ocean Sentinel would vary appreciably from the WET-NZ test.

TRIAXYS™ Wave Measurement Buoy Mooring System for WEC Devices in Future Tests
In future test deployments, the TRIAXYS™ wave measurement buoy would use anchoring and mooring equipment and a configuration that is nearly identical to the one used during the 2012–2013 WET-NZ test. Subtle differences (e.g., anchor line length) may occur to optimize the anchoring and mooring configuration to match the specific conditions of the precise deployment location. However, because the physical and environmental parameters within the test site are relatively uniform, it is not likely that anchoring and mooring configurations for future deployments of the TRIAXYS™ wave measurement buoy would vary appreciably from the WET-NZ test.

Mooring Systems for Vessels in Future Tests
As described above, testing equipment for future tests could be installed onboard a testing vessel. In test scenarios where two WEC devices are under test simultaneously, one may be coupled to this manned testing vessel. The vessel's mooring system consists of a 600-pound (272 kilograms) Danforth anchor with 30.5 meters (100 feet) of chain attached to it, followed by 137 meters (450 feet) of 3.2 centimeters (1.25-inch) Samson double-braid nylon line, followed by 183 meters (600 feet) of 1.9 centimeter (0.75-inch) steel cable.

Mooring Systems for WEC Devices in Future Tests
In future tests, WEC device moorings are uncertain and although DOE anticipates some similarities they may not use mooring systems similar to that planned in the 2012–2013 WET-NZ deployment. Although, detailed mooring plans and the location of the moorings within the test site are not available for future WEC device tests it is probable that they would require relatively taut moorings capable of testing large devices.

Anticipated anchoring systems could include drag anchors, deadweight anchors, suction-installed pile anchors, and plate anchors. Generally, a three- to four-point anchoring layout would be used. It is also anticipated that the WEC device and optional subsurface floats would be coated with an antifouling paint prior to installation to prevent marine life from colonizing on these project components. The specific mooring configuration would vary depending on the WEC device under test. WEC device developers would be required to submit detailed mooring plans to NNMREC for review and approval. Northwest National Marine Renewable Energy Center would require that all WEC devices to be tested use only TBT-free antifouling paints and coatings.

Operations and Maintenance of WEC Devices in Future Tests

The procedures for operations and maintenance of other future tests that could be conducted over the 10-year operation of the test center are anticipated to be similar to those employed in the 2012–2013 WET-NZ test.

In other future tests, the data acquisition systems (DAS), load bank, and other equipment may be contained onboard a manned testing vessel. In this scenario, the WEC device would be connected to the equipment on the vessel by a floating or submerged umbilical cable enabling the separation between the vessel and the WEC device to be about 100 meters (328 feet). The vessel would be manned at all times and located using its own anchor. Such tests would not be expected to last more than 10 days, at which time, the vessel would disconnect from the WEC device and return to shore.

Testing conducted by equipment on board a manned vessel would occur in the months of May to October only. Though single test events would not exceed 10 days, the testing vessel may engage in multiple tests per season.

For future tests, the Ocean Sentinel would operate for a testing period of up to 6 months. The WEC devices would operate for up to 12 months after they are installed. When not on station, the Ocean Sentinel’s anchors would be left in place and its mooring lines would be buoyed off with marker buoys. The anchoring and moorings for the Ocean Sentinel may be left installed at the test site for the 10-year duration of test center operations if permitted and authorized beyond the WET-NZ test period, in order to minimize disturbance to benthic habitats.

During future tests, visual inspections, maintenance operations, and safety checks of the Ocean Sentinel would be performed every 4 weeks by NNMREC, and would include retrieving data storage devices, replacing batteries, and conducting any other corrective maintenance needed. Initially, weekly visits to the Ocean Sentinel would be conducted to visually inspect its exterior for signs of premature wear or excessive biofouling. NNMREC would maintain a dedicated staff person to be in charge of daily monitoring of the Ocean Sentinel and WEC devices, which would respond to alarms and initiate emergency response, if needed. The staff person would monitor a prearranged set of WEC device parameters either directly through the floating power cable or through an external Internet-based interface into the Ocean Sentinel's monitoring computer. The data stream would be available for local and remote monitoring, data analysis, and reporting.

The Ocean Sentinel is designed for minimal maintenance. Between each deployment, the Ocean Sentinel would undergo servicing such as replacing batteries, checking all alarms and component function, and checking for excessive biofouling around the mooring connections.

To limit bottom disturbance, if future WEC tests can use the same mooring configuration, the anchor and mooring system may be left in place temporarily between tests, if it is properly permitted. If WEC device anchors are designed and installed by the device developers, they may be retrieved upon completion of the device's test.

All WEC devices under test during 10-year operation of the test center would be required by NNMREC to comply with requirements designed to minimize the impact of tests on marine habitats and life, as well as human health and safety. These include an Installation and Removal Plan, Ocean Sentinel Mooring Plan, WET-NZ Mooring Plan, Operations and Maintenance Plan, Decommissioning Plan, Spill Contingency and Emergency Response Plan, Emergency Response and Recovery Plan, Safety Management Plan, and Navigational Lighting Plan. Both NNMREC and the WEC device developers would have local contingency response capability to respond to alarms or unexpected conditions and take corrective action, as needed. In addition to contingency response, salvage plans for the Ocean Sentinel and WEC device would be in place in the event of a catastrophic event. These plans would be developed in coordination with the Oregon Parks and Recreation Department and the Oregon Department of State Lands prior to any deployment of the Ocean Sentinel or a WEC device. A detailed set of WEC device operations and maintenance procedures would be developed for each specific WEC device to be deployed at the test site. These procedures would include training and qualification requirements, startup, shutdown, and contingency response procedures. Maintenance of the WEC devices would be unique to each device and the responsibility of each developer. NNMREC would be supplied with a WEC maintenance plan for review and approval before deployment of the WEC devices.

In addition, during the 10-year operation of the test center, NNMREC and all WEC device developers would follow the procedures outlined in an adaptive management and mitigation process (detailed in section 1.3.6.6). This requires that the WEC developer prepare an adaptive mitigation plan prior to their individual test. Each test-specific mitigation plan would include thresholds and mitigation actions for the particular test and would account for the unique attributes of that test, such as the characteristics of the technology being tested and duration of testing. In addition, results and analysis of previously completed monitoring studies would be used to inform the adaptive mitigation plans for future tests. The adaptive management process would provide a framework for the broader regulatory and stakeholder communities to stay informed of and provide feedback on test site monitoring. As part of the process, adaptive management thresholds have been developed to evaluate the monitoring results of both single-year and multi-year data from test activities.

Associated monitoring equipment would be periodically installed and recovered depending on the parameters being monitored, battery life, and data storage capacity of the devices. This includes equipment deployed directly within the 3.4-km2 test site, as well as equipment deployed within the 9.3-km action area. Specific information detailing the known types and locations of scientific equipment that would be deployed as part of the proposed action are included in the monitoring plans (Appendix A).

Removal and Decommissioning of WEC Devices after Future Tests
A number of WEC devices could be tested throughout the 10-year operation of the test center. It is likely that the equipment and procedures employed in removal and decommissioning of WEC devices in other future tests would be nearly identical to those employed in the removal and decommissioning of the 2012–2013 WET-NZ test. NNMREC would request that all WEC device developers responsibly dispose of the WEC device and all associated materials, if they are to be disposed of after the testing period and would require that each WEC device developer prepare and submit a detailed removal and decommissioning plan. Throughout this process, the WEC device developers would coordinate with NNMREC for a smooth and orderly removal. General parameters for anticipated removal and decommissioning procedures are described below.

When WEC device developers have completed testing their device, the power would be de-energized and a vessel of opportunity would be used to disconnect the umbilical cable from the Ocean Sentinel and from the WEC device. With the umbilical cable removed, the WEC device would be transported back to the dock from the test site. Anchors could be retrieved by a vessel with adequate assets and load-handling capabilities or decommissioned on site. If being removed completely, the anchors and mooring lines would be retrieved by attaching a recovery line to the anchor and then winching it to the surface. This may be accomplished using a remote-operated vehicle. It may be possible to recover the anchors through the mooring lines; if this is the case, the remote-operated vehicle would not be needed. Suction-installed pile anchors could be retrieved by pumping water into the anchor chamber, creating positive pressure that forces the embedded anchor out of the sediment. If decommissioned on site, embedment anchors such as plate or pile anchors could be cut off at the ocean floor using underwater acetylene torches. The Ocean Sentinel moorings and anchors may remain in place in the test site for the 10-year lifetime operation of the test center in order to minimize seabed disturbance, or they may be removed between deployments. The procedures and equipment employed in the removal of the Ocean Sentinel and its anchors and moorings would be to be identical to the procedures and equipment that would be employed at the conclusion of the 2012-2013 WET-NZ test. The decommissioning of the Ocean Sentinel at the conclusion of the 10-year operation of the test center would be identical with the Overall Decommissioning described above.

If the testing vessel is used in future WEC device tests , it would not be decommissioned; rather it would resume a schedule of research activities to support HMSC and OSU upon conclusion of operation of the test center.

1.3.6 Protection, Mitigation and Enhancement Measures

The measures described here were presented by DOE and the Corps in the consultation initiation package as part of the proposed action, and are intended to reduce or avoid adverse effects on listed species and their habitats.

Northwest National Marine Renewable Energy Center has committed to incorporating protection, mitigation and enhancement (PME) measures in the implementation of the WET-NZ test, as well as throughout the 10-year operation of the test center to facilitate the safe deployment of the project technology, and to minimize and mitigate impacts on the marine environment.

In this analysis, NMFS includes these conservation measures as components of the proposed action and conducts its analysis accordingly.

1.3.6.1 Planning and Development

The following project measures address planning and development of the proposed action for the 10-year operation of the test center, the WET-NZ test and for all future WEC tests.

- WEC device developers will submit a maintenance plan to NNMREC for review and approval prior to deployment.
- WEC device developers and/or NNMREC will prepare a decommissioning plan that outlines responsible methods for decommissioning or removal and disposal of the Ocean Sentinel and mooring system components. This will include, where applicable, recycling, reuse, or repurposing of materials.
- NNMREC will request that all WEC device developers responsibly dispose of the WEC devices and all associated materials, if they are to be disposed of after the testing period.
- NNMREC will request that all WEC device developers that would test their devices at the test site would submit a mooring removal and disposal plan that includes provisions for the responsible disposal, recycling, or repurposing of mooring components installed to test their device.

1.3.6.2 Navigation and Transportation

The following project measures address navigation and transportation of the proposed action for the 10-year operation of the test center, the WET-NZ test and for all future WEC tests.

- An automatic identification system transmitter will be used to provide navigation assistance for locating the Ocean Sentinel in the unlikely event it breaks free from the mooring system.
- Marker buoys will be placed at the test site when a WEC device or Ocean Sentinel has been removed (e.g., brought to Newport for maintenance).
- The Ocean Sentinel will comply with applicable navigational regulations for marking, lighting, and informing boaters of the location of in-water and on-water system components.
- WEC device developers will be required to submit detailed mooring plans to NNMREC for review and approval.
- Northwest National Marine Renewable Energy Center will include the U.S. Coast Guard, the Fisherman Involved in Natural Energy (FINE) committee, the Oregon State Police, and the Oregon Marine Board in determining the most appropriate navigational designations for the test site both during and between tests.

- Two weeks prior to deployment, installation, and removal of an Ocean Sentinel or WEC device, NNMREC will request that the U.S. Coast Guard publish a Local Notice to Mariners describing the proposed action and potential navigation exclusion zone or area to be avoided.

1.3.6.3 Safety and Survivability

The following project measures address the safety of the proposed action and its resilience and operability in the marine environment for the 10-year operation of the test center, the WET-NZ test and for all future WEC tests.

- Prior to testing, salvage plans for the Ocean Sentinel and WEC devices will be in place in the event of a catastrophic event. These plans will be developed in coordination with the Oregon Parks and Recreation Department and the Oregon Department of State Lands. The salvage plan will include available salvage resources and the ability of those resources to respond in real- time.
- The project design will identify and address safety features for installation, operations, maintenance, modification, repair, removal, and decommissioning.
- The Ocean Sentinel will be capable of surviving 50-year storm conditions at the test site.
- The Ocean Sentinel will be capable of surviving a tsunami event consistent with Lincoln County guidance on tsunami planning.
- The Ocean Sentinel will have the capability to remotely trigger alarm conditions for events exceeding predetermined thresholds.
- Visual inspections, maintenance operations, and safety checks for the Ocean Sentinel will be performed every 4 weeks.
- Monitoring personnel will follow notification procedures in the event of Ocean Sentinel system failure. In particular, the procedures will address major or cataclysmic events affecting the system that require notification of emergency or safety services, including the U.S. Coast Guard, local emergency responders, law enforcement, or emergency response agencies.
- The Ocean Sentinel will contain safety features to avoid accidental shock or injury to system workers or to nearby personnel, property, or marine vessels.
- A separate set of backup batteries in the Ocean Sentinel will be reserved for emergency data transmissions and bilge operation.

Before testing, each WEC device developer will submit to NNMREC for review and approval a spill contingency and emergency response plan, which will contain measures, intended to ensure a rapid response and recovery that minimizes potential environmental harm.

1.3.6.4 Measures for the Protection of Biological Resources

The following project measures address the impacts of the proposed action on biological resources for the 10-year operation of the test center, the WET-NZ test and for all future WEC tests.

- Any WEC device that was tested in other waters prior to shipment to the test site will undergo purging of contained water, cleaning, and drying to prevent the spread of invasive species.
- Umbilical cables will have at least single armor to reduce the electromagnetic field (EMF).
- The umbilical cable connection on the WEC devices and Ocean Sentinel will be constructed of steel or other metal to discourage chewing, gnawing, or pecking and prevent electrocution by marine life.
- The connection node on the umbilical cable will be filled with biodegradable seed-based oil.
- The Ocean Sentinel and each subsequent WEC device test would include either appropriate haul-out deterrents approved by NMFS for or a monitoring plan for all project components which provide opportunity for pinnipeds to haulout to assess the potential for, or occurrence of, pinniped haulout. If pinniped haulout occurs or is reasonably likely to occur, NNMREC would, in consultation with NMFS; install or implement an approved deterrent.
- The Ocean Sentinel will use only tributyltin (TBT)-free and copper-free antifouling paints and coatings, and NNMREC will require that all WEC devices to be tested as part of the proposed action use only TBT-free antifouling paints and coatings.
- All vessels engaged in activities to support the proposed action will comply with NMFS marine mammal viewing guidelines.

1.3.6.5 Research and Monitoring

The proposed monitoring plans have been developed for the 10-year operation of the test center and the WET-NZ test considered here and for all future WEC tests. These plans have been designed to increase the knowledge of the potential effects that the proposed action, and wave energy projects in general, may have on the environment. The monitoring plans serve two purposes: first, monitoring is used to collect data and information on the affect the proposed action has on key elements of the marine environment and second, monitoring will be used to develop, assess, and apply thresholds through adaptive management and mitigation, as detailed in Section 1.3.6.6 to minimize or mitigate for project effects.

- NNMREC Ocean Test Facility (OTF) Short-Term Acoustic Test
- Northwest National Marine Renewable Energy Center OTF Benthic Monitoring Studies;
- Electric and Magnetic Field Monitoring of WET-NZ half-scale Wave Energy Generator at NNMREC Ocean Test Facility; and

The full text of the monitoring plans are available in Appendix A. Below is a summary of the hypotheses and objectives for each proposed monitoring plan.

Benthic Habitat and Derelict Gear

1. The presence of anchors and the potential for changes in benthic habitat may affect the distributions of benthic fishes and invertebrates. To investigate this hypothesis, benthic species and habitat monitoring will be conducted to determine how benthic organisms will respond to WEC-induced changes to the habitat.
2. The introduction of hard surfaces may encourage colonization by marine invertebrates and fish attraction. To investigate this hypothesis, NNMREC, or its contractor will conduct visual observations of the introduced surfaces to assess colonization. Additionally, the ongoing benthic sampling conducted under objective (1) will investigate whether resident species are being affected by those attracted to the structures.
3. Marine mammals could become entangled or entrapped by derelict gear that has been ensnared on any Project structure. To investigate this hypothesis, derelict gear monitoring will be conducted to determine if gear is being ensnared by the anchors and mooring lines.

Acoustic

1. The objective of the acoustic monitoring is to determine if the device under test transmits acoustic energy above marine mammal harassment thresholds.

Electromagnetic Fields

Electromagnetic Field monitoring for marine renewable energy is a newly emerging field that requires mission-specific instrumentation. OSU has designed an advanced EMF monitoring instrument and will carry out the first deployment and monitoring during the 2012-2013 WET-NZ test period.

1. Researchers under contract to NNMREC hypothesize that the proposed action is highly unlikely to generate EMF at levels that would adversely impact endangered species. To investigate this hypothesis NNMREC's researchers will characterize EMF within the action area during an energized WEC test.

In addition to conducting the monitoring referenced above, NNMREC staff will make opportunistic observations of marine mammals and other listed species during installation, maintenance, monitoring and any activities at the test site. Northwest National Marine Renewable Energy Center will record all opportunistic observations and include them in the annual report of monitoring results as detailed in section 1.3.6.6.

Monitoring results will be reviewed by NNMREC in real-time, whenever possible, to determine if thresholds from the NNMREC Adaptive Management Framework (NAMF) (Appendix B of this opinion) or the WET-NZ Adaptive Mitigation Plan (WAMP) (Appendix C of this opinion) described in section 1.3.6.6 below, have been exceeded. If the results show that thresholds are not exceeded, then no action will be taken. If results show that thresholds are exceeded, NNMREC will consult with NMFS and ODFW to carry out an appropriate response. Responses may include changes to monitoring methods, project operations and/or mitigation actions, as appropriate.

Activities required to carry out these environmental studies are expected to vary, but they would be carried out during daylight, during spring, summer, and fall, as specified in the study plans. The vessels used would be similar in size to fishing and recreational boats that frequent this part of the Oregon coast. Proponents of future monitoring that has the potential to affect listed species will be required to obtain a research permit through the State of Oregon and NMFS' scientific take permitting process. Therefore take associated with future environmental studies is not evaluated as a part of the proposed action in this opinion[3].

1.3.6.6 Adaptive Management and Mitigation

NNMREC Test Center Adaptive Management Framework

The purpose of the NNMREC Test Center Adaptive Management Framework (NAMF), which will guide adaptive management of the test center over the 10-year period, is two-fold. First, it provides a means for the broader regulatory and stakeholder communities to stay informed of and provide feedback on NNMREC test center monitoring and mitigation. The Adaptive Management Committee (AMC), described below, will receive an Annual Operations and Monitoring Report (Annual Report). The Annual Report will be a compilation of monitoring results, adaptive management thresholds, and mitigation actions taken during tests conducted at the NNMREC site. The AMC will meet on an annual basis to review results and provide guidance on future test center activities. The NAMF will be in place for the proposed 10-year duration of NNMREC test center operations.

The NNMREC test center will be in operation from 2012 – 2022. Throughout this period, NNMREC will provide an opportunity for various WEC technologies to conduct short-term, non grid-connected tests within the test center.

Second, the NAMF provides a foundation for the monitoring and adaptive management and mitigation associated with individual tests at the NNMREC site. For each test performed at the NNMREC ocean site, NNMREC will require WEC developers to prepare an Adaptive Mitigation Plan that includes effect thresholds and mitigation actions for their particular test. The future Adaptive Mitigation Plans will account for the unique attributes of each WEC test, such as the characteristics of the technology being tested and duration of testing. In addition, results and analysis of previously completed monitoring studies will be used to inform the plans for future tests.

The general process for this NNMREC Test Facility (test Center) Adaptive Management Framework (NAMF) is depicted in Figure 9.

[3] Benthic monitoring is currently conducted under such an authorization which is renewed annually and is currently not authorized to take any ESA-listed species.

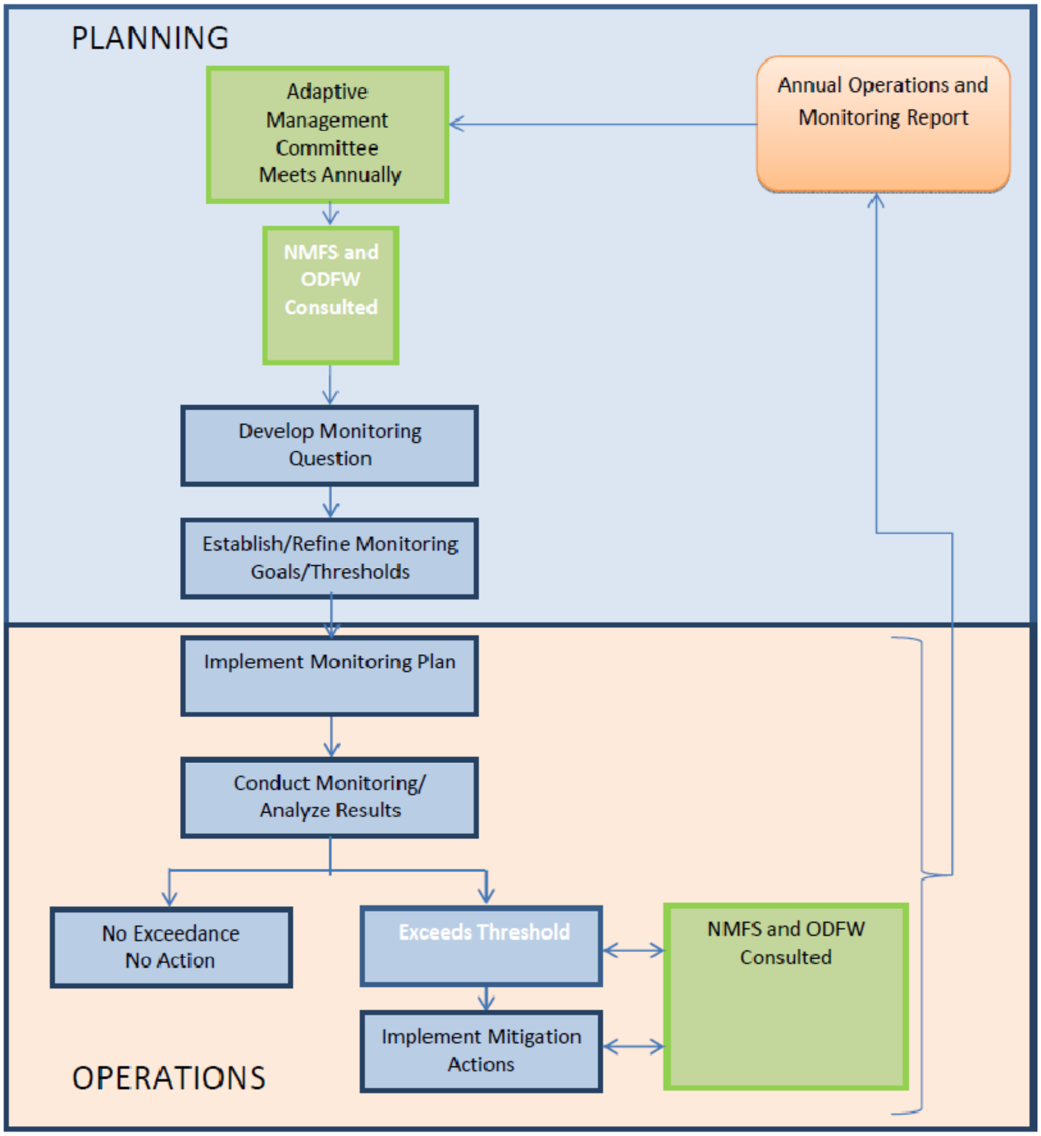

Figure 9. Adaptive Management Framework Flow Chart (from ICF 2012, Appendix C)[4]

Adaptive Management Committee

The purpose of the AMC which will remain active over the 10-year period the test center is in operation is to review marine resource issues (i.e. benthic habitat, derelict gear, marine mammals, acoustics, and electromagnetic fields) related to wave energy testing activities at the NNMREC test site and to make recommendations for changes in monitoring, project operations, and/or adaptive management/mitigation thresholds for the test site.

[4] Note that the reference to "NMFS and ODFW consulted" does not imply that NMFS would conduct ESA Section 7(a)(2) consultation.

RECOMMENDATION AND REVIEW PROCESS

The timelines outlined in this section are designed to ensure that previous year's test information can be used to inform any permitting, adaptive management or other review processes for future year tests.

Annual Report

No later than December 1 of each year, an Annual Report will be provided to the AMC for all tests conducted in the previous 12 months. The Annual Report will include a compilation of monitoring conducted (including a summary of the purpose for monitoring, the methods used, and monitoring results) and mitigation actions taken. In addition, plans for future tests will be summarized.

Adaptive Management Committee Meeting

No later than January 31 of each year, NNMREC will convene and facilitate an annual meeting of the AMC. The AMC will evaluate the information relative to the adaptive management thresholds and mitigation actions discussed in the sections that follow.

The AMC will also evaluate technical issues and data interpretation associated with the monitoring, as appropriate. Such evaluation will include the sufficiency and adequacy of the information provided by the monitoring, consideration of monitoring results, as well as possible adjustments to subsequent monitoring methods and frequencies. Key functions of the AMC are to:

- Review the results of studies and monitoring conducted during the previous testing period;
- Use study and monitoring results, as well as other sources of relevant information, if applicable, to determine whether a change to project monitoring (e.g., study design, methods, or duration) is warranted or if existing monitoring approaches continue to be appropriate;
- Review available information about wave energy devices proposed for testing in the following test season;
- Evaluate any changes in plans made by NNMREC in response to the studies and/or monitoring, or upcoming devices; and
- In the event effects are identified that require modification to project operations or monitoring, provide NNMREC with recommended measures to avoid, minimize, or mitigate the effects, which may include ceasing testing and/or removal of project structures.

AMC Recommendations

The Annual Reports will be used by the AMC to inform discussions and make recommendations to NNMREC for the monitoring, operations, and AMPs' associated with the NNMREC test site. The recommendations of the AMC are not intended to supplant or fulfill any required permitting processes needed for future tests, but will be completed no later than February 28 of each year.

NNMREC and Agency Review
Upon conclusion of the AMC review, NNMREC, in consultation with NMFS and ODFW, will consider the AMC recommendations and implement the appropriate approach to the monitoring, operations, and adaptive management/mitigation thresholds to ensure the Project's compliance with the ESA, MMPA and other relevant Federal and state statutes. NNMREC, in consultation with NMFS, USFWS and Oregon Department of Fish and Wildlife (ODFW), will also consider the AMC's recommendations in determining whether any additional mitigation measures are needed no later than March 31 of each year.

AMC MEMBERSHIP AND PARTICIPATION
Participation on the AMC by state or Federal agencies does not affect their statutory responsibilities and authorities. Issues involving the exercise of agencies' specific authorities can be discussed, but agency decisions are not delegated to the AMC. Representatives of the following organizations will be invited to join the AMC:

- Northwest National Marine Renewable Energy Center
- US Army Corps of Engineers
- National Marine Fisheries Service
- U.S. Fish and Wildlife Service
- Oregon Department of Fish and Wildlife
- Oregon Department of Land Conservation and Development
- Department of State Lands
- Local Tribes
- Oregon Coastal Zone Management Agency
- Fishermen Involved in Natural Energy (or other appropriate fishing organization)
- Surfrider Foundation
- Oregon Shores

Representatives from other organizations may be asked to join, as deemed appropriate by NNMREC.

MEETING PROVISIONS

Northwest National Marine Renewable Energy Center shall arrange, administer, and chair all meetings, unless otherwise agreed. The AMC shall establish protocols for AMC meetings such as agenda development, subcommittee involvement, and timely distribution of materials, location and scheduling.

Northwest National Marine Renewable Energy Center will convene and facilitate an annual meeting of the group to be schedule no later than January 31 of each year. The AMC will convene annually for the life of the test center operations, unless deemed otherwise by Members.

Northwest National Marine Renewable Energy Center shall send the AMC meeting schedule, agenda, and supporting materials directly to Committee members via e-mail and will also make materials available on its web site. Northwest National Marine Renewable Energy Center shall bear all costs associated with conducting meetings. Each Member shall bear its own cost of attendance. A Member's ongoing participation on the AMC is subject to that Member's budget and resource constraints.

Adaptive Management Thresholds
The Adaptive Management Thresholds outlined in this section are used by the AMC, NMFS, USFWS, ODFW and NNMREC in the annual review of monitoring results and other operational information. These thresholds are used to evaluate single year data and multi-year data from the monitoring program. These Adaptive Management Thresholds do not apply to individual testing operations. Specific adaptive mitigation thresholds developed for each test will be implemented during operations of individual tests.

In addition to conducting the monitoring referenced below, NNMREC staff will make opportunistic visual observations from the water surface during installation, maintenance, monitoring and other activities at the test site, and at least bi-weekly during project deployment. NNRMEC will record all opportunistic observations of marine mammals, seabirds, listed species, and/or derelict gear and include them in the Annual Report of monitoring results provided to the AMC, NMFS, USFWS and ODFW. Additionally, NNMREC will coordinate with NMFS, USFWS, and ODFW, either through their participation in the AMC or otherwise, to develop a standard form to use in recording and reporting observations.

BENTHIC SPECIES AND HABITAT

Adaptive Management Threshold 1: If monitoring conducted as described in the Benthic Species and Habitat Monitoring Plan (Appendix A), which includes visual observation and gut analysis, shows substantial differences or significant trends as defined in consultation with ODFW and NMFS in benthic habitat or associated ecological communities between the action area sites and reference sites, or at any one site over time, as defined by:

1. substrate composition; for example changes in grain size proportions;
2. species composition; for example there could be new species attracted to anchors/devices or species no longer present;
3. species relative abundances; for example, existing species becoming more common or rare; and/or
4. changes to feeding habits; for example a new prey item or disappearance of a species both from visual observation and from gut analysis.

NNMREC will, after consultation with the AMC, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, implement one or more of the following actions to ensure Project compliance with ESA, MMPA and other relevant Federal and state statutes:

- Modify the monitoring plan and/or sampling frequency to determine if ecological interactions have negative effects on protected species, benthic habitat or associated ecological communities;
- Modify the proposed action to mitigate for adverse effects;
- Conduct additional sampling or studies; and/or
- Make determination that no changes to monitoring plans or test center operations are needed.

DERELICT GEAR

Derelict gear monitoring and removal will be conducted in accordance with the procedures and adaptive management thresholds described below. In addition, NNMREC will participate in monthly FINE meetings, engage with members of the fishing community directly, and maintain ongoing communication with ODFW in regards to lost or entangled gear. Further, NNMREC will consult with NMFS and ODFW, either through their participation in the AMC or otherwise, to ensure the efficacy of the derelict gear monitoring and response methods for the duration of the proposed action. For instance, if derelict gear is routinely found caught on the mooring lines or anchors, monitoring and removal episodes may need to be increased.

General Procedures for Derelict Gear

i. Detection: NNMREC will perform underwater visual monitoring at least three times for each test: once prior to device deployment, once during active deployment, and once after device removal. Video lander sampling of anchors and reference locations will continue for the duration of the proposed action (i.e., when any project related structure or equipment is in the water) weather permitting. In addition, NNMREC will make visual observations from the water surface at least bi-weekly, during all visits to the test site to identify any derelict gear.

ii. Notification: If derelict gear is detected, NNMREC will contact NMFS and ODFW within two days of detection.

iii. Removal: Any gear entangled with project structures or moorings will be removed in spring/summer (prior to test device deployment) or in fall (immediately following test device removal). If the gear poses an entanglement risk to marine organisms, NNMREC will consult with NMFS and ODFW to determine if an earlier or more immediate response is necessary (as described in the Adaptive Management Thresholds below).

iv. Return: NNMREC will make every effort to return gear to owner and will be responsible for storing the gear and contacting the owner to retrieve it; ODFW can provide owner contact information.

v. Recycle: In the event that attempts to return gear are unsuccessful, it may be recycled at the "Fishing for Energy" project located at Newport's International Port.

Adaptive Management Threshold 1: If Annual Reports indicate that derelict gear is being ensnared on the Ocean Sentinel or project structures and posing harm to species, NNMREC will, after consultation with the AMC, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, implement one or more of the following actions to ensure compliance with ESA, MMPA and other relevant Federal and state statutes:

- Modify the Adaptive Management Plan to assure that derelict gear is addressed in a timely manner; or
- Modify the Project to reduce the incidences of derelict gear being ensnared on the Ocean Sentinel and/or its mooring configuration.

Adaptive Management Threshold 2: If Annual Reports indicate that derelict gear is being ensnared on and posing harm to species during project tests on WEC devices similar to those proposed for upcoming test, NNMREC will, after consultation with the AMC, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, implement one or more of the following actions to ensure compliance with ESA, MMPA and other relevant federal and state statutes:

- Recommend an Adaptive Mitigation Plan , which includes derelict gear removal, to the WEC developer to assure that derelict gear is addressed in a timely manner; or
- Require WEC developer to modify its device and/or mooring configuration to reduce the incidences of derelict gear being ensnared.

MARINE MAMMALS

As a matter of practice, NNMREC staff will make visual observations from the water surface during all visits to the test site, and at least all bi-weekly during project deployment. If project devices are not deployed but anchors and mooring lines remain in place during the April/May grey whale migration, NNMREC will perform visual observations at least bi-weekly during that period. NNRMEC will record all opportunistic observations of marine mammals and other listed species and include them in the Annual Report of monitoring results provided to the AMC, NMFS and ODFW. Additionally, NNMREC will coordinate with NMFS and ODFW, either through their participation in the AMC or otherwise, to develop a standard form to use in recording and reporting marine mammal observations.

Adaptive Management Threshold 1: If Annual Reports indicate observations of pinnipeds hauled out on the Ocean Sentinel, NNMREC will, after consultation with the AMC, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, implement one or more of the following actions to ensure Project compliance with ESA, MMPA and other relevant federal and state statutes:

- Modify the Project to reduce the potential for pinniped haul-out on the Ocean Sentinel; and/or
- Apply for an Incidental Harassment Authorization (IHA) if needed for deterrence or removal of hauled-out pinnipeds.

Adaptive Management Threshold 2: If Annual Reports indicate observations of pinnipeds hauled out on WEC devices similar to those being proposed for upcoming test, NNMREC will, after consultation with the AMC, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, require the WEC developer to implement one or more of the following actions:

- Require WEC developer to modify its device to reduce the potential for pinniped haul-out; and/or
- Require WEC developer to apply for an Incidental Harassment Authorization if needed for deterrence or removal of hauled-out pinnipeds.

ACOUSTICS

Adaptive Management Threshold 1: If acoustic monitoring indicates that sound pressure levels attributable to the Ocean Sentinel device at a distance[5] of 100m are above Level A injury threshold criteria (either continuous or impulse of 180dB RMS for cetaceans and 190dB RMS for pinnipeds) or Level B harassment threshold criteria (120dB RMS continuous and 160dB RMS impulse), NNMREC will, after consultation with the AMC, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, implement one or more of the following actions to ensure compliance with ESA, MMPA and other relevant Federal and state statutes:

- Design and perform additional monitoring;
- Modify the operation of the Ocean Sentinel to decrease its acoustic emissions (e.g., locking down the device during high surf, increasing controls to slow the motion of the device, or repairing the device if noise is due to device malfunction);
- Apply for an Incidental Harassment Authorization for acoustic emissions of the Ocean Sentinel.

Adaptive Management Threshold 2: If acoustic monitoring indicates that sound pressure levels attributable to a WEC device similar to the device type (e.g. buoy or attenuator) proposed for testing are above Level A injury threshold criteria (either continuous or impulse of 180dB RMS for cetaceans and 190dB RMS for pinnipeds) or Level B harassment threshold criteria (120dB RMS continuous and 160dB RMS impulse) at a distance of 100m (see footnote 4 regarding rationale for 100m), NNMREC will, after consultation with the AMC, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, assure that

[5] It may be ineffective to use an acoustic threshold 10 meters from the Ocean Sentinel as it not likely to result in measurements of the actual noise levels generated solely by the device. A 10-meter distance would be inside the larger project installation and Or is this fine/the signals received may be inaccurate due to reflections (and other interactions) with other physical structures nearby. Therefore a greater threshold distance of 100 meters is proposed. Marine mammal detections in surveys covering the Oregon-Washington coast (*Green et al. 1992*) indicate a mean incidence of 0.5 animals per km2. A 100-meter radius around the device corresponds to an area of 0.03 km2 so the risk of marine mammal exposure within that area is 0.03/0.5 = 0.06 animals, or about a 6% risk in association with a day or an incident of elevated underwater sound generation. Since the test device would be deployed for limited periods of time, there is lower potential for such incidents to occur frequently or for a sustained long period of time. As such the risk of exposure for any marine mammal is very low, even within the 100-meter radius.

one or more of the following is implemented during testing of the WEC device to ensure compliance with ESA, MMPA and other relevant federal and state statutes:

- Additional monitoring;
- Modify the operation of the WEC device to decrease its acoustic emissions (e.g., locking down the WEC device during high surf, increasing controls to slow the motion of the WEC device, or repairing the WEC device if noise is due to device malfunction);
- Applying for an Incidental Harassment Authorization for acoustic emissions of the WEC device.

Adaptive Management Threshold 3: After review of individual test results, NNMREC, in consultation with the AMC, will:

- Evaluate whether acoustic monitoring techniques are sufficient to adequately assess potential effects of different technologies;
- Assess new information about other sources of noise to confirm confidence in study ability to assess device noise; and
- Determine whether acoustic testing is required for all devices and whether previous study results can be used to support future tests.

Based on the evaluation and assessment described above, NNMREC, after consultation with the AMC, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, will implement one or more of the following to ensure compliance with ESA, MMPA and other relevant Federal and state statutes:

- Modified or additional monitoring techniques;
- Use data and information from existing studies to estimate acoustic emissions and perform potential effects analysis for future tests.

ELECTROMAGNETIC FIELDS

Monitoring electromagnetic fields (EMF) for marine renewable energy is a newly emerging application, and mission-specific instrumentation is needed. NNMREC has designed and will carry out the first deployment of an advanced 2nd generation EMF monitoring instrument to characterize the ambient EMF at the test site and measure the EMF during an energized WEC test. Post monitoring data analysis will take about 90 days. The results will be written up in a monitoring summary and provided the AMC as soon as possible following the initial test.

Adaptive Management Threshold 1: NMREC, after consultation with the AMC, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, will consider the following:

- Validate the effectiveness of the EMF Propagation Model and assess its efficacy in estimating[6] EMF for future tests. If necessary, potential modifications to the model will be recommended.
- Consider both the ability to detect and measure the level of EMF generated from project devices and determine whether there is a meaningful (i.e., biologically significant) source of EMF from the proposed action.

Adaptive Management Threshold 2: Based on the evaluation and assessment described above, NNMREC will, after consultation with the AMC, in consultation with NMFS and ODFW, and after approval by NMFS implement one or more of the following to ensure Project compliance with ESA, MMPA and other relevant federal and state statutes:

- Modified or additional monitoring techniques;
- Compare the EMF results with known values for impact on ESA-listed species known or likely to be present in the area. If the results indicate that WEC-related EMF levels are within the documented magnetic or electric field sensitivity range of such species and could have an effect on orientation, reproduction, predator/prey dynamics, or the behaviors of any affected species or of fish aggregations either residing nearby or migrating through the action area, NMFS, ODFW, OSU scientists and the Ocean Facilities Manager will work together on an approach to reduce EMF levels during a test. In the event that the monitoring shows EMF signatures at levels below concern, and after consulting with NMFS and ODFW, the EMF monitoring program will be modified accordingly.
- Use data and information from existing studies to estimate EMF emissions and perform potential effects analysis for future tests.

Adaptive Management Threshold 3: If monitoring indicates that EMF attributable to the project components is in excess of levels known to have an adverse impact on marine life, NNMREC will, after consultation with the AMC, in consultation with and upon approval by NMFS and ODFW pursuant to their respective statutory authority, develop and implement a response plan that outlines the appropriate mitigation action. Actions may include, but are not limited to:

- Additional shielding of cables or other project components;
- Delaying subsequent deployment of tests until resolution of the issue is achieved;
- Adoption of new timeframe restrictions designed to address specific resource conflicts (e.g. green sturgeon); or
- Decommissioning the site and terminating the test.

WET-NZ Adaptive Mitigation Plan

The WET-NZ Adaptive Mitigation Plan (WAMP) outlines the thresholds and real-time mitigation actions that may be taken during the test of the NNMREC's Ocean Sentinel and the

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[6] The monitoring plan states that the model will *measure* EMF however; models can only estimate that NMFS has made this correction to the statement.

WET-NZ device. All mitigation action decisions associated with the WET-NZ and Ocean Sentinel will be made by NNMREC and Northwest Energy Innovations, Inc. (NWEI) in consultation with NMFS and ODFW. The AMC (as described above in the NAMF will not be convened or be used to inform real-time decisions for mitigation outlined below in the WAMP.

An Annual Report of monitoring results, adaptive management thresholds, and any mitigation actions associated with the WET-NZ test will be provided to the AMC no later than December 1 following the test. This report will be used to inform the AMC's discussion of monitoring and adaptive management plans associated with the test center and future tests as outlined in the NAMF above.

The WAMP will serve as template for Adaptive Mitigation Plans that will be developed for all future WEC tests and identifies thresholds that if exceeded may require a mitigation response. Monitoring results would be reviewed by NNMREC in real-time, whenever possible, to determine if effects thresholds have been exceeded. If the results show that thresholds are not exceeded then no action will be taken. If results show that thresholds are exceeded, NNMREC will consult with NMFS and ODFW to develop an appropriate response. Responses may include changes to monitoring methods, project operations and/or mitigation actions, as appropriate.

Adaptive Mitigation Thresholds and Measures

In addition to conducting the monitoring referenced below, NNMREC staff will make opportunistic visual observations from the water surface during installation, maintenance, monitoring and other activities at the test site, and at least bi-weekly during project deployment. NNRMEC will record all opportunistic observations of marine mammals, seabirds, listed species, and/or derelict gear and include them in the Annual Report of monitoring results provided to the AMC, NMFS and ODFW. Additionally, NNMREC will coordinate with NMFS, USFWS and ODFW, either through their participation in the AMC or otherwise, to develop a standard form to use in recording and reporting marine mammal observations.

BENTHIC SPECIES AND HABITAT

Consistent with the Benthic Monitoring Plan (Appendix A), benthic monitoring will be conducted prior to, during, and after the test. The monitoring results will be summarized and provided to the AMC as outlined in the NAMF above.

There are no adaptive mitigation thresholds for benthic habitat associated with this test.

DERELICT GEAR

Derelict gear monitoring and removal will be conducted in accordance with the procedures and adaptive mitigation thresholds and measures described below.

General Procedures for Derelict Gear

i. Detection: NNMREC will perform underwater visual monitoring at least three times for each test: once prior to device deployment, once during active deployment, and once after device removal. Video lander sampling of anchors and reference locations will continue for the duration of the project (i.e., when any project related structure or equipment is in the water) weather permitting. In addition, NNMREC will make visual observations from the water surface at least bi-weekly, during all visits to the test site to identify any derelict gear.

ii. Notification: If derelict gear is detected, NNMREC will contact NMFS and ODFW within two days of detection.

iii. Removal: Any gear entangled with project structures or moorings will be removed in spring/summer (prior to test device deployment) or in fall (immediately following test device removal). If the gear poses an entanglement risk to marine organisms, NNMREC will consult with NMFS and ODFW to determine if an earlier or immediate response is necessary (as described in the Adaptive Management Thresholds below).

iv. Return: NNMREC will make every effort to return gear to owner and will be responsible for storing the gear and contacting the owner to retrieve it; ODFW can provide owner contact information.

v. Recycle: In the event that attempts to return gear are unsuccessful, it may be recycled at the "Fishing for Energy" project located at Newport's International Port.

Adaptive Mitigation Threshold and Measure 1: If monitoring shows that derelict gear has become ensnared or collected on any Project structure but no organisms are caught within it and the gear poses no threat to navigational safety or marine species, NNMREC will remove the derelict gear during removal of the test devices.

Adaptive Mitigation Threshold and Measure 2: If monitoring shows that derelict gear has become ensnared or collected on any Project structure and has entangled or poses the risk of entanglement to organisms, NNMREC will remove the derelict gear as soon as feasible, notify NMFS and ODFW within two days, and provide a report with all available information on the case. NNMREC will then, after consulting with NMFS and ODFW, modify the Project and/or monitoring plan if necessary.

Adaptive Mitigation Threshold and Measure 3: If monitoring shows marine mammals or sea turtles entangled in fishing gear or marine debris, NNMREC will report the incident as soon as practical and remove the gear consistent with the Reporting Protocol for Injured or Stranded Marine Mammals (outlined below). NNMREC will then, after consulting with NMFS and ODFW, and approved by NOAA modify the Project and/or monitoring plan if necessary.

ENTANGLED OR INJURED SPECIES

As a matter of practice, NNMREC staff will make visual observations from the water surface during all visits to the test site and at least bi-weekly during project deployment. If project devices (i.e. Ocean Sentinel, WET-NZ) are not deployed but anchors and mooring lines remain in place during the April/May grey whale migration, NNMREC will perform visual observations at least bi-weekly during that period. NNMREC will record all opportunistic observations of marine mammals, seabirds, listed species, and/or derelict gear and include them in the Annual Report provided to the AMC, NMFS and ODFW. Additionally, NNMREC will coordinate with NMFS and ODFW, either through their participation in the AMC or otherwise, to develop a standard form to use in recording and reporting these observations.

Adaptive Mitigation Threshold and Measure 1: If marine mammals or sea turtles are observed entangled, injured or impinged at the Project Structure, NNMREC will immediately follow the Reporting Protocol for Injured or Stranded Marine Mammals (listed below) and give NMFS and ODFW all available information on the incident. In addition, NNMREC will contact NMFS and ODFW as soon as practical within 24 hours to consult with them regarding modifying the Project and/or monitoring plans.

Reporting Protocol for Injured or Stranded Marine Mammals: NNMREC proposes to implement the following NMFS protocols in the event an injured or stranded marine mammal is observed:

i. ***Live marine mammals or sea turtles observed swimming but appearing debilitated or injured.***
Capability to respond to free swimming animals is very limited and relocation is a major issue. In addition, medical treatment facilities for marine mammals and sea turtles are for the most part non-existent in Oregon. Therefore, we recommend that monitors record the sighting as part of the monitoring report and provide the information to the Stranding Network. The data should include: 1) any photos or videos, if possible 2) species or common name of the animal involved; 3) date of observation; 4) location (lat/long in decimal degrees); 5) description of injuries or unusual behavior observed.

ii. ***Live marine mammals or sea turtles observed entangled in fishing gear or marine debris.***
The marine mammal disentanglement network in Oregon is based at Hatfield Marine Science Center - contact Jim Rice at 541-867-0446 or Barb Lagerquist at 541-867-0128. The national network is available at 877-SOS-WHALE (877-767-9425). Contact should be made immediately if an entanglement is observed and, if possible the reporting vessel should remain on scene while contact is made. Report should include the following information: 1) species or common name of animal involved; 2) location (lat/long in decimal degrees); 3) whether the animal is anchored by the gear or swimming with the gear in tow; 4) a description of the entangling gear (line size, line color, size number and color of floats if attached, presence or absence of pots or webbing; 5) if animal is towing gear, give direction of travel and current speed; 6) local weather conditions (sea state, wind speed and direction) 7) whether the vessel can stand by until someone is able to get there. The disentanglement network will determine whether or not a response can be mounted immediately and will advise the reporting vessel on next steps.

iii. ***Dead marine mammals or sea turtles observed floating at sea.***
Dead floating marine mammals fall within the definition of "stranded" under the MMPA. To report strandings off central Oregon coast contact the Oregon Marine Mammal Stranding Network (Jim Rice) 541-867-0446.

iv. ***Dead protected species found entangled or otherwise impinged at the project.*** These should be reported as part of the monitoring report to NMFS and ODFW, giving all available information on the case. The report should include the following information; 1) species or common name of animal involved; 2) location (lat/long in decimal degrees); 3) whether the animal was found on a project device or anchoring system; 4) a description of injuries or entanglement observed; if derelict fishing gear or other debris was involved, give a description of the gear (line size, line color, size number and color of floats if attached, presence or absence of pots or webbing; photographs if possible. In the event derelict gear is involved, the presence of protected species entangled in the gear should be included in the report initiating gear removal planning and coordination.

Adaptive Mitigation Threshold 2: If pinnipeds are identified on one or more of the project structures, NNMREC will implement the NMFS haulout protocols listed below. In addition, NNMREC will notify NMFS and ODFW within two weeks of the haul-out incident.

Pinniped Haulout Protocols

i. If pinnipeds are present on one of the project structures, monitoring or maintenance activities will occur at minimum of 100 yards from the structure (in accordance with the current NMFS guideline of 100 yards for vessel approach of hauled out pinnipeds).

ii. If the pinnipeds do not leave the structure upon approach up to 100 yards and the pinnipeds are non-ESA listed species (e.g., California sea lions), NNMREC may proceed to deter the pinniped from project structures so long as such measures do not result in the death or serious injury of the animal (pursuant to Section 101.(a)(4)(A) of the MMPA. NNMREC will follow NMFS' guidance on deterring pinnipeds: http://www.nwr.noaa.gov/marine-mammals/seals-and-sea-lions/deterring-pinnipeds.cfm.

iii. If pinnipeds present on project structures are an ESA-listed species (e.g., Steller sea lions), NNMREC will not pursue any directed take or intentional harassment, and will remain at least 100 yards from the structure so long as the ESA-listed species is present.

iv. If NNMREC needs to perform emergency maintenance that requires immediate attention (e.g. closing an opened hatch, repairing a failed mooring or electrical fault) and deterrence of a listed species is necessary, NNMREC staff will request assistance from a government official.7 The NNMREC Response Coordinator will provide an account of the incident to the appropriate staff at NMFS and ODFW as soon as possible.

[7] Section 109(h) of the Marine Mammal Protection Act provides exceptions for take of listed and non-listed marine mammals by Federal, state or local government officials if such taking is for the protection or welfare of the mammal, the protection of the public health and welfare, or the nonlethal removal of nuisance animals [50 CFR 223.202].

ACOUSTICS

The objective of the acoustic monitoring is to determine if the WET-NZ and/or Ocean Sentinel devices increase the ambient noise in the action area beyond mammal harassment thresholds, as described in the Acoustic Monitoring Plan (Appendix A). This will be accomplished by measuring time-dependent acoustic background levels and frequency distributions of environmental, biological and anthropogenic sound sources that contribute to the noise budget during the test. NNMREC has collected continuous passive acoustic data to characterize the baseline acoustic conditions at the test site. During the WET-NZ/Ocean Sentinel test, amplitude and frequency distribution through time of the ambient noise field will be characterized and sound sources will be identified.

- Initial monitoring will occur within two weeks following deployment of the WET-NZ/Ocean Sentinel test. (This window may be modified if the health and safety of personnel is at risk due to unforeseen conditions such as weather or operational complications where approaching the device is not safe.)
- Results will be made available to NMFS and ODFW within seven days of the completion of monitoring. If results cannot be transmitted to NMFS and ODFW within seven days, NNMREC will contact NMFS and ODFW with an updated delivery schedule and the reason for delay.
- The following contacts will be notified regarding monitoring results and proposed mitigation, if applicable:
  - .. NMFS: Keith Kirkendall, Chief of FERC and Water Diversion Branch, 503-230-5431 or keith.kirkendall@noaa.gov
  - .. ODFW: Delia Kelly, Ocean Energy Coordinator, 541-867-0300 or delia.r.kelly@state.or.us

Adaptive Mitigation Threshold and Measure 1: If acoustic monitoring indicates that sound pressure levels attributable to the WET-NZ and/or Ocean Sentinel device at a distance[8] of 100m are above Level A injury threshold criteria (either continuous or impulse of 180dB RMS for cetaceans and 190dB RMS for pinnipeds) or Level B harassment threshold criteria (120dB RMS continuous and 160dB RMS impulse), NNMREC scientists and Ocean Test Facility Manager, in coordination with and after approval from NMFS and ODFW pursuant to their respective statutory authority, will develop and implement a response plan that outlines the appropriate

[8] It may be ineffective to use an acoustic threshold 10 meters from the Ocean Sentinel as it not likely to result in measurements of the actual noise levels generated solely by the device. A 10-meter distance would be inside the larger project installation and the signals received may be inaccurate due to reflections (and other interactions) with other physical structures nearby. Therefore, a greater threshold distance of 100 meters is proposed. Marine mammal detections in surveys covering the Oregon-Washington coast (Green et al 1992) indicate a mean incidence of 0.5 animals per km2. A 100-meter radius around the device corresponds to an area of 0.03 km2 so the risk of marine mammal exposure within that area is 0.03/0.5 = 0.06 animals, or about a 6% risk in association with a day or an incident of elevated underwater sound generation. Since the test device would be deployed for limited periods of time, there is lower potential for such incidents to occur frequently or for a sustained long period of time. As such the risk of exposure for any marine mammal is very low, even within the 100-meter radius.

mitigation action within 14 days of acquiring monitoring results. Actions may include, but are not limited to:

- Performing additional or alternative monitoring;
- Modifying the operation of the WET-NZ and/or Ocean Sentinel (e.g., locking down the device during high surf, increasing controls to slow the motion of the device, or conducting on-site repairs if noise is due to the device malfunction);
- Ceasing operations and performing necessary modifications to minimize noise levels. Subsequent monitoring would be conducted to verify that the noise associated with the test has been abated;
- Decommissioning of the test/installation; and/or
- Applying for an Incidental Harassment Authorization.

ELECTROMAGNETIC FIELDS

As described in the EMF Monitoring Plan (Appendix A), monitoring of Electromagnetic fields (EMFs) will be conducted during deployment of the Ocean Sentinel and the WET-NZ when the devices are energized. Following device removal and before any subsequent deployments, NNMREC will return to test site and repeat the survey to characterize baseline levels of EMF at the test site. The monitoring results will be summarized and provided to the AMC as outlined in the NAMF.

Adaptive Mitigation Threshold and Measure 1: If monitoring results indicate that EMF attributable to the project components is in excess of levels known to have an adverse impact on marine life, NNMREC will, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, develop and implement a response plan that outlines the appropriate mitigation action any 2013 Ocean Sentinel/WET-NZ test. Actions may include, but are not limited to:

- Additional shielding of cables or other project components;
- Delaying subsequent deployment of tests until resolution of the issue is achieved;
- Adoption of new timeframe restrictions designed to address specific resource conflicts (e.g., green sturgeon); or
- Decommissioning the site and terminating the test.

1.4 Action Area

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

The action area includes the open ocean wave energy test site about 3.4-km^2 (1-square-nautical-mile) centered about 3 km (2 miles) off the Oregon coast near the city of Newport, Oregon (Figure 1, Section 1.3) where floating WEC devices and instrumentation test buoys would be moored during short-term tests and any additional area surrounding the physical footprint where acoustic emissions or electromagnetic fields generated by the proposed action may be audible. The coordinates marking the four corners of the open ocean test site are presented in Table 1 in Section 1.3.

While all WEC devices, the Ocean Sentinel and the TRIAXYS™ buoy would be deployed within the boundary of the 3.4 km^2 test site as described above and shown in Figure 1, Section 1.3 the action area comprises a 9.3-km radius from the proposed test site based on the potential extent of acoustic and EMF effects potentially extending up to 500 meters from WEC devices deployed in the test site and the proposed monitoring where ancillary scientific equipment used to collect reference samples for comparative analyses would be deployed north, south, or west of the test site, and east of the test site up to the shorelines (Figure 2, Section 1.3).

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

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with the United States Fish and Wildlife Service, NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Section 7(b)(3) requires that at the conclusion of consultation, the Service provide an opinion stating how the agencies' actions will affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires the consulting agency to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts.

2.1 Approach to the Analysis

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species. The adverse modification analysis considers the impacts on the conservation value of designated critical habitat.

"To jeopardize the continued existence of a listed species" means to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02).

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[9]

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

- ***Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.*** This section describes the current status of each listed species and its critical habitat relative to the conditions needed for recovery. For listed salmon and steelhead, NMFS developed specific guidance for analyzing the status of the listed species' component populations in a "viable salmonid populations" paper ((VSP); McElhany et al. 2000). The VSP approach considers the abundance, productivity, spatial structure, and diversity of each population as part of the overall review of a species' status. For listed salmon and steelhead, the VSP criteria therefore encompass the species'

[9] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

"reproduction, numbers, or distribution" (50 CFR 402.02). In describing the range-wide status of listed species, we rely on viability assessments and criteria in technical recovery team documents and recovery plans, where available, that describe how VSP criteria are applied to specific populations, major population groups, and species. We determine the rangewide status of critical habitat by examining the condition of its physical or biological features (also called "primary constituent elements" or PCEs in some designations) – which were identified when the critical habitat was designated. Species and critical habitat status are discussed in Section 2.2.

- ***Describe the environmental baseline for the proposed action***. The environmental baseline includes the past and present impacts of Federal, state, or private actions and other human activities *in the action area*. It includes the anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process. The environmental baseline is discussed in Section 2.3 of this opinion.

- ***Analyze the effects of the proposed actions***. In this step, NMFS considers how the proposed action would affect the species' reproduction, numbers, and distribution or, in the case of salmon and steelhead, their VSP characteristics. NMFS also evaluates the proposed action's effects on critical habitat features. The effects of the action are described in Section 2.4 of this opinion.

- ***Describe any cumulative effects****.* Cumulative effects, as defined in NMFS' implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation. Cumulative effects are considered in Section 2.5 of this opinion.

- ***Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat****.* In this step, NMFS adds the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5) to assess whether the action could reasonably be expected to: (1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 2.2). Integration and synthesis occurs in Section 2.6 of this opinion.

- ***Reach jeopardy and adverse modification conclusions*****.** Conclusions regarding jeopardy and the destruction or adverse modification of critical habitat are presented in Section 2.7. These conclusions flow from the logic and rationale presented in the Integration and Synthesis section (2.6).

- ***If necessary, define a reasonable and prudent alternative to the proposed action***. If, in completing the last step in the analysis, NMFS determines that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, NMFS must identify a reasonable and prudent alternative (RPA) to the action. The RPA must not be likely to jeopardize the continued existence of ESA-listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements.

In this Opinion, NMFS has determined that the proposed action is likely to adversely affect UWR Chinook, LCR Chinook, SR fall Chinook, SR spring/summer Chinook, UWR Chinook, CC Chinook, CV spring-run Chinook, SAC winter-run Chinook, LCR coho, OC coho, SONCC coho, CCC coho, eulachon, green sturgeon, Southern Resident killer whales, humpback whales and Steller sea lions, and their designated critical habitat. NMFS' jeopardy and adverse modification analyses for these species and critical habitats follow the approach to the analysis described above. NMFS concurs with the DOE and Corps determination that the proposed action is not likely to adversely affect (NLAA) SR basin steelhead, UCR steelhead, MCR steelhead, LCR steelhead, UWR steelhead, South-Central CC steelhead, Central CC steelhead, NC steelhead, CCV steelhead, SR sockeye, CR chum, blue whales, fin whales, Sei whales, sperm whales, leatherback sea turtles and their designated critical habitat, loggerhead sea turtles, green sea turtles and olive ridley sea turtles. NMFS' rationale for its concurrence with the NLAA determination is in section 2.11.

2.2 Rangewide Status of the Species and Critical Habitat

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

The action area is within the range of 36 ESA-listed species (Table 2). The only species for which critical habitat is designated within the action area are the Southern DPS North American green sturgeon and the leatherback sea turtle.

Table 2. Federal Register notices for final rules that list threatened and endangered species and designate critical habitats for species considered in this consultation.

Species/DPS	Listing Status	Critical Habitat
CHINOOK SALMON (*Oncorhynchus tshawytscha*)		
Lower Columbia River	Threatened; NMFS 2005a	NMFS 2005b
Upper Willamette River	Threatened; NMFS 2005a	NMFS 2005b
Upper Columbia River spring run	Endangered; NMFS 2005a	NMFS 2005b
Snake River spring/summer run	Threatened; NMFS 2005a	NMFS 1999a
Snake River fall run	Threatened; NMFS 2005a	NMFS 1993a
California Coastal	Threatened; NMFS 2005a	NMFS 2005b
Sacramento River winter run	Endangered; NMFS 2005a	NMFS 1993b
Central Valley spring run	Threatened; NMFS 2005a	NMFS 2005b
COHO SALMON (*O. kisutch*)		
Lower Columbia River	Threatened; NMFS 2005a	Under development
Oregon Coast	Threatened; NMFS 2008a	NMFS 2008a
Sothern Oregon/Northern California Coast	Threatened; NMFS 2005a	NMFS 1999b
Central California Coast	Endangered; NMFS 2005a	NMFS 1999b
STEELHEAD (*O. mykiss*)		
Snake River	Threatened; NMFS 2006a	NMFS 1995b
Upper Columbia River	Listed as endangered on June 13, 2007 [Court decision]	NMFS 2005b
Middle Columbia River	Threatened; NMFS 2006a	NMFS 2005b
Lower Columbia River	Threatened; NMFS 2006a	NMFS 2005b
Upper Willamette River	Threatened; NMFS 2006a	NMFS 2005b
South-Central California Coast	Threatened; NMFS 2006a	NMFS 2005b
Central California Coastal	Threatened; NMFS 2006a	NMFS 2005b
Northern California Coast	Threatened; NMFS 2006a	NMFS 2005b
California Central Valley	Threatened; NMFS 2006a	NMFS 2005b
SOCKEYE SALMON (*O. nerka*)		
Snake River	Endangered; NMFS 2005a	NMFS 1993a
CHUM SALMON (*O. keta*)		
Columbia River	Threatened; NMFS 2005a	NMFS 2005b
GREEN STURGEON (*Acipenser mediorostris*)		
Southern DPS	Threatened; NMFS 2006b	NMFS 2009
EULACHON (*Thaleichthys pacificus*)		
Eulachon	Threatened; NMFS 2010a	NMFS 2011a

Species/DPS	Listing Status	Critical Habitat
KILLER WHALE (*Orcinus orca*)		
Southern Resident	Endangered; NMFS 2005c	NMFS 2006c
STELLER SEA LION (*Eumetopias jubatus*)		
Eastern DPS	Threatened; NMFS 1990	NMFS 1993c
HUMPBACK WHALE (*Megaptera novaengliae*)		
Humpback whale	Endangered; NMFS 1970	Not designated
SEI WHALE (*Balaenoptera musculus*)		
Sei whale	Endangered; NMFS 1970	Not designated
BLUE WHALE (*B. musculus*)		
Blue whale	Endangered; NMFS 1970	Not designated
FIN WHALE (*B. physalus*)		
Fin whale	Endangered; NMFS 1970	Not designated
SPERM WHALE (*Physeter macrocephalus*)		
Sperm whale	Endangered; NMFS 1970	Not designated
LEATHERBACK SEA TURTLE (*Dermochelys coriacea*)		
Leatherback sea turtle	Endangered; NMFS 1970	NMFS 2011b
GREEN SEA TURTLE (*Chelonia mydas*)		
Green sea turtle	Threatened; NMFS 1978	Not designated in action area
OLIVE RIDLEY SEA TURTLE (*Lepidochelys olivacea*)		
Olive Ridley sea turtle	Endangered; NMFS 1978	Not designated
LOGGERHEAD SEA TURTLE (*Caretta caretta*)		
Loggerhead sea turtle	Threatened; NMFS 1978	Not designated

2.2.1 Status of the Species

The following summarizes the status of ESA-listed species, and their designated critical habitats, that would be affected by the proposed action and are considered in this opinion. More detailed information on the status and trends of these listed resources, and their biology and ecology, can be found in the listing regulations and critical habitat designations published in the Federal Register (Table 2).

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

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

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

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

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

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

2.2.1.1 Salmon and Steelhead

The biological requirements, life histories, historical abundance, current viability, and factors contributing to the decline of Pacific Northwest salmon and steelhead have been well documented. The following sections summarize the rangewide status of each species and its designated critical habitat from recent technical reports as cited in the following subsections.

The status of species sections below are organized under six recovery domains (Table 3) to better integrate recovery planning information that NMFS is developing on the conservation status of the species and designated critical habitats considered in this opinion. Recovery domains are the geographically based areas that NMFS is using to prepare multi-species recovery plans.

For each recovery domain, a technical review team (TRT) appointed by NMFS has developed, or is developing, criteria necessary to identify independent populations within each species, recommended viability criteria for those species, and descriptions of factors that limit species survival. Viability criteria are prescriptions of the biological conditions for populations, biogeographic strata, and Evolutionarily Significant Unit (ESUs) that, if met, would indicate that the ESU will have a negligible risk of extinction over a 100-year time frame.

Table 3**.** ESA-listed salmon and steelhead considered in this opinion and their respective recovery planning domains.

Recovery Domain	**Species**
Willamette/Lower Columbia (LC)	LCR Chinook salmon UWR Chinook salmon LCR coho salmon
Interior Columbia (IC)	UCR spring Chinook salmon SR spring/summer Chinook salmon SR fall Chinook salmon
Oregon Coast (OC)	OC coho salmon
Southern Oregon/Northern California Coasts (SONCC)	SONCC coho salmon
North-Central California Coast	CC Chinook salmon CCC coho salmon
Central Valley	Sacramento River winter run Chinook Central Valley spring Chinook

The definition of a population used by each TRT to analyze the status of salmon and steelhead is set forth in the "viable salmonid population" (McElhany *et al*. 2000). That document defines population viability in terms of four parameters: abundance, population growth rate (productivity), population spatial structure, and genetic diversity.

Abundance is of obvious importance since, in general, small populations are at greater risk of extinction than large populations, primarily because many processes that affect population dynamics may operate differently in small populations than in large populations (Shaffer 1987, McElhany *et al.* 2000).

- Population growth rate, the productivity over the entire life cycle (e.g. recruits per spawner), and factors that affect population growth rate provide information about how well a population is performing in the various habitats it occupies across the life cycle. Population growth rate indicates if a population is able to replace itself. Populations that consistently fail to replace themselves (productivity less than one) are at greater risk of extinction than populations that are consistently at or above replacement levels.

Spatial structure refers to the distribution of individuals within a population at a certain life stage throughout the available habitats, recognizing the abiotic and biotic processes that give rise to that structure. McElhany *et al.* (2000) gave two main reasons why spatial structure is important to consider when evaluating population viability: 1) overall extinction risk at longer time scales may be affected in ways not apparent from short-term observations of abundance and productivity, because there can be a time lag between changes in spatial structure and the resulting population-level effects, and 2) spatial population structure affects the ability of a population to respond to changing environmental conditions and therefore can influence evolutionary processes. Maintaining spatial structure within a population, and its associated benefits to viability, requires appropriate habitat conditions and suitable corridors linking the habitat and the marine environment to be consistently available.

Diversity relates to the variability of phenotypic characteristics such as life histories, individual size, fecundity, run timing, and other attributes exhibited by individuals and populations, as well as the genetic diversity that may underlie this variation. There are many reasons diversity is important in a spatially and temporally varying environment. Three key reasons are 1) diversity allows a species to use a wide array of environments, 2) diversity protects a species against short-term spatial and temporal changes in the environment, and 3) genetic diversity provides the raw material for surviving long-term environmental change (McElhany *et al.* 2000).

Although the TRTs operated from the common set of biological principals described in McElhany *et al.* (2000), they worked semi-independently from each other and developed criteria suitable to the species and conditions found in their specific recovery domains. All of the criteria have qualitative as well as quantitative aspects. The diversity of salmonid species and populations makes it impossible to set narrow quantitative guidelines that will fit all populations in all situations. For this and other reasons, viability criteria vary among salmonid species, mainly in the number and type of metrics and the scales at which the metrics apply (*i.e.*, population, major population group (MPG), or ESU) (Busch *et al.* 2008).

Overall viability scores (high to low risk of extinction) are based on combined ratings for the abundance and productivity (A/P) and spatial structure and diversity[10] (SS/D) metrics. The A/P score considers the TRT's estimate of a populations' minimum threshold size, current abundance, proportion of natural-origin spawners, and its productivity. The four metrics (abundance, productivity, spatial structure, and diversity) are not independent of one another and their relationship to sustainability depends on a variety of interdependent ecological processes (Wainwright *et al.* 2008).

Diversity factors include:

- Life history traits: Distribution of major life history strategies within a population, variability of traits, mean value of traits, and loss of traits.
- Effective population size: One of the indirect measures of diversity is effective population size. A population at chronic low abundance or experiencing even a single episode of low abundance can be at higher extinction risk because of loss of genetic variability, inbreeding and the expression of inbreeding depression, or the effects of mutation accumulation.
- Impact of hatchery fish: Interbreeding of wild populations and hatchery origin fish can be a significant risk factor to the diversity of wild populations if the proportion of hatchery fish in the spawning population is high and their genetic similarity to the wild population is low.
- Anthropogenic mortality: The susceptibility to mortality from harvest or habitat alterations will differ depending on size, age, run timing, disease resistance or other traits.

[10] The WLC-TRT provided ratings for diversity and spatial structure risks. The IC-TRT provided spatial structure and diversity ratings combined as an integrated SS/D risk.

- Habitat diversity: Habitat characteristics have clear selective effects on populations, and changes in habitat characteristics are likely to eventually lead to genetic changes through selection for locally adapted traits. In assessing risk associated with altered habitat diversity, historical diversity is used as a reference point.

The size and distribution of the populations considered in this opinion generally have declined over the last few decades due to natural phenomena and human activity, including climate change (as described in Section 2.2.3), the operation of hydropower systems, over-harvest, effects of hatcheries, and habitat degradation. Enlarged populations of terns, seals, California sea lions, and other aquatic predators in the Pacific Northwest may be limiting the productivity of some Pacific salmon and steelhead populations (Ford 2011).

Salmonids in the Willamette-Lower Columbia Recovery Domain. Species considered in this opinion in the WLC Recovery Domain include LCR Chinook salmon, and LCR coho salmon.

LCR Chinook salmon. This species includes all naturally-spawned populations of Chinook salmon in the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a point in Washington east of the Hood River and in Oregon east of the White Salmon River.; The ESU's range extends up the Willamette River to Willamette Falls, Oregon, but does not include the spring-run Chinook salmon population in the Clackamas River (grouped with the UWR Chinook salmon ESU). The progeny of seventeen artificial propagation programs are also part of the listed species. Lower Columbia River Chinook exhibit three different life history types based on adult return timing and other features: fall ("tules"), late fall ("brights"), and spring runs. Of the 32 historical populations in three ecoregions (Coast, Cascades, and Gorge), 28 are considered extirpated or at very high risk (Ford 2011).

Most spring Chinook salmon populations remain cut off from access to essential spawning habitat by hydroelectric dams. Projects to allow access have been initiated in the Cowlitz and Lewis River systems, but these are not yet producing self-sustaining populations. The Sandy spring-run Chinook population, without a mainstem dam blocking access to its habitat, is considered at moderate risk and is the only spring Chinook population not considered extirpated or nearly so (Ford 2011). Hood River currently contains an out-of-ESU hatchery stock. The two late fall populations, Lewis and Sandy, are the only populations considered at low or very low risk; they contain relatively few hatchery fish and have maintained high spawner abundances (especially the Lewis River population). The remaining populations are considered extirpated or nearly so and are therefore at high risk of extinction.

Limiting factors and threats include (LCFRB 2010, NOAA Fisheries 2011):

- The Federal Columbia River Power System (FCRPS) has altered the flow regime and temperatures in the estuary; cumulative impacts of land use and flow management have degraded shallow estuarine habitat.
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development.
- Reduced access to spawning and rearing habitat mainly as a result of tributary hydropower projects.

- Hatchery-related effects.
- Harvest-related effects on fall Chinook salmon.
- Reduced access to off-channel rearing habitat in the lower Columbia River.
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary.
- Juvenile fish strandings that result from ship wakes.
- Contaminants affecting fish health and reproduction.

In summary, the LCR Chinook Salmon ESU is at high risk of extinction due to the high number of extirpated populations. The main causes for the decline of this ESU include degradation of freshwater habitats and freshwater hydropower related adverse affects.

UWR Chinook Salmon. This species includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River; in the Willamette River and its tributaries above Willamette Falls, Oregon; and progeny of seven artificial propagation programs. The seven historical populations in the ESU are in a single ecoregion/stratum that drains the Cascade Range. As described in Ford (2011), five of these are considered at very high risk of extinction. The remaining two (Clackamas and McKenzie) are considered at moderate to low risk, but even these have hatchery fractions above the TRTs viability thresholds. Recent data show substantial prespawning mortality. Although recovery plans target key limiting factors for future actions, there have been no significant on-the-ground actions that resolve the lack of access to historical habitat above the dams, nor have there been substantial efforts to remove hatchery fish from the spawning grounds.

Limiting factors and threats to UWR Chinook salmon include (ODFW and NMFS 2011, NOAA Fisheries 2011):

- Significantly reduced access to spawning and rearing habitat because of tributary dams.
- Degraded freshwater habitat, especially floodplain connectivity and function, channel structure and complexity, and riparian areas and large wood recruitment as a result of cumulative impacts of agriculture, forestry, and development.
- Degraded water quality and altered temperature as a result of both tributary dams and the cumulative impacts of agriculture, forestry, and urban development.
- Hatchery-related effects.
- Anthropogenic introductions of non-native species and out-of-ESU races of salmon or steelhead have increased predation on, and competition with, native UWR Chinook salmon.
- Historical ocean harvest rates of about 30 percent, which in recent years have decreased to around 11 percent.

In summary, the UWR Chinook Salmon ESU is at very high risk of extinction due to the degradation of freshwater habitats and freshwater hydropower related adverse affects.

LCR Coho Salmon. This species includes all naturally-spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia up to and including the Big White Salmon and Hood rivers; in the Willamette River to Willamette Falls, Oregon; and progeny of 25 artificial propagation programs. The Willamette Lower Columbia Technical Review Team (WLCTRT) identified 24 historical populations of LCR coho salmon and divided these into two diversity strata based on major run timing (early and late) and three ecoregion strata (Coast, Cascades, and Gorge; Myers *et al.* 2006).

Most of the historical populations in the ESU are at "very high" risk of extinction. The remaining three (Sandy, Clackamas and Scappoose) are at "moderate" or "high" risk (Ford 2011). Smolt traps indicate some natural production in Washington populations, though given the high fraction of hatchery origin spawners suspected to occur in these populations it is not clear that any are self-sustaining (Good et al. 2005).

Limiting factors and threats to LCR coho salmon include (LCFRB 2010, NOAA Fisheries 2011):

- The FCRPS has altered the flow regime and temperatures in the estuary; cumulative impacts of land use and flow management have degraded shallow estuarine habitat.
- Fish passage barriers that limit access to spawning and rearing habitats.
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large wood supply, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development.
- Hatchery-related effects.
- Harvest-related effects.
- Reduced access to off-channel rearing habitat in the LCR.
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary.
- Juvenile fish strandings that result from ship wakes.
- Contaminants affecting fish health and reproduction.

In summary, the LCR coho salmon ESU is at high risk of extinction due to the degradation of freshwater habitats and hatchery related adverse affects.

Salmonids in the Interior Columbia Recovery Domain. Species in the Interior Columbia (IC) recovery domain considered in this opinion are UCR spring-run Chinook salmon, SR spring/summer run Chinook salmon, and SR fall-run Chinook salmon.

UCR Spring-run Chinook Salmon. This species includes all naturally-spawned populations of Chinook salmon in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam in Washington (excluding the Okanogan River), the Columbia River from the mouth upstream to Chief Joseph Dam in Washington, and progeny of six artificial propagation programs. Increases in natural origin abundance relative to the extremely low spawning levels observed in the mid-1990s are encouraging; however, average productivity remains extremely low. The three extant populations constitute a single MPG. Overall, the viability of UCR Spring Chinook salmon has improved somewhat in recent years, but the ESU is still clearly at “moderate-to-high” risk of extinction (Ford 2011).

Limiting factors and threats to the UCR spring-run Chinook salmon ESU include (UCSRB 2007, NOAA Fisheries 2011):

- Mainstem Columbia River hydropower–related adverse effects: upstream and downstream fish passage, ecosystem structure and function, flows, and water quality.
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large woody debris recruitment, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Degraded estuarine and nearshore marine habitat
- Hatchery related effects: including past introductions and persistence of non-native (exotic) fish species continues to affect habitat conditions for listed species
- Harvest in Columbia River fisheries

In summary, the UCR Spring-run Chinook Salmon ESU is at moderate-to-high risk of extinction due to the degradation of freshwater habitats and freshwater hydropower related adverse affects.

SR Spring/summer Chinook Salmon. This species includes all naturally-spawned populations of spring/summer Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins; and progeny of fifteen artificial propagation programs. The 28 extant populations constitute five MPGs. Population level status ratings remain at high risk across the ESU, although recent estimates of natural-origin spawners have increased. Spawning escapements in the most recent years were generally above the extreme low levels in the mid-1990s, but below peak returns. Low natural productivity remains a major concern across the ESU so that the ability of SR spring/summer Chinook salmon populations to be self-sustaining through periods of low ocean productivity remains uncertain.

Limiting factors and threats to the SR spring/summer Chinook salmon ESU include (NOAA Fisheries 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large wood supply, stream substrate, elevated water temperature, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development.
- Mainstem Columbia River and Snake River hydropower impacts.
- Harvest-related effects.
- Predation.

In summary, the SR Spring/summer Chinook Salmon ESU is at high risk of extinction due to the degradation of freshwater habitats and freshwater hydropower related adverse affects.

SR Fall Chinook Salmon. This species includes all naturally-spawned populations of fall-run Chinook salmon in the mainstem Snake River below Hells Canyon Dam, and in the Tucannon, Grande Ronde, Imnaha, Salmon, and Clearwater rivers, and progeny of four artificial propagation programs. The single extant population of Snake River fall Chinook salmon is the only one that remains from an historical distribution that included large mainstem populations upstream of the current location of Hells Canyon Dam (IC-TRT 2003, Ford 2011).

Recent increases in natural origin abundance are encouraging. However, hatchery origin spawner proportions have increased dramatically in recent years – on average, 78% of the estimated adult spawners have been hatchery origin over the most recent brood cycle. The abundance/productivity risk rating for the population is "moderate" and the population is also at moderate risk for diversity and spatial structure. Given these findings, (Ford 2011) gave SR fall Chinook salmon an overall rating of "maintained" (supporting ecological functions and preserving options for ESU/DPS recovery while not meeting the criteria for a viable population).

Limiting factors and threats to SR fall Chinook salmon include (NOAA Fisheries 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, and channel structure and complexity have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Harvest-related effects
- Mainstem Columbia River and Snake River hydropower impacts
- Hatchery-related effects
- Degraded estuarine and nearshore habitat

In summary, the SR Fall Chinook Salmon ESU is at moderate risk of extinction due to the loss of mainstem freshwater habitat and freshwater hydropower and hatchery related adverse affects.

Salmonids in the Oregon Coast Recovery Domain

OC Coho Salmon. This species includes all naturally spawned populations of coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco: 13 functionally independent, eight potentially independent[11], and 35 dependent populations in five biogeographic strata (Lawson et al. 2007). The Yaquina River population in the Mid-Coast stratum is located close to the action area, such that juveniles leaving natal streams and adults returning to spawn could be disproportionately affected by the proposed action.

Recent natural-origin returns have also improved from the extreme low numbers in the 1990s, largely due to reduced harvest rates and hatchery production and improved ocean conditions

[11] An independent population is any collection of one or more local breeding units whose population dynamics or extinction risk over a 100-year time period are not substantially altered by exchanges of individuals with other populations (McElhany et al 2000).

(Stout et al. 2011). The ESU contains relatively large wild populations throughout its range, which reduces risks associated with spatial structure. Managers continue to reduce hatchery releases in some populations with near-term ecological benefits that are expected to improve natural production even further. However, past forest management practices combined with lowland agriculture and urban development have severely degraded the areas of highest (potential) habitat capacity. When ocean conditions cycle back to a period of poor survival for coho salmon, the ESU could rapidly decline to the low abundance seen in the mid-1990s.

Limiting factors and threats to the OC Coho salmon ESU include (Stout *et al.* 2011, NOAA Fisheries 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large wood supply, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, instream mining, dams, road crossings, dikes, levees, etc.
- Fish passage barriers that limit access to spawning and rearing habitats.
- Adverse climate, altered past ocean/marine productivity, and current ocean ecosystem conditions have favored competitors and predators and reduced salmon survival rates in freshwater rivers and lakes, estuaries, and marine environments.

In summary, the OC coho salmon ESU is at moderate-to-high risk of extinction due to the degradation of freshwater habitats and the adverse affects of climate change.

Salmonids in the Southern Oregon - Northern California Coast Recovery Domain.

SONCC Coho Salmon. This species includes all naturally-spawned populations of coho salmon in coastal streams between Cape Blanco, Oregon, and Punta Gorda, California, and progeny of three artificial propagation programs. Seven biogeographic strata[12] are comprised of 31 historical populations and although long-term data on abundance are scarce, all available evidence from shorter-term research and monitoring efforts indicate that recent population trends have been downward, potentially driven by low marine survival (Williams *et al.* 2011).

All populations spend a significant portion of their life in the marine environment, but little is known about their location during marine residence. Limiting factors and threats to SONCC coho salmon include (NMFS 2005a, NOAA Fisheries 2011):

- Lack of floodplain and channel structure
- Impaired water quality
- Altered hydrologic function due to altered amount and timing of river flows
- Degraded riparian forest conditions and large wood recruitment
- Altered sediment supply
- Degraded stream substrate

[12] Strata are groupings above the population level that are connected by some degree of migration, based on ecological subregions.

- Impaired estuarine function
- Impaired fish passage
- Hatchery-related adverse effects
- Effects of predation, competition, and disease mortality

Threats from natural or man-made factors have worsened in the past 5 years, primarily due small population dynamics, climate change, multi-year drought, and poor ocean survival conditions (NOAA Fisheries 2011).

In summary, the SONCC coho salmon ESU is at likely to become endangered due to the degradation of freshwater habitats and nonnative species interactions.

Salmonids in the North-Central California Coast Recovery Domain

California Coastal Chinook salmon

The species includes all naturally spawned populations of Chinook salmon from rivers and streams south of the Klamath River to the Russian River, California, as well as the progeny of seven artificial propagation programs. Bjorkstedt et al. (2005) identified 15 independent populations of fall-run and six of spring-run CC Chinook salmon, constituting four geographic strata.

Myers et al. (1998) and Good et al. (2005) concluded that California Coastal Chinook salmon were likely to become endangered. Good et al (2005) cited continued evidence of low population sizes relative to historical abundance, mixed trends in the few available time series of abundance indices available, and low abundance and extirpation of populations in the southern part of the ESU. Williams et al (2011) note that it remains difficult to characterize the status of this ESU based on the available data and did not find evidence of a substantial change in conditions since the last status review where it was concluded that the species was likely to become endangered (Good et al. 2005). The loss of diversity, the loss of the spring-run life history type, and the diminished connectivity between populations in the northern and southern half of the ESU are of concern for the future status of the species. Limiting factors include destruction and modification of habitat, blocked access to habitat and recreational harvest.

In summary, the CC Chinook Salmon ESU is at moderate-to-high risk of extinction due to the degradation of freshwater habitats and hatchery related adverse affects.

Central California Coast Coho

The species includes all naturally spawned populations of coho salmon from Punta Gorda in northern California south to and including the San Lorenzo River in central California, as well as populations in tributaries to San Francisco Bay (excluding the Sacramento-San Joaquin River system), as well four artificial propagation programs. The Central California Coast (CCC) coho salmon ESU historically comprised 12 functionally independent populations and 4 potentially independent populations as well as a number of dependent populations, representing five diversity strata (Spence et al. 2008).

Estimates of abundance are derived from partial population and spawner/redd counts. Some show slight increases or decreases and a few are statistically significant (Williams et al. 2011). Although long term data on abundance are scarce, all available evidence from short-term research and monitoring efforts indicate that population numbers have declined in recent years. Many populations are well below abundance targets and several are either extinct or below high-risk thresholds (densities at which populations are at heightened risk of a reduction in per capita growth rate) (Spence et al. 2008). Limiting factors include habitat degradation, water quality, and loss of riparian and estuarine habitat, alteration of the hydrograph.

In summary, the CCC coho salmon ESU is at very high risk of extinction due to the degradation of freshwater habitats and hatchery related adverse affects.

Salmonids in the Central Valley Recovery Domain

Sacramento River winter-run Chinook

The species includes all naturally spawned populations of winter-run Chinook salmon in the Sacramento River and its tributaries in California, as well as two artificial propagation programs. Only one of four historical populations is extant and it is spawning outside of its historical range in artificially maintained habitat that is vulnerable to drought (Williams et al. 2011). The Sacramento River winter-run Chinook ESU is listed as endangered.

The Sacramento River population did increase in abundance in the first half of the decade, but these increases have reversed during the more recent period of unfavorable ocean conditions (2005-06) and drought (2007-09). Although concerns of genetic introgression with hatchery populations are increasing, the ESU is probably at lower extinction risk with contributions from the Livingston Stone National Fish Hatchery and the naturally-spawning population than it would be with just the single naturally-spawning population, at least in the near term. Improvement in the status of the ESU depends on re-establishing a low-risk population in a historically used area.[13] Fish passage projects in the planning phase, if successful, would also significantly benefit Sacramento River winter-run Chinook ESU.

Limiting factors include: habitat degradation, water quality, loss of riparian and estuarine habitat, loss of access to upstream spawning habitat, impaired passage, and alteration of the natural hydrograph and the influence of hatchery fish.

In summary, the Sacramento River winter-run Chinook salmon ESU is at very high risk of extinction due to the degradation of freshwater habitats and hatchery and freshwater hydropower related adverse affects.

Central Valley Spring-run Chinook

The species includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries in California, including the Feather River, as well as the Feather River Hatchery spring-run Chinook program. The Central Valley TRT delineated 18 or 19 independent populations of Central Calley Spring-run (CVSR) Chinook, along with a number

[13] For example, spring-run Chinook salmon appear to be repopulating Battle Creek, home to an historical independent population that was extirpated for many decades (Williams et al. 2011).

of smaller dependent populations, in four diversity groups (Lindley et al. 2004). Of these 18 populations, only three are extant and they represent only the Northern Sierra Nevada diversity group. All populations in the Basalt and Porous Lava group and the Southern Sierra Nevada group were extirpated, and only a few dependent populations persist in the Coast Range group (Williams et al. 2011). Lindley et al. (2007) found that the three extant populations were at or near low risk of extinction. The ESU as a whole, however, could not be considered viable because there were no extant populations in the three other diversity groups.

The time since 2005 has been a period of widespread declines in the abundance of Chinook in the Central Valley, including Central Valley spring-run Chinook salmon. In an analysis focused on Sacramento River fall Chinook salmon, Lindley et al. (2009) found that unusual ocean conditions in the spring of 2005 and 2006 led to poor growth and survival of juvenile salmon entering the ocean in those years. From 2007-2009, the CV experienced drought conditions and low river and stream discharges, which are generally associated with lower survival of Chinook salmon. There is a possibility that with the recent cessation of the drought and a return to more favorable patterns of upwelling and sea-surface temperatures, trends in abundance may have become more positive.

Limiting factors include threats from hatchery production, climate change, elevated water temperatures, predation, and water diversions.

In summary, the CV Spring-run Chinook salmon ESU is at moderate-to-high risk of extinction due to the degradation of freshwater habitats and hatchery related adverse affects.

2.2.1.2 Other Marine Fishes

Green Sturgeon

Green sturgeon range from the Bering Sea, Alaska, to Ensenada, Mexico. A few green sturgeon have been observed off of the southern California coast, including fish less than 100 cm total length (TL). Green sturgeon abundance increases north of Point Conception, California (Moyle et al. 1995). Green sturgeon occupies freshwater rivers from the Sacramento River up through British Columbia (Moyle 2002), but spawning has been confirmed in only three rivers: the Rogue River in Oregon and the Klamath and Sacramento rivers in California. Based on genetic analyses and spawning site fidelity (Adams et al. 2002; Israel et al. 2004), NMFS determined green sturgeon are comprised of at least two DPSs:

(1) Northern DPS consisting of populations originating from coastal watersheds northward of and including the Eel River (i.e., the Klamath and Rogue rivers) (“Northern DPS”); and

(2) Southern DPS consisting of populations originating from coastal watersheds south of the Eel River (“Southern DPS”).

The only known spawning population for the Southern DPS is in the Sacramento River. The Northern DPS and Southern DPS are distinguished based on genetic data and spawning locations, but their distributions outside of natal waters generally overlap with one another (NMFS 2009a). Both Northern DPS and Southern DPS fish occupy coastal waters from Southern California to Alaska and are known to aggregate in the Columbia River estuary, Washington estuaries, and Oregon estuaries (such as Winchester Bay) in the spring to late summer months. Thus, green sturgeon observed in coastal bays, estuaries, and coastal marine waters outside of natal rivers may belong to either DPS. However, only the Southern DPS of green sturgeon is classified as a listed species under the ESA. Tagging or genetics data are needed to determine to which DPS an individual belongs.

Subadult and adult green sturgeon spend most of their lives in marine and estuarine waters from southern California to Alaska. These appear to be important habitats within which green sturgeon make seasonal, long-distance migrations (up to 100 km per day), probably associated with foraging and aggregation areas along the coast. Green sturgeon primarily occur within the 110-m depth contour. Some tagged individuals have been observed swimming at slower speeds and spending long periods of time (on the order of days) within certain areas, suggesting these individuals were foraging. Prey are likely to include species similar to those fed on in bays and estuaries (e.g., burrowing ghost shrimp, crangonid shrimp, amphipods, isopods, Dungeness crab). These species occur throughout coastal marine waters.

Eulachon

The ESA-listed DPS of eulachon includes all naturally-spawned fish in the Skeena River in British Columbia to the Mad River in California (inclusive). Core populations for this species include the Fraser River, Columbia River and (historically) the Klamath River. The Columbia River and its tributaries support the largest known eulachon run.

Eulachon leave saltwater to spawn in their natal streams late winter through early summer. They typically spawn at night in the lower reaches of larger rivers with snowmelt fed spring freshets. After hatching, larvae are carried downstream and widely dispersed by estuarine and ocean currents. Movements in coastal waters are poorly known although the amount of eulachon bycatch in the pink shrimp fishery indicates that the distributions of these organisms overlap.

There are few direct estimates of eulachon abundance. In most areas of the southern DPS escapement counts or estimates of spawning stock biomass are unavailable. When available, catch statistics from commercial or recreational eulachon fisheries have been used to estimate relative abundance. However, inferring population status or even trends from yearly changes in catch statistics requires assumptions that are seldom met including similar fishing effort and efficiency, assumptions about the relationship of the harvested portion to the total portion of the stock, and statistical assumptions, such as random sampling. There are few fishery-independent sources of abundance data available for eulachon, and there are few monitoring programs for them (in the United States). However, the combination of catch records and anecdotal information indicate that eulachon were present in large annual runs in the past and that significant declines in abundance have occurred over the last 20-30 years (Gustafson et al. 2010), enough so that eulachon numbers are at, or near, historically low levels throughout the range of the southern DPS.

The primary factors responsible for the decline of the southern DPS of eulachon are changes in ocean conditions due to climate change (Gustafson et al. 2010, Gustafson et al. 2011), particularly in the southern portion of its range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success. Additional factors include climate-induced change to freshwater habitats; dams and water diversions (particularly in the

Columbia and Klamath Rivers where freshwater hydropower generation and flood control are major activities); and bycatch of eulachon in commercial fisheries (NOAA Fisheries 2011).

2.2.1.3 Marine Mammals

Southern Resident Killer Whales

The Southern Resident killer whale DPS was listed as endangered under the ESA on November 18, 2005 (NMFS 2005c). Southern Residents are designated as depleted and strategic under the Marine Mammal Protection Act on May 29, 2003 (NMFS 2003). NMFS issued the final recovery plan for Southern Residents in January 2008 (NMFS 2008b). This section summarizes information taken largely from the recovery plan and five-year status review (NMFS 2011c) as well as new, unpublished data that became available more recently.

Southern Resident killer whales are a long-lived species, with late onset of sexual maturity (NMFS 2008b). Mothers and offspring maintain highly stable social bonds throughout their lives, which is the basis for the matrilineal social structure in the Southern Resident population (NMFS 2008b). Groups of related matrilines[14] form pods. Three pods – J, K, and L – make up the Southern Resident killer whale DPS. All Southern Residents are individually identified by photo-identification based on uniquely shaped and scarred dorsal fins and saddle patches (NMFS 2011c).

Vocal communication is advanced in killer whales and is important to their social structure, navigation and foraging (NMFS 2008b). Southern Residents consume a variety of fish and one species of squid, but salmon, and Chinook salmon in particular, are their primary prey (Ford and Ellis 2006, Hanson et al. 2010). Ongoing and past diet studies of Southern Residents have been conducted during spring, summer and fall in inland waters of Washington State and British Columbia (i.e., Ford and Ellis 2006; Hanson et al. 2010; ongoing research by Northwest Fisheries Science Center (NWFSC)). Therefore, our knowledge of diet is specific to inland waters. Less is known about diet of Southern Residents off the Pacific Coast. However, chemical analyses support the importance of salmon in the year-round diet of Southern Residents (Krahn et al. 2002; Krahn et al. 2007). The predominance of Chinook salmon in the Southern Residents' diet when in inland waters, even when other species are more abundant, combined with information indicating that the killer whales consume salmon year round, makes it reasonable to expect that Southern Residents predominantly consume Chinook salmon when available in coastal waters.

Spatial Distribution and Diversity

The Southern Resident killer whale DPS is composed of a single population that is found throughout the coastal waters of Washington, Oregon, and Vancouver Island and known to travel as far south as central California and as far north as Chatham Strait, Southeast Alaska. From late spring to early autumn, Southern Residents spend considerable time in the Salish Sea; with concentrated activity around the San Juan Islands, and then move south into Puget Sound in early autumn. Pods make frequent trips to the outer coast during this time. Although the entire Southern Resident killer whale DPS has the potential to occur along the outer coast at any time during the year, occurrence along the outer coast is more likely from late autumn to early spring.

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[14] Matrilines are a group of orcas with one common female relative.

The estimated effective size of the population (based on the number of breeding individuals under ideal genetic conditions) is very small, <30 whales or about 1/3 of the current population size (Ford et. al. 2011). The small effective population size, the absence of gene flow from other populations, and documented breeding within pods may elevate the risk from inbreeding and other issues associated with genetic deterioration (Ford 2011). In addition, the small effective population size may contribute to the lower growth rate of the Southern Resident population in contrast to the Northern Resident population (Ford 2011, Ward et al. 2009).

Abundance and Productivity
As of the 2011 census, there were 26 whales in J pod, 20 whales in K pod and 42 whales in L pod, for a total of 88 whales. The historical abundance of Southern Resident killer whales is estimated from 140 whales (based on removals of animals for public display; Olesiuk et al. 1990) up to 400 whales as used in Population Viability Analysis (PVA) scenarios (Krahn et al. 2004). Over the last 28 years (1983-2010), population growth has been variable, averaging 0.3 percent per year (standard deviation = ± 3.2 percent (NMFS 2011c).

A delisting criterion for the Southern Resident killer whale DPS is an average growth rate of 2.3 percent for 28 years (NMFS 2008b). In light of the recent average growth rate of 0.3 percent, this recovery criterion has not yet been met (NMFS 2011c) and the recent low population growth rate is not sufficient to achieve recovery. There are also several demographic factors of the Southern Resident population that are cause for concern, namely the small number of breeding males (particularly in J and K pods), reduced fecundity, decreased sub-adult survivorship in L pod, and the total number of individuals in the population (NMFS 2008b).

Limiting Factors
Several factors identified in the final recovery plan for Southern Resident killer whales may be limiting recovery (NMFS 2008b). These are quantity and quality of prey (particularly their primary prey, Chinook salmon), exposure to toxic chemicals that accumulate in top predators, and disturbance from sound and vessels. Oil spills are also a risk factor. It is likely that multiple threats are acting in concert to impact the whales. Although it is not clear which threat or threats are most significant to the survival and recovery of Southern Residents, all of the threats identified are potentially limiting improvements in their population dynamics (NMFS 2008b).

In summary, the Southern Resident Killer whale is endangered and considered depleted under the MMPA due to the quantity and quality of prey (particularly their primary prey, Chinook salmon), exposure to toxic chemicals that accumulate in top predators, and disturbance from sound and vessels.

Steller Sea Lions
NMFS listed Steller sea lions as threatened under the ESA on November 26, 1990 (NMFS 1990) across their entire range. Continued declines in the western portion of the population led to listing the western stock as endangered on May 5, 1997, however the eastern stock remained listed as threatened (note: the proposed fishing only has potential to affect eastern DPS Steller sea lions, as described further below). Under the (MMPA), all Steller sea lions are classified as

strategic stocks[15] and are considered depleted. NMFS issued the final revised recovery plan for Steller sea lions in March 2008 (NMFS 2008c). The final Steller sea lion recovery plan identified the need to initiate a status review for the eastern DPS of Steller sea lions and consider removing it from the Federal List of Endangered Wildlife and Plants (NMFS 2008c). On December 13, 2010, NMFS announced a decision to review the status of the eastern DPS in response to two petitions to delist the eastern DPS (NMFS 2010b). On April 18, 2012, NMFS issued a proposed rule to remove the eastern DPS of Steller sea lions from the List of Endangered and Threatened Wildlife (NMFS 2012). This section summarizes information taken largely from review of the recovery plan (NMFS 2008c) and the most recent stock assessment report (Allen and Angliss 2011).

Steller sea lions are a long-lived species, and reproduction is somewhat delayed (until age 10 years; NMFS 2008c). Breeding occurs at rookeries where males compete for females by defending territories. Females bear at most a single pup each year between late May through early July, with peak numbers of births during the second or third week of June.

Steller sea lions are generalist predators, able to respond to changes in prey abundance. Their primary prey includes a variety of fishes and cephalopods. Some prey species are eaten seasonally when locally available or abundant, and other species are available and eaten year-round (NMFS 2008c). Pacific hake appears to be the primary prey item across the range of eastern Steller sea lion (NMFS 2008c). Other prey items include Pacific cod, walleye Pollock, salmon, and herring, among other species.

Spatial Distribution and Diversity

The eastern DPS of Steller sea lions are a single population that ranges from southeast Alaska to southern California, including inland waters of Washington State and British Columbia. Occurrence in inland waters of Washington is limited to primarily male and sub-adult Steller sea lions in fall, winter, and spring months. Mature animal breed on rookeries in southeast Alaska, British Columbia, Oregon, and California (i.e., there are no rookeries in Washington). Haulout sites, used for predator avoidance, thermal regulation, social activity, parasite reduction and rest, are located throughout their range (NMFS 2008c).

Steller sea lions are not known to migrate. Rather, they disperse from rookeries after the breeding season (late May – early July), with adult males and juveniles ranging further than adult females (Allen and Angliss 2011). Exchange of breeding animals appears low between rookeries (Allen and Angliss 2011). The breeding distribution of the eastern DPS has shifted north, with

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[15] Strategic Stock: defined by the MMPA as a marine mammal stock—1) for which the level of direct human-caused mortality exceeds the potential biological removal level; 2) which, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the ESA within the foreseeable future; or 3) which is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA.

range contraction in southern California and new rookeries established in southeast Alaska (Pitcher et al. 2007).

Abundance and Productivity

The total population estimate is a range between 58,334 and 72,223 animals, based on extrapolation from pup counts. The estimated minimum abundance of non-pup and pup counts from all rookeries is 52,847 animals (Allen and Angliss 2011), not corrected for animals that were at sea. The population has increased at a rate of 3.1% per year from the 1970s until 2002 (Pitcher et al. 2007). The greatest increases have occurred in southeast Alaska and British Columbia (together accounting for 82% of pup production), but performance has remained poor in California at the southern extent of their range (Allen and Angliss 2011). In Southeast Alaska, British Columbia and Oregon, the number of Steller sea lions has more than doubled since the 1970s. Historical abundance is not well known, because prior to 1970, count data were only intermittently available and therefore are not comparable with more recent data sets (NMFS 2008c).

Limiting Factors

Given the long-term positive population growth, no threats to the continued recovery of the eastern DPS were identified in the final revised recovery plan (NMFS 2008c). There are, however, factors that affect or have the potential to affect population dynamics of the eastern DPS. Those factors are predation (from killer whales and sharks), harvests, fishing bycatch and other human impacts, entanglement in debris, parasitism and disease, toxic substances, global climate change, reduced prey biomass and quality, and disturbance (NMFS 2008c).

In summary, the Steller sea lion is under consideration for removal from the ESA-list due to improvements in the limiting factors noted above however, at this time they are still ESA-listed as threatened due to predation (from killer whales and sharks), harvests, fishing bycatch and other human impacts, entanglement in debris, parasitism and disease, toxic substances, global climate change, reduced prey biomass and quality, and disturbance.

Humpback Whales

NMFS listed humpback whales as endangered under the ESA in 1970 (NMFS 1970a). A Recovery Plan was finalized for this species in 1991 (NMFS 1991). Under the MMPA, NMFS classified humpback whales as a strategic stock and considered depleted. On August 12, 2009, NMFS initiated an ESA status review of humpback whales. The status review is currently in progress. This section summarizes information taken from the recovery plan (NMFS 1991), stock assessment reports (reports for each stock are available online at: http://www.nmfs.noaa.gov/pr/sars/species.htm#largewhales), the most recent status review (Fleming and Jackson 2011) as well as data that became available more recently.

Humpback whales are a long-lived species, with late onset of sexual maturity (NMFS 1991). In the Pacific Ocean, females bear their first calves at between 8–16 years of age, and the maximum life-span is at least 50 years, with an average generation time of 21.5 years. Calving intervals are from 2–3 years following an 11-month gestation period. Humpback whales feed on krill and small schooling fish, using solitary and group foraging strategies.

Spatial Distribution and Diversity

Humpback whales are found in all oceans of the world with a broad geographical range from tropical to temperate waters in the northern hemisphere and tropical to arctic waters in the southern hemisphere. All populations migrate seasonally between their winter calving and breeding grounds and summer feeding grounds. Humpback whales typically occur on the feeding grounds during the summer and fall months.

In the North Pacific, the primary breeding grounds are located in coastal areas of Central America, Mexico, Hawaii, the Philippines, the islands of Ogasaware and Okinawa, and an unidentified additional Western Pacific breeding ground (Calambokidis et al. 2008, Fleming and Jackson 2011). The breeding populations are genetically different (Baker et al. 1998, Baker and Steel 2010), and photo-id-based mark/recapture studies indicate a high, but not complete, degree of individual fidelity to one of the four general breeding areas (Mexico, Central America, Hawaii, Asia; (Calambokidis et al. 2008)).

Feeding areas include coastal waters across the Pacific Rim from California to Japan. Humpback whales are commonly observed off the California, Oregon and Washington coasts during the spring, summer and fall months (**Figure 10**), and they have also been detected off California (Forney and Barlow 1998) and Washington (Olsen et al. 2009, NWFSC unpublished. data) during the winter. The whales feeding off of California and Oregon are primarily from the Mexican breeding area, with smaller contributions from Central America. The whales feeding off of Washington and Southern British Columbia (BC) are also from the Mexican and Central American breeding areas, but include in addition a significant number of individuals from the Hawaiian breeding area (Calambokidis et al. 2008).

There is relatively high site fidelity of individuals to broad feeding grounds (Calambokidis et al. 2008), but movements likely occur between feeding areas. The migratory routes used by humpbacks from their West Coast feeding areas to breeding areas are not well known. Based on photo-id data, their movements in Oregon and California are probably primarily coastal, as they move to Mexico and Central America. Limited information is available on the routes of whales tagged on their Mexican breeding ground, but the movements of one whale to the BC feeding ground was generally near or westward of the continental slope (Lagerquist et al. 2008). This coastal migration pattern may be similar for the portion of the northern Washington animals that also breed in these areas, but a substantial proportion of the animals observed in this area winter in Hawaii, and these animals obviously must have a less coastal migration pattern.

West Coast humpback whales migrate from breeding grounds in Mexico and Hawaii to the West Coast of the United States and British Columbia to feed in the summer. Thus, while whales do occur throughout the shelf waters of the U.S. West Coast, they aggregate off central California, Oregon, and the northwest coast of Washington State (**Figure 10**). In California, the whales use the Monterey Bay and Gulf of the Farallons (Barlow et al. 2009, Benson 2002, Benson et al. 2002, Forney 2007, Kieckhefer 1992). Off the northwest coast of Washington, whales are primarily observed east of the Barkley Canyon, between the La Perouse Bank and Nitnat Canyon, and on the shelf edge near the Juan de Fuca Canyon (Figure 10); (Calambokidis et al. 2004, Dalla Rosa 2010). In particular, the whales occur primarily on the periphery of the

Juan de Fuca Eddy (Dalla Rosa 2010). In northern California and southern Oregon, humpbacks occurrence may be associated with the inside edge of the coastal upwelling front (Tynan et al. 2005).

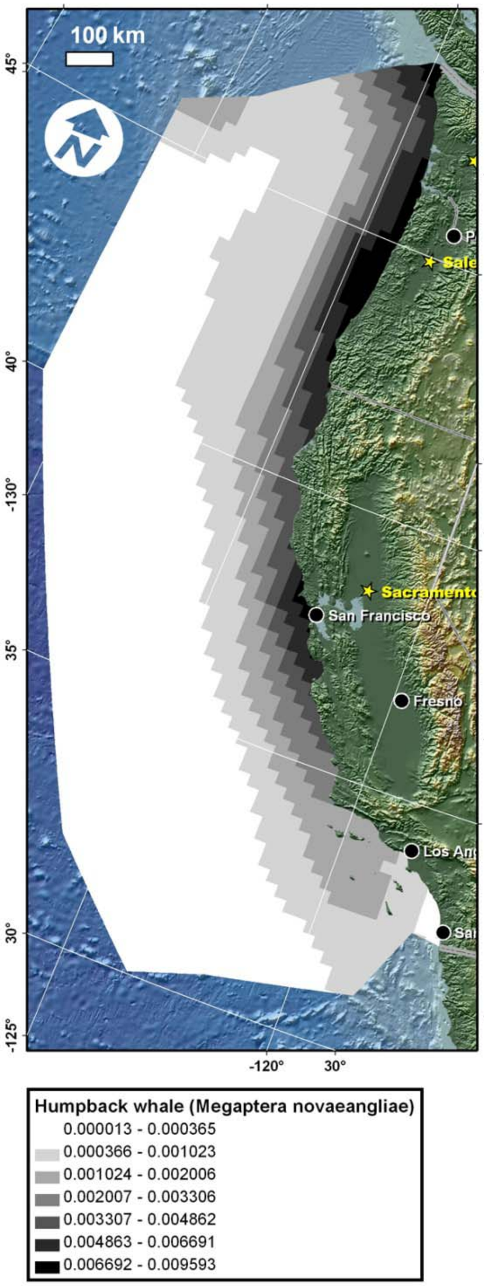

Figure 10*. Mean predicted humpback whale density (number of animals/km^2), based on surveys conducted from June through November, from 1991 – 2005 (data from Barlow et al. 2009). Ship-based cetacean and ecosystem assessment surveys of humpback sighting locations were extrapolated to a regular grid (25 km resolution) for each year and were smoothed with geospatial methods to obtain a continuous grid of density estimates for the California Current Ecosystem (NWFSC 2011).*

Abundance and Productivity
The most recent population estimate of humpback whales in the North Pacific Ocean is 21,808 (CV=0.04) (2004-2006 estimate; Barlow et al. 2011), which is higher than the estimated pre-exploitation abundance of ~15,000. There is, however, uncertainty about the latter estimate (Rice 1977). Estimates of the breeding population sizes are about 10,000 whales (Hawaii), 6,000-7,000 whales (Mexico, including Baja and the Revillagigedos Islands), 500 whales (Central America), and 1,000 whales (Western Pacific) (Calambokidis et al. 2008). For management under the MMPA, humpback whales stocks are defined based on feeding areas, with the whales feeding off California, Oregon, and Washington currently considered one stock (Carretta et al. 2010). The estimated abundance of this feeding stock as of 2007/2008 was 2,043 whales (CV=0.10) (mark-recapture estimate; Carretta et al. 2010), with a minimum population estimate of 1,878 whales (lower 20th percentile of the mark-recapture estimate; Calambokidis et al 2008).

The maximum expected rate of annual increase for the species as a whole ranges from an estimated 7.3–8.6% (Zerbini et al. 2010), with a maximum plausible rate (upper 99% confidence interval of the expected maximum) of 11.8% annually. North Pacific populations as a whole grew by an estimated 6.8% annually over the period from 1966 to 2006 (based on an estimated post-exploitation abundance of 1,400 in 1966; (Calambokidis et al. 2008). The Hawaiian breeding population grew by an estimated 5.5–6.0% annually over the period from 1991–1993 to 2006. The annual growth rate for the California, Oregon and Washington feeding stock is estimated at 7.5% (Carretta et al. 2010). Most Southern Hemisphere populations have been increasing at annual rates of 7–9% since the early- to mid-1990s (Fleming and Jackson 2011). The Gulf of Maine feeding population has been estimated to be increasing at a lower rate of ~3% annually from 1979 to 1993 (Stevick et al. 2003).

Limiting Factors
Humpback whales face a variety of threats, depending on the region in which they occur. Threats listed in the Recovery Plan include entrapment and entanglement in fishing gear, collisions with ships, acoustic disturbance, habitat degradation, and competition for resources with humans (NMFS 1991). Globally, entrapment and entanglement in fishing gear and collisions with ships represent most of the reported and observed serious injuries and mortalities for the species (review in Carretta et al. 2010).

In summary, the humpback whale is endangered and depleted throughout its range due to entrapment and entanglement in fishing gear, collisions with ships, acoustic disturbance, habitat degradation, and competition for resources with humans.

2.2.2 Status of Critical Habitat

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

For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each listed species they support[16]; the conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review teams; evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area. Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or the fact that it serves another important role (e.g., obligate area for migration to upstream spawning areas).

2.2.2.1 Salmon and Steelhead

"Critical habitat" defined as specific areas within the geographical area occupied by the species at the time of listing that contain physical or biological features essential to the conservation (i.e., recovery) of the listed species. Because West Coast salmon and steelhead range throughout the north Pacific, NMFS has been unable to identify specific areas in the ocean that are essential to the species' recovery. Critical habitat for all of the species considered in this opinion has been designated in fresh and brackish water only and the proposed action has no effects, direct or indirect, on these areas. Therefore, the proposed action would not affect designated critical habitat for LCR Chinook, UWR Chinook, UCR spring-run Chinook, SR spring/summer Chinook, SR fall Chinook, CC Chinook, CV spring Chinook, SR winter Chinook, OC coho, SONCC coho, or CCC coho salmon.[17]

2.2.2.2 Eulachon

NMFS designated critical habitat for ESA-listed DPS of eulachon in fresh and brackish water only and the proposed action has no effects on these areas. Therefore, the proposed action would not affect designated critical habitat for the southern DPS of eulachon.

2.2.2.3 Southern Green Sturgeon

NMFS designated critical habitat for this species in coastal U.S. marine waters within the 60 fathom depth contour from (and including) Monterey Bay, California, north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to the boundary with Canada; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; the lower Columbia River estuary; and certain coastal bays and estuaries in California (Humboldt Bay), Oregon

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

[17] NMFS has not yet designated critical habitat for LCR coho salmon.

(Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) and freshwater (NMFS 2009). The primary constituent elements (PCE)s of critical habitat for Southern DPS green sturgeon in coastal marine areas are shown in Table 4.

NMFS identified several activities that may threaten these PCEs and may necessitate special management considerations or protection. Prey resources can be affected by commercial shipping, activities generating contaminants that bioaccumulate in green sturgeon through their prey; burial under disposed dredged materials; and trawl fisheries that disturb the bottom. Proposed coastal hydrokinetic projects could affect water quality or hinder the migration of green sturgeon along the coast (NMFS 2009a).

Table 4. PCEs of critical habitat proposed for Southern DPS green sturgeon and corresponding species life history events

Primary Constituent Elements		Species Life History Event
Site Type	**Site Attribute**	
Coastal marine areas	Food resources Migratory corridor Water quality	Subadult growth and development, movement between estuarine and marine areas, and migration between marine areas Adult sexual maturation, growth and development, movements between estuarine and marine areas, migration between marine areas, and spawning migration

2.2.3 Climate Change

One final factor affecting the status of ESA-listed marine fishes and marine mammals, and aquatic habitat at large is climate change. Climate change is likely to play an increasingly important role in determining the abundance of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. Areas with elevations high enough to maintain temperatures well below freezing for most of the winter and early spring will be less affected. Low-elevation areas are likely to be more affected.

During the last century, average regional air temperatures increased by 1.5°F, and increased up to 4°F in some areas (USGCRP 2009). Warming is likely to continue during the next century as average temperatures increase another 3 to 10°F (USGCRP 2009). Overall, about one-third of the current cold-water fish habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (USGCRP 2009).

Precipitation trends during the next century are less certain than for temperature but more precipitation is likely to occur during October through March and less during summer months, and more of the winter precipitation is likely to fall as rain rather than snow (ISAB 2007, USGCRP 2009). Where snow occurs, a warmer climate will cause earlier runoff so stream flows in late spring, summer, and fall will be lower and water temperatures will be warmer (ISAB 2007, USGCRP 2009).

Higher winter stream flows would increase the risk that winter floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (USGCRP 2009). Earlier peak stream flows would also flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and the risk of predation (USGCRP 2009). Lower stream flows and warmer water temperatures during summer would degrade summer rearing conditions, in part by increasing the prevalence and virulence of fish diseases and parasites (USGCRP 2009). Other adverse effects are likely to include altered migration patterns, accelerated embryo development, premature emergence of fry, variation in quality and quantity of tributary rearing habitat, and increased competition and predation risk from warm-water, non-native species (ISAB 2007).

The earth's oceans are also warming, with considerable interannual and inter-decadal variability superimposed on the longer-term trend (Bindoff *et al*. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances (Scheuerell and Williams 2005, Zabel *et al*. 2006, USGCRP 2009). Ocean conditions adverse to salmon and steelhead may be more likely under a warming climate (Zabel *et al*. 2006).

2.3 Environmental Baseline

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

A suite of actions have impacted, and are continuing to impact, the environment within the action area, including boating, floating navigational and fishing devices, derelict gear, fishing, sonar, contaminant leaks and disposal, and submarines, as described below.

2.3.1 Status of Listed Species in the Action Area

In determining the status of listed species in the action area, NMFS used materials found in scientific literature, including peer reviewed journals and other recent research reports, along with input from state and Federal agency scientists, on the abundance, distribution and behavior of ESA-listed fishes, marine mammals, and sea turtles in the action area[18].

2.3.1.1 Salmonids

There are no data on the numbers, distribution, or behavior of salmon specific to the 0.25 square mile action area. Juvenile salmon generally exhibit a northward orientation and swim pattern toward the migration corridor of the Alaska Current however, juvenile Chinook salmon from Oregon coastal rivers south of Cape Blanco (about 125 miles south of the action area) tend to migrate southward and mature in waters off southern Oregon and northern California, south of the action area (Pool et al.2011). When found in nearshore waters (within about 300 feet of the shore), juvenile Chinook salmon are generally in cooler waters than are juvenile coho (Brodeur et al 2004).

[18] NOAA Northwest and Alaska Fish Science Center Library database searches.

Recent research efforts (Pool et al.2011, Petersen et al 2010, Bi et al 2008 and 2007 and Brodeur et al. 2004) document that although some habitat elements such as salinity, chlorophyll *a*, water depth, and temperature are likely to influence the distribution of juvenile salmonids in coastal waters, it is not possible to predict, with certainty, their distribution at any point in time. Further, these authors report that although juvenile salmonids were most abundant off the coast of Washington, fine-scale distributions were patchy and unpredictable. In comparison, Weitkamp (2010), Weitkamp and Neely (2002), and Weitkamp et al. (1995) reported that adult coho and Chinook salmon were widely dispersed in the coastal ocean based on 1.77 million Coded Wire Tags (CWT) recoveries from Alaska to California. Based on this information, it is likely that some juvenile and adult coho and Chinook salmon from the ESUs considered in this opinion will move through and possibly feed within the action area during their ocean residency.

Many recent studies document that ocean conditions are influenced by large-scale environmental factors (much greater than the proposed action area) and can vary greatly from year to year. This variability affects prey availability and habitat suitability for the growth and survival of salmonids (Bi et al 2007, Peterson et al 2010, and Pool et al 2011). Juveniles are subject to natural predation by hake, mackerel, some rockfishes, and adult salmonids. Adult salmon are eaten by marine mammals, including Southern Resident killer whales and Steller sea lions. Another effect on the salmon is from Federal fisheries that begin 3 miles offshore, which is just outside the action area.

2.3.1.2 Green Sturgeon

No data have been collected on green sturgeon within the action area. Based on genetic analyses, limited tagging studies, and commercial fishing reports, green sturgeon are believed to make extensive movements from natal rivers, generally in a northerly direction (NMFS 2006b, Adams et al. 2002, Erickson and Hightower 2007, Israel and May 2007, Lindley et al. 2008). Information obtained from off-shore commercial trawling efforts and tracking studies indicate green sturgeon typically occupy the water column at 20 to 70 meters and remain within the 110-meter contour line during southward migration in the spring (Huff et al 2011, Erickson and Hightower 2007, NMFS 2006b). Huff et al (2011) also report that green sturgeon appear to prefer area with high seafloor complexity such as boulders and rocky reefs. Therefore, adult and sub-adult green sturgeon could be moving through the action area throughout the year but the lack of seafloor complexity (Section 2.3.5 below) in the test site would likely limit their use of the area.

Oregon Department of Fish and Wildlife has deployed arrays of acoustic telemetry receivers near Seal Rock and Siletz Reef, Oregon (about 10 miles south and 25 miles north of the action area, respectively), to detect the movements of tagged green sturgeon. Out of about 350 green sturgeon tagged on the West Coast, 75 were detected by the array and some of these were members of the Southern DPS (Lindley et al., 2008). Emmett et al. (1991) reports that green sturgeon (of undetermined DPS) are common in Yaquina Bay, most likely using the bay as over-summering habitat, though to a lesser extent than Winchester Bay and Coos Bay. In a summary of 4 years of attempted data collection (2000-2004), no southern DPS green sturgeon were captured in Yaquina Bay. However, during the same period, 24 green sturgeon were captured

and tagged in the ocean just off-shore from Yaquina Bay (Farr et al. 2001, Farr and Rien 2002, Farr and Rien 2003, Farr and Kern 2004).
The action area is within the area designated as critical habitat for southern DPS green sturgeon. The relevant physical and biological features identified as essential to the conservation of the species include water quality, forage and safe passage.

2.3.1.3 Eulachon

There are no data on the numbers, distribution, or behavior of eulachon specific to the action area and little information about movements in nearshore waters in general. There is no information regarding the characteristics or conditions in coastal waters that would make a specific area suitable for passage, and there is no evidence that eulachon use specific marine areas for migration. Off British Columbia the 2-3 year period between hatchling and spawning appears to be spent mainly in near-benthic habitats in open marine waters (Hay and McCarter 2000). Based on analyses of the distribution of eulachon as bycatch in shrimp trawls, eulachon live near the bottom in water 20- to 250-m deep. Although there are is no known spawning occurring in Yaquina Bay or the Yaquina River, eulachon may migrate through and possibly feed within the action area during their ocean residency.

2.3.1.4 Southern Resident Killer Whales

From late spring to early autumn Southern Residents concentrate their activity in inland waters of Washington State, but make frequent trips to the outer coast of Washington and Oregon. In the winter to early spring, Southern Resident killer whales spend considerable time along the outer coast from as far north as Southeast Alaska to as far south as central California, including coastal Oregon. 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 action area. Southern Residents are likely to occur in the action area 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; NWFSC unpublished data).

2.3.1.5 Steller Sea Lions

Steller sea lions of the eastern DPS occur in Oregon waters throughout the year, with breeding rookeries at Rogue and Orford reefs, over 100 miles from the action area. The nearest large haulouts used regularly by Steller sea lions are Seal Rock (11 miles to the south) and Cascade Head (28 miles to the north) (NMFS 2008c). Steller sea lions occur in coastal waters and are known to occasionally haul-out near the action area, which is within the foraging range of both regular and occasional haulouts.

2.3.1.6 Humpback Whales

We have limited information about humpback whale foraging habits and distribution along the Oregon coast (Figure 10, Lagerquist and Mate 2002), and do not have any information specific to the action area. However, given their general tendency to occupy shallow, coastal waters when foraging, which is consistent with nearshore sightings of humpback whales off the Oregon coast (Lagerquist and Mate 2002), humpback whales are likely to occur within the action area.

2.3.2 Vessel Traffic and Navigation

The action area is used by a variety of boats including recreation, charter and commercial fishing, and commercial crabbing vessels. Boat traffic is more concentrated south of the proposed action area, near the mouth of the Yaquina Bay. The Port of Newport in Yaquina Bay is one of only three deepwater draft ports on the coast and supports local and international shipping, commercial and sport fishing, fish processing, marine research, tourism, recreation, and lumber and wood processing industries. Regular dredging maintains shipping channel depths, with dredged material dumped at an ocean site outside the river mouth.

The nautical book Coast Pilot 7 (NOAA, 2012) recommends that vessels traveling along the Oregon Coast proceed along a course from Cape Blanco (about 125 miles south of the test site) to the Columbia River entrance that falls about 15 miles to the west of proposed boundary of the test site. Vessels of 300 gross tons or larger are encouraged by the West Coast Offshore Vessel Traffic Risk Management Project to voluntarily stay a minimum distance of 25 miles from the shoreline, or well outside the project boundary. The test site would be marked to aid navigation for vessel traffic and fishing activities, but not closed to access.

2.3.3 Acoustic Environment

The study area for underwater sound and vibration is defined as the vicinity within 4.8 km (3 miles) of the test site (an area smaller than the action area), and the navigation lanes between the onshore support docks and the test site. The test site off the coast near Newport already experiences considerable commercial marine vessel traffic from the Port of Newport, which is home to one of Oregon's largest commercial fishing fleets. The test site is close enough to shore that surf sound could be within detectable levels. Therefore, background underwater sound levels were expected to be moderate to high (Austin et al. 2009).

Haxel et al. (2011) report baseline acoustic monitoring data for the test site. The study team deployed two acoustic recording devices on the ocean floor in and near the test site in March 2010. The devices recorded continuously, monitoring underwater sound generated at frequencies of 1 Hz to 2 KHz. The underwater sound pressure levels recorded during the monitoring period ranged from a low of 95 dB RMS re:1 μPa to 136 dB RMS re:1 μPa, with a time-averaged sound pressure level for the monitoring period of 113 dB RM re:1 μPa; a histogram of hourly root meaned squared (RMS) values shows a normal distribution. The spectrum during periods of above-average underwater sound intensity was dominated by low frequency noise associated with wave action, primarily surf along the shoreline. Haxel et al. (2011) report that level of ambient sound in the action area is higher than the typical deep ocean noise found in the NE Pacific Ocean (Haxel et al 2011).

2.3.4 Chemical Contaminants

Water quality data are available from one station in the vicinity of the project located about 2.0 miles west test site (Station ID 30244). Sampling at this station was conducted in 2003 by

ODEQ at a variety of depths in the water column. Sediment and fish tissue grab samples were analyzed for total copper concentrations although no water quality samples were taken. Sampling did not report any detections of copper in the sediment or tissues (ODEQ 2003).

2.3.5 Benthic Habitat

Henkel (2011) conducted baseline benthic habitat characterization at the proposed test site and summarized conditions at the site as follows:

> *"Sedimentary (soft bottom) habitat is the predominant habitat on the continental shelf and slope throughout the Pacific Northwest. Although these sandy or muddy habitats are sometimes considered an ocean 'desert', they are dynamic and full of life. Organisms living in and on the sediment have to contend with significant changes to their habitat as a result of wave action and ocean currents, making them generally resilient to disturbance. This habitat encompasses two main community types: infaunal (living in the sediment) and epifaunal (living on top of the sediment). Infaunal invertebrates modify the sediment and structure the habitat, making them key species despite their individual small sizes. Since sediment grain size often determines which animals can live in the sediment, changes to sediment movement due to ocean energy extraction or alterations of flow and sediment scour around large device arrays and associated anchors may affect the distribution of infaunal soft-bottom organisms."*

Benthic monitoring conducted by Henkel (2011) in and around the proposed test site reported the following findings:

- Two distinct sediment types were found in the area proposed for the test site near Newport, OR: silty sand at about 30 m and potentially shallower depths and nearly pure sand at 40 m and deeper (median grain size of the sampling stations over the course of the study ranged from 188 µm to 462 µm with smaller grain sizes found at the 30 m stations while larger grain sizes were found at the 40 and 50 m stations).
- Distinct infaunal invertebrate assemblages were found in the silty sand that were different from the deeper, sand stations.
- Distinct infaunal invertebrates' assemblages were found at different stations within the deeper depth ranges (i.e., patchy distributions).
- Fish species present in the area varied with season: flatfish dominated the summer catch, poacher abundances increased in the fall, and smelt (not Pacific eulachon) abundances were high in winter.
- Mysid shrimp and Crangon shrimp were highly abundant and likely form the basis of the food web in this nearshore zone as opposed to the krill-supported food web further offshore.
- Videographic observations are challenging in this sedimentary habitat; however, it is a more effective tool for sampling large invertebrate species than the trawl.

2.3.6 Climate Change

Although there is no detailed information on climate change specifically focused on the action area the key stressors related to climate change in Oregon's coastal ocean are ocean warming, altered currents, and acidification (OCCRI 2012).

2.4 Effects of the Action on Species and Designated Critical Habitat

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

There are no operating wave energy conversion deployments that have conducted field studies analyzing all potential environmental effects. Columbia Power Technologies conducted field measurements of acoustic outputs for a single buoy deployed in Puget Sound however, the deployment and testing were limited in scope and duration (Bassett et al 2011). Several environmental reports that discuss known baseline conditions in the action area and the potential project effects of the construction and operation of wave technology projects constitute the best scientific and commercial data available. NMFS uses this information, combined with other information provided in the Biological Assessment (BA) (ICF 2012) and Corps Nationwide Permit Application (PEV 2012), to evaluate the potential effects of the proposed action.

As described in Section 1.3, the proposed action includes the DOE funding for the development and operation of the test center and the Ocean Sentinel instrumentation and TRIAXYS™ buoys, as well as the 2012-2013 WET-NZ test Nationwide Permit # 5 authorization by the Corps. The WET-NZ test includes installation, maintenance, and operation of the WET-NZ WEC device, the Ocean Sentinel instrumentation buoy, the TRIAXYS™ wave-monitoring buoy and all associated moorings. The action area comprises the test site of 3.4 km^2 where the WEC devices, Ocean Sentinel and TRIAXYS™ wave buoy would be deployed and extends to a radius of 9.4 km^2 within which monitoring equipment, such as hydrophones, may be temporarily deployed. Components deployed during the WET-NZ WEC device test may experience a catastrophic failure of moorings and either sink in the action area or run aground on shore. NNMREC has anticipated this potential and developed safety measures, monitoring plans and emergency response plans to minimize the possibility of failure and the associated environmental impacts to the greatest extent possible.

The project components for the WET-NZ test are estimated to occupy about 0.085km^2 or 2% of the test site. The footprint of future WEC tests is unknown but NNMREC anticipates it would be similar to the WET-NZ test.

While each future WEC device test could occupy about 0.085km^2, about 2% of the test site, no more than two tests would be conducted concurrently. Assuming that the footprint of each test would be similar, two concurrent tests could occupy about 0.16km^2 or 5% of the test site. Tests could occur anywhere within the 3.4km^2 test site, therefore, over the 10-year operation of the test center at least 5% of the test site could be in use or occupied at any given time and that the entire 3.4km^2 would be occupied for some period of time during the 10-year period.

Environmental monitoring studies were developed by NNMREC with the state and Federal resource agencies, government and academic researchers, and other stakeholders. The members of the AMC (including NMFS) would use the resulting information to determine if thresholds are met and determine the most appropriate and effective mitigation action as described in detail in the NAMF and WAMP. Mitigation and management actions will be approved by NMFS before one of the action agencies or the owner of the test device implements them.

Based on proposed action, the action area, and listed species potentially affected; the proposed action is likely to affect ESA-listed species through the following pathways: (1) sound; (2) electromagnetic fields; (3) habitat alteration; (4) chemical contamination; (5) entanglement and collision; (6) creation of haulout habitat; and (7) prey availability as described in the following sections. Effects of these pathways are described specific to listed fishes and marine mammals, separately. Where a pathway is specific to one group or the other, potential effects are described only for the relevant species.

2.4.1 Sound

Sound Type and Intensity: Installation, Maintenance, Removal and Monitoring Activities
Vessel propellers would generate sound during project installation, maintenance and monitoring activities (Minerals Management Service [MMS] 2007). NMFS expects the peak 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 (re: 1 μPa) over a frequency range of 20 Hz to 10 kHz (Richardson et al. 1995). The sound intensity would be lower when the vessels are operating at idle speed.

Vessels and gear associated with installation of the wave energy conversion (WEC)s, Ocean Sentinel and TRIAXYS™ structures, as well as vessels used for monitoring, maintenance, and project-related studies, including tug/barge, small vessels, and research ships, would cause short-term increases in marine traffic in the vicinity of the action area. Most of the sound pressure produced by vessels would dissipate to ambient levels a short distance from the vessel. Vessels would be slow moving or idle in the action area.

Associated monitoring equipment (e.g. hydrophones on a lander) deployed and operated during the 10-year lifetime of the proposed action may include devices that actively generate or emit sound waves in a wide range of frequencies which may be perceptible to marine species, these audible acoustic telemetry devices would be used once per test period (6 months to 12 months) and would occupy very small portions of the action area.

Sound Type and Intensity: Project Operation

During operation of the 2012-2013 WET-NZ test and operation of other future tests during the 10-year operation of the test center, sound from the WEC devices' impellors, gearbox, generator, or other moving components (all of which would be contained inside of the device) and from waves impacting the above water portion of WEC devices, the Ocean Sentinel and the TRIAXYS™ buoys, would be propagated into the surrounding water. In addition, cablestrumming sound can be generated by waves or currents passing by anchor cables and submarine power cables. The magnitude of underwater sound generated by the operation of each WEC device would vary depending on the specific device being tested at any given time. Such sounds would be nearly continuous, but might vary depending on the amount of electricity being generated or mechanical motion at any given time.

Very little is known about the acoustic signature produced by wave energy devices (MMS, 2007) however, a general idea of the sound intensity and frequencies that might result during project operations can be developed by reviewing the recent research and studies of other mechanical sources of underwater sound. Recent research conducted by Bassett et al (2011) monitored the acoustic signature of a single buoy deployed in Puget Sound, Washington. Researchers report the device tested, a point absorber style WEC developed by Columbia Power Technologies, produced received sound pressure levels attributed to the WEC cycle ranging from 116 to 126 dB re 1µPa in the integrated bands from 60 Hz to 20 kHz at distances from 10 to 1500 m from the device (Bassett et al 2011).

Studies of other mechanical sources of underwater sound can aid in understanding the intensity and frequencies that may result from WEC tests at the site. As noted previously, the propellers of ships and barges under full power generally create peak sound intensities of 130-160 dB (re: 1 µPa) over a frequency range of 20 Hz to 10 kilohertz (kHz). Offshore wind turbines have been reported to transmit noise underwater at intensities ranging from 90 to 115 dB (re: 1 µPa) over a frequency range of 20-1,200 Hz, over a distance of about 360 feet (Thomsen et al., 2006). However, there are no data on the acoustic signature of the WET-NZ, Ocean Sentinel, or other potential WEC devices, which may be deployed at the test site. Further, we do not know if their operations are likely to be audible to marine fishes or mammals. As described above (Section 2.3.3), NNMREC has collected data to characterize background sound in the action area. Haxel et al (2011) report baseline acoustic monitoring data for the action area indicate the baseline underwater sound pressure levels are moderate to high, ranging from a low of 95 dB RMS re:1 µPa to 136 dB RMS re:1 µPa, with a time-averaged sound pressure level for the monitoring period of 113 dB RM re:1 µPa. NNMREC proposes to conduct monitoring of ambient and device sound during the 2012-2013 WET-NZ test period to study potential amplification or dampening of sound produced by the proposed action.

Although formal guidance is not yet available, NMFS uses conservative exposure thresholds of sound pressure levels from impulse sounds that have been shown to cause behavioral disturbance (a negative effect) in marine fishes; 183 dB (SEL) re: 1 µPa for fishes weighing up to 2 g and 187 dB (SEL) re: 1 µPa for fishes weighing over 2g and a peak sound level of 206 dB (Peak) re: 1 µPa Fisheries Hydroacustic Working Group (FHWG 2008). For marine mammals, NMFS uses conservative exposure thresholds for behavioral disturbance of 160 dBrms re: 1µPa for impulse sound and 120 dBrms re: 1µPa for continuous sound and injury 190 dBrms re: 1µPa for pinnipeds (NMFS 2005d). Sounds exceeding these thresholds can result in harm or harassment of ESA-listed marine species. The thresholds, detailed above, are lower for marine mammals for both harassment and harm than the thresholds for marine fishes.

2.4.1.1 Sound Effects on ESA-listed Fishes

The proposed action may produce sound within the hearing range of salmonids and other marine fishes as described in section 2.4.1.

Hastings and Popper (2005) provide an overview of published and gray literature studies that have evaluated the effects of sound on fish and note that the effect of anthropogenic noise, other than pile driving, has received little attention. They report that the majority of Pacific fishes studied are "hearing generalists," (i.e., have no special adaptations to enhance their hearing), capable of detecting sounds at intensities of between 75 and 150 dB (re: 1 μPa) and frequencies of between 30 and 2,000 Hz. However, per the authors, the data in the literature are only relevant to specific species and not easily extrapolated. In a later paper, Popper and Hastings (2009) conclude that the available literature does not support meaningful noise exposure metrics or reliable noise exposure criteria for fish. Therefore, we must evaluate the likely effects of noise associated with the proposed action qualitatively.

Although the acoustic signature of WEC devices is uncertain, they may produce sounds, which include both impulse and continuous characteristics. High level, short duration, impact sounds, such as the noise from pile driving, also referred to as "impulse" sounds, are known to cause behavioral changes, physical injury and in some instances are lethal depending on the level of sound and distance from the source. In comparison, the response to non-impulse or continuous sound such as vessel traffic or the continuous sound might range from no overt change in fish behavior to a startle response to evidence of just a mild awareness of the sound (Wardle et al. 2001). These types of responses can be small, temporary movements for the duration of the sound to larger and more persistent movements that displace fish from their normal locations (e.g. Slotte et al. 2004). In some cases, sound can change the migration routes of fish (Popper and Hastings 2009).

We do not have fine-scale information about use of the action area by salmonids, eulachon or green sturgeon but sound from the project could interrupt foraging in the action area because fish may avoid the sound sources. There is no information available to suggest that the action area is an important foraging area for these marine fishes, and there is similar habitat in the surrounding area that could be used by these species. It is likely that continuous, non-impact sound emissions from WET-NZ or future WEC device tests will result in behavioral avoidance of the action area.

Noise generated by the proposed action during operation may be similar to, or masked by the ambient noise of the ocean in the action area which is reported to be higher than the typical deep ocean noise found in the NE Pacific Ocean (Haxel et al 2011) likely due to wave activity and vessel traffic. However, uncertainty regarding the acoustic signature of WEC devices and the potential response of marine species remains a concern to NMFS. To address this uncertainty NNMREC will conduct in situ measurements of the acoustic emissions during the 2012- 2013 WET-NZ test and during the full 10-year operation of the test center. Equipment would include devices to measure and record underwater sound generated by the Ocean Sentinel or manned testing vessel and WEC devices under test.

As detailed in the WAMP, results of acoustic monitoring will be provided to NMFS within 7 days and a determination will be made based on whether the results indicate that noise produced exceeds NMFS criteria for potential harm caused by impulsive sounds for marine fishes and impulsive and continuous underwater sound effects on marine mammals. NMFS' Marine mammal exposure criteria for impulse sound is lower than that for marine fishes therefore it is reasonable to conclude that applying the criteria for marine mammals would also be protective for marine fishes with regards to impulse sounds. It is important to note that NMFS' exposure thresholds for marine fishes only applies to impulse sounds and that no criteria exist for exposure of marine fishes to continuous sounds.

If monitoring results indicate that the effects of the proposed action have met an acoustic management or mitigation threshold, adaptive management and mitigation measures addressing the effect(s), as detailed in the NAMF and WAMP would be carried out by NNMREC. All recommended adaptive management and mitigation actions are subject to review and approval by NMFS to ensure compliance with ESA, MSA, MMPA and other relevant Federal statutes.

Therefore, as a result of the proposed monitoring and the use of the adaptive management framework and adaptive mitigation plan to ensure that sound produced by WEC device tests is below NMFS established exposure thresholds, the likelihood that any ESA-listed marine fishes would be injured or killed by the sound from proposed action is very small. The likely behavioral responses, even considering potential for repeat exposures to sound from various periodic tests over the 10-year life of the project, will not reduce the reproductive success or increase the risk of injury or mortality for any individual ESA-listed salmonids, eulachon or green sturgeon because noise levels will be below the threshold for behavioral effects, and the area the noise will affect is insignificant compared to their range. Therefore, sound from the proposed action will not affect the numbers, reproduction, or distribution of ESA-listed salmon, green sturgeon, or eulachon at the population level.

2.4.1.2 Sound Effects on ESA-listed Marine Mammals

Southern Resident Killer Whale and Humpback Whale

As described above, most of the sound pressure produced by vessels involved in installation, monitoring or maintenance activities will be below background levels a short distance from the vessel and sound associated with vessels will be temporary and of short duration. With regards to operation of various WEC devices over the 10-year operation of the test center sounds produced may cause behavioral disruption of marine mammals if they generate sound above an intensity of 120 dBrms within the bandwidth of species'groups respective hearing ranges. NMFS is currently developing comprehensive guidance on sound levels likely to cause injury and different levels of behavioral disruption for marine mammals in the context of the MMPA and the ESA, among other statutes. Although the comprehensive guidance is not yet available, NMFS uses conservative exposure thresholds of sound pressure levels from broadband sounds that have been shown to cause behavioral disturbance (a negative effect) (160 dBrms re: 1μPa for impulse sound and 120 dBrms re: 1μPa for continuous sound) and injury (190 dBrms re: 1μPa for pinnipeds) (NMFS 2005d). The WEC devices will be a source of continuous sound.

As previously described, the bandwidth and intensity of acoustic emissions from both the WET-NZ and other potential WEC devices is unknown. The only available acoustic data on WEC device acoustic signatures is from a 1/7 scale WEC device deployed in Puget Sound during 2011 with received sound pressure levels attributed to the WEC cycle varying from 116 to 126 dB re 1 μPa at frequencies of 60 Hz to 20 kHz at distances from 10 to 1500 m from the WEC (Bassett et al. 2011). The WET-NZ device and future WEC devices are likely to be larger than 1/7 scale, the mechanism and mode of operation would likely vary from the studied device. Due to these differences, uncertainty about their acoustic signature and the magnitude of effects from sounds produced by these devices remains a concern for NMFS. To address the uncertainty NNMREC will carry out an acoustic monitoring plan to develop a better understanding of the acoustic emissions generated by the WET-NZ and any potential for sound disturbance (Appendix A). If acoustic monitoring indicates that the WET-NZ or Ocean Sentinel device generate sound above the 120 dB sound threshold, mitigation actions will be implemented within 14 days; and may include additional monitoring, modification of operations, or ceasing operations to minimize or eliminate acoustic disturbance, or applying for an Incidental Harassment Authorization under the MMPA.

Additionally, following each field deployment season, results of underwater sound monitoring would be presented to NMFS in a summary report, for discussion and potential action for future tests if required by NMFS, as detailed in the NAMF. This summary and review process would assure that NMFS is able to evaluate the observed effects of underwater sound after the various device tests, and is able to require necessary mitigation to avoid future adverse effects on marine mammals.

As described in the Status of the Species sections, we do not have fine-scale information about use of the action area by humpback whales or Southern Resident killer whales, but since the action area is within their known range, sound from the project could interrupt foraging in nearshore waters because sound can travel a long way. There is no information available to suggest that the action area is an important foraging area for either species, and there is similar habitat in the surrounding area that would serve as alternate foraging areas for these species. If the continuous, non-impact sound from the WET-NZ or future WEC device tests exceeds the 120 dB threshold, marine mammals could be exposed for short durations of a few months during periodic tests and may deflect around the action area. The size of any potential area of deflection would depend on the sound source levels (from the WET-NZ, ocean sentinel, or TRIAXYS™ buoy; or other WEC device), however, the increased whale travel time and energy expenditure associated with any deflection should be small (i.e., from a few feet to a few miles) and there is ample open water to accommodate passage. Any additional distance traveled is unlikely to cause a significant increase in an individual’s energy budget, and negative effects would therefore be small and temporary. It is likely that continuous, non-impact sound emissions from WET-NZ or future WEC device tests will result in behavioral avoidance of the action area, which could have the beneficial effect of reducing the risk of collision or entanglement. The likely behavioral responses, even considering potential for repeat exposures of individual whales to sound from various periodic tests over the 10-year life of the project, will not reduce the reproductive success, or increase the risk of injury or mortality for any individual humpback or Southern Resident killer whale.

In addition to sound generated by the WEC devices over the 10-year test period, individual projects may include use of active acoustic telemetry devices (i.e., echosounders, chirp profilers) to collect environmental data. While many of these devices produce sound at frequencies outside of the hearing range of marine mammals a small number of devices may emit sounds within the hearing range of marine mammals. These audible acoustic telemetry devices would be used once per test period (6 months to 12 months) to transmit data at a frequency of 3 to 15 kilohertz. Based on the expected use of these devices and the likelihood that the transmissions would be outside of their hearing range, it is extremely unlikely that a marine mammal would be in the limited location of exposure at the precise moment when a device would transmit detectable frequencies. Therefore, use of these devices will not have adverse effects on these whales at a population level because it is so unlikely that a whale would be in hearing range when the device is used.

Steller Sea Lions

Steller sea lions may use structures associated with various WEC device tests as haul outs (see Section 2.4.5.2, below on creation of haulout habitat), increasing the likelihood of exposure to sound from project operations. Exposure to sound from vessels within the area is likely to be minimal because most of the sound pressure produced by vessels involved in installation, monitoring or maintenance activities should be below background levels, a short distance from the vessel. Sound associated with vessels will be temporary and of short duration. With regards to operation of various WEC devices over the 10-year operation of the test center, sounds produced may cause behavioral disruption of marine mammals if they generate sound above an intensity of 120 dBrms within the bandwidth of species' groups respective hearing ranges. Some individual sea lions could experience short-term, localized displacement from the action area. For the same reasons identified above for ESA-listed whales (i.e., any impacts would be short-term until adaptive mitigation measures are implemented to reduce or eliminate impacts), these effects will not harm the species at a population level because they should not reduce the reproductive success or increase the risk of injury or mortality for any individual Steller sea lion.

2.4.2 Electromagnetic Fields

EMF Type and Intensity: Project Operation

Electromagnetic fields (EMF) originate from both natural and man-made sources. Natural sources include the earth's magnetic field and various biochemical, physiological, and neurological processes within organisms. Electromagnetic fields consists of both electric (E) and magnetic (B) field components with a second, weak induced electric (iE) component to the latter, created by the flow of seawater or movement of organisms. The strength of the two main fields (E and B) that would be generated by the proposed action depends on the magnitude and type of current flowing through the cable and the way the cable is constructed. Overall, strength of both the E and B fields in seawater, whether man made or naturally occurring, would diminish with distance from the source (Slater et al. 2010). Cable construction methods can shield and thus reduce or eliminate the E-field, but not B-field strength.

The proposed action would differ from the traditional type of anthropogenic EMF in the ocean—that generated by underwater power cables. Typically, a single EMF-generating cable lies on or under the seabed, but in this case, the power cable (umbilical cable) would be suspended by floats in the upper portion of the water column or on the surface eliminating the possibility of reducing EMF through burial. Further, EMF may be emitted by a WEC device or the Ocean Sentinel. Power transmitted via the power or umbilical cable should be low (about 30 kW for the WET-NZ deployment and no greater than 100 kW[19]), and the cable would be, at a minimum, single-shielded to reduce EMF generated.

2.4.2.1 EMF Effects on ESA-listed Fishes

Based on the information provided in Sections 2.2 and 2.3, the following life-stages and species are likely to be in the action area during these activities and therefore exposed to the stressor "EMF:" juvenile and adult LCR Chinook, UWR Chinook, UCR spring-run Chinook, SR spring/summer run Chinook, SR fall-run Chinook, CC Chinook, SAC winter-run Chinook, and CV spring-run Chinook salmon; LCR coho, OC coho, SONCC coho, and CCC coho salmon; adult eulachon, and adult and sub-adult green sturgeon.

Gill et al. (2005) assert that the current understanding of potential impacts to marine species from anthropogenic EMFs is limited. Normandeau et al. (2011) note that although anticipated EMF from power cables can be readily modeled and it is understood that many species exhibit sensitivity to EMF, few studies have examined responses of marine species to EMF from undersea power cables. Short of site-specific studies, which are not available for the action area, any conclusions about responses and effects are are based on a limited amount of information, and are somewhat speculative.

Marine animals that can detect B fields are presumed to do so through either iE field detection or through magnetite based detection.[20] Although data are limited, studies have shown that organisms as diverse as Atlantic salmon, cod, plaice, eels, lampreys, sea trout, yellowfin tuna, lobster, crab, shrimp, prawns, snails, bivalves, and squid are able to detect B fields (Gill et al., 2005). Yano et al. (1997) investigated the effects of artificial B fields on oceanic migrating chum salmon (*Oncorhynchus keta*). In this study, chum salmon were fitted with a tag that generated an artificial B field around the head of the fish. There was no observable effect on the horizontal and vertical movements of the salmon when the tag's magnetic field was altered. Quinn and Brannon (1982) conclude that while salmon can apparently detect B fields, their behavior is likely governed by multiple stimuli. Similar results were found in studies conducted on the Atlantic salmon (*Salmo salar*). Summarizing research results, Scottish Executive (2007) concluded that the navigation and migration of Atlantic salmon was not expected to be impacted by the magnetic field produced by an underwater cable.

Sturgeon use electroreceptive organs to locate prey. While no research has been conducted on sturgeon species found on the Pacific coast, research has been conducted in Europe. The behavior of the sterlet (*Acipenser ruthenus*) and Russian sturgeons (*A. gueldenstaedtii*) varies in the presence of different E-field frequencies and intensities ranging from searching for the source and active foraging to avoidance of the source (Basov 1999). However, Basov did not provide

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[19] The Ocean sentinel design is limited to a maximum 100 kW capacity.

[20] In the magnetite-based sensory model, magnetic fields are transduced by small magnetic crystals (magnetite) in special receptors on an animal's head (Normandeau et al. 2011).

information that would allow a comparison of his experimental conditions to the type of EMF likely to occur as a result of the proposed action.

Although no research is available on the potential effect of EMF on eulachon or their response, Normandeau et al. (2011) notes that it is possible that EMF may affect eulachon similarly to salmonids as they are thought to use magnetic fields to navigate during migration.

Risk of Negative Effects
As described above, although there is no evidence to indicate that EMF affects salmonids, eulachon or green sturgeon either positively or negatively, there are gaps in knowledge regarding the sources and effects of EMF in the marine environment. Normandeau et. al. (2011) state that more work is needed to understand nature and magnitude of effects on marine fishes. To address the uncertainty about the effects of EMF that is likely to be generated by the proposed action on marine fishes, NNMREC willconduct monitoring using a state-of the art instrument capable of detecting EMF signals smaller than on ten-millionth the magnitude of the earth's magnetic field. These instruments will be used to measure electric and magnetic fields on the seafloor within and adjacent to the test site during periods when the Ocean Sentinel and WEC are installed and energized and to characterize background, baseline EMF levels, during periods when the devices have been removed.

As detailed in the NAMF and WAMP, results of EMF monitoring will be provided to the AMC as soon as they are available[21]. If monitoring results indicate that EMF attributable to the project components is in excess of levels known to have an adverse impact on marine life, adaptive management and mitigation measures addressing EMF effects, as detailed in the NAMF and WAMP, would be carried out by NNMREC. All recommended adaptive management and mitigation actions are subject to review and approval by NMFS to ensure compliance with ESA, MSA, MMPA and other relevant federal statutes.

These measures do not alter the existing uncertainty regarding potential effects of EMF generated by the WET-NZ test or other future tests during the 10-year operation of the test center, but attempt to address the uncertainty. However, as described above ,actual power generation levels are expected to be low, all cables carrying current would be shielded, and the footprint of WEC device tests will very small (0.085km^2) due to the 100 kW capacity of the Ocean Sentinel. Therefore, the likelihood that any ESA-listed marines fishes would be injured or killed by EMF caused by the proposed action is small. Even if a few individual fish are affected, EMF is not likely to affect the numbers, reproduction, or distribution of ESA-listed salmon, green sturgeon, or eulachon at the population level.

2.4.2.2 EMF Effects on ESA-listed Marine Mammals

As described above, it is unknown how the WET-NZ device, Ocean Sentinel, the TRIAXYS™ wave measurement buoy, future WEC devices tested, or associated monitoring equipment will affect the EMF in the action area. Actual power generation levels are, however, expected by DOE and the Corps to be low (not exceeding a 30 kW generating capacity for the WET-NZ test

[21] Analysis of the complex EMF data from the proposed monitoring could take up to 90 days.

and not exceeding the 100 kW capacity of the Ocean Sentinel). Marine mammals are not known to be adversely affected by B-fields (which cannot be shielded). Although NNMREC anticipates that its layer of shielding would reduce the EMF generated by the WEC devices, Ocean Sentinel and cables, there are no field data on the effectiveness of this type of shielding in reducing the EMF propagation in seawater. NNMREC will address these uncertainties about effects on marine mammals through monitoring of the WET-NZ, future WEC device tests, and the ocean sentinel and TRIAXYS™ buoys (Appendix A). If adverse effects are observed at any time, the NAMF and WAMP require consultation with NMFS to determine appropriate steps through adaptive management/mitigation to either further evaluate or mitigate for the effects of the EMF on marine mammals in the action area. Adaptive management/mitigation actions may include modified or additional monitoring techniques, additional literature review to assess the sensitivity of species, and perform effects analysis for future tests. Based on the low amplitude and short range of EMF fields generated by the devices, the likelihood that individual marine mammals would be injured or killed by EMF caused by the proposed action is low. Any effects that are observed will not affect the numbers, reproduction, or distribution of Southern Residents, Steller sea lions, or humpback whales on a population level.

2.4.3 Habitat Alteration—Chemical Contamination

Installation, Maintenance, and Monitoring Activities

A number of vessels, including tugs, barges, cranes, and workboats, would be employed during installation, operation, maintenance, and monitoring. Each of these vessels contains fuel, hydraulic fluid, and potentially other hazardous materials. There is the potential for spills of such materials while vessels are in use, which could reduce water quality in the action area.

Project Operations

The WET-NZ device contains less than 25 gallons of hydraulic fluid and the Ocean Sentinel will carry up to a total of 240 gallons of biodiesel in three separate baffled tanks, motor oil in the diesel generator and a glycol-based coolant in the diesel generator and power converter heat exchangers. The TRIAXYS™ buoy as detailed in the BA (ICF 2012) does not contain any hazardous fluids. WECs, which may be deployed in future tests, are likely to contain some amount of hydraulic fluids, depending on their individual designs. Any of these could leak into the water column if the hull of the WEC or Ocean Sentinel was compromised or by other catastrophic device failure. To reduce the possibility of such an accident, all devices containing such fluids would be monitored by NNMREC via wireless communication links to detect any leaks and inspected during each maintenance visit to the site.

The Ocean Sentinel will use only tributyltin (TBT)-free and copper-free antifouling paints and coatings, and NNMREC will require that all WEC devices to be tested as part of the proposed action use only TBT-free antifouling paints and coatings. However, the wetted surface of the WET-NZ device and future WEC devices tested in the test site would be treated with a copper-based antifouling coating, albeit TBT-free, which would leach copper into the surrounding seawater. It is likely that the rate of leaching would be high within the first two months and then slower for another seven months, at which time a steady state would be reached (Valkirs et. al 2003).

Information on PowerBuoys can be used to help understand the effects of anti-fouling paint because both use antifouling coatings containing copper. The proposed WET-NZ device is a one-half scale model and is significantly smaller than a single PowerBuoy[22]. Antifouling paint used on the PowerBuoys contains copper, which would to leach into the surrounding seawater, similar to the WET-NZ device. A total of 10 PowerBuoys will be deployed for the Reedsport OPT Wave Park (OPT) and were considered in the 401 Water Quality Certification for the Reedsport OPT Wave Park,[23] where the (ODEQ 2011) calculated the concentrations of copper expected to occur within the Reedsport action area as 0.02 μg/L/day and 0.08 μg/L/4 days. This level is well below the 2.9 μg/L levels established for buildup of toxic material that affects aquatic life or human uses and also below the levels considered lethal to juvenile and adult salmonids (range: 21 μg/L over 60 days to 57 μg/L over 72 hours; (Hecht et al 2007). Further, copper ions bind with dissolved organic material in seawater, decreasing its bioavailability and partially protecting organisms against copper's neurotoxicity (Hecht et al.2007, City of San Jose 2005).

2.4.3.1 Chemical Contamination Effects on ESA-Listed Fishes

Based on the information provided in Sections 2.2 and 2.3, the following life-stages and species are likely to be in the action area and therefore exposed to the stressor "chemical contamination:" juvenile and adult LCR Chinook, UWR Chinook, UCR spring-run Chinook, SR spring/summer run Chinook, SR fall-run Chinook, CC Chinook, SAC winter-run Chinook, CV spring-run Chinook, LCR coho, OC coho, SONCC coho, and CCC coho, adult eulachon, and adult and sub-adult southern green sturgeon.

Petroleum based contaminants, such as fuel, oil, and some hydraulic fluids, contain polycyclic aromatic hydrocarbons, which can kill salmon 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). 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). No toxicity data are available for eulachon or green sturgeon.

Risk of Negative Effects

To reduce the risk of exposure to hydraulic fluid leaks and to ensure a quick clean-up response should this occur, the WET-NZ test includes a Spill Contingency and Emergency Response Plan

[22] WET-NZ device has a draft of 15m and displacement volume of 50 metric tons. A single powerbuoy has a draft of 35m and a displacement volume of 272 metric tons. The wetted surface area is not readily available for these devices.

[23] The Reedsport OPT Wave Park is located less than 75 miles south of the test site, is a matrix of 10 WEC devices and associated moorings coated with antifouling paints that are expected to leach copper into the surrounding environment.

(PEV 2012). Further, future proposed WEC tests would develop either a Spill Prevention Control and Countermeasure Plan in accordance with EPA requirements or a Spill Contingency and Emergency Response Plan if a spill prevention, control and countermeasures (SPCC) plan is not required under EPA regulations. These plans would require best construction practices and proper equipment maintenance. The proposed action includes conservation measures to remotely monitor the deployed project components and response plans to facilitate removal of a leaking device in a timely manner. These mechanisms greatly reduce the likelihood that a spill large enough to negatively affect more than a few individual fish, or to affect habitat function, would occur.

In summary, based on the spill prevention and control measures, clean-up response plan, and anticipated low copper concentrations due to leaching from antifouling coatings, it is unlikely that contaminant concentrations would reach levels in the action area where individual listed fishes would experience lethal or sub-lethal adverse effects. Therefore, the likelihood that chemical contamination from spills and antifouling coatings caused by the proposed action would reduce the numbers, distribution, or reproduction of ESA-listed salmonids, eulachon or green sturgeon at the population level is very small.

2.4.3.2 Chemical Contamination Effects on ESA-listed Marine Mammals

Contaminant levels of prey resources used by marine mammals are likely to be minimally affected by the project, as described for ESA-listed fish above. Thus, NMFS anticipates that any accumulation of contaminants in ESA-listed marine mammals from exposed prey resources will be insignificant. There is a potential for the project to affect water quality if hydraulic fluid contained within a WEC device or biodiesel in the Ocean Sentinel tanks leaks, which could result in direct exposure of marine mammals in the vicinity. However, the WET-NZ test has emergency response and spill prevention plans in place to minimize direct exposure, and before testing any future WEC device, the developer will submit to NNMREC for review and approval a spill contingency and emergency response plan, which would contain measures intended to ensure a rapid response and recovery that minimizes potential environmental harm. Because provisions would be in place to ensure that leaks are prevented or addressed in a timely manner, any exposure of marine mammals to the hydraulic fluid or diesel fuel should be insignificant.

2.4.4 Habitat alteration—Suspended Sediment

The proposed action for the WET-NZ test includes the placement of seven anchors on or in the seabed. Future WEC device tests will likely have similar anchoring schemes over the 10-year operation of the test center. All future WEC device tests would be required to obtain a Corps Clean Water Act authorization for the placement of “fill” (moorings). Installation and removal of anchors and mooring system would temporarily displace the sandy substrate in the immediate area of each anchor, but because the sediment is sand (i.e., not finer grained material); much of the suspended sediment should quickly settle into, or near, the disturbed area. Any remaining material would be dispersed by currents, which are strong in the action area, creating a thin layer of sediment beyond the immediate vicinity each anchor.

2.4.4.1 Suspended Sediment Effects on ESA-Listed Fishes

Based on the information provided in Sections 2.2 and 2.3, the following life-stages and species are likely to be in the action area during these activities and therefore exposed to the stressor "suspended sediment:" juvenile and adult LCR Chinook, UWR Chinook, UCR spring-run Chinook, SR spring/summer run Chinook, SR fall-run Chinook, CC Chinook, SAC winter-run Chinook, CV spring-run Chinook, LCR coho, OC coho, SONCC coho, and CCC coho, adult eulachon, and adult and sub-adult southern green sturgeon.

Small numbers of the non-motile or slow moving infaunal or epi-benthic organisms eaten by listed fishes would be injured or killed (by impact or suffocation) during installation of the anchors in the seabed. However, effects of increased suspended sediments on prey resources would be minor and temporary.

Salmonids and eulachon typically occupy the upper levels of the water column and would be likely to encounter only dispersed levels of suspended sediments released during anchor installation. Green sturgeon, which feed on the bottom, would be more likely to encounter suspended sediments before it begins to disperse, but it is unlikely that green sturgeon would be present just when the anchors are installed. Therefore, the likelihood that any ESA-listed marines fishes would be injured or killed by impact or increases in suspended sediment caused by the proposed action is very small because the chances of listed fish being near the anchor location are remote. Increases in suspended sediment by the proposed action is therefore not going to affect the numbers, reproduction, or distribution of ESA-listed salmon, green sturgeon, or eulachon at the population level.

2.4.5 Habitat Alteration—Physical Structures

The installation of project features would alter habitat in the action area by creating structure and hard surfaces in the water column and on the bottom. These factors would be likely to alter hydraulics around the anchors, changing the distribution of sediment grain sizes due to scour/erosion and/or deposition (removal of energy from the water column). These changes, which would be in place over the 10-year operation of the test center, are likely to affect the composition of ecological communities within the test site.

Henkel (2011), summarizing available research, reports that the effects of the reduction in wave energy or scour around anchors may go beyond the spatial extent of an installation. Sand adjacent to an artificial reef installed in La Jolla, California, at 13 m water depth was scoured to a depth of 20 to 40 cm as far as 15 m from the reef (Davis et al. 1982). Grain size analysis of sediment collected along a transect from Oil Platform "Eva" off Huntington Beach, California, in 18 m water depth indicated coarse sand to 20 m from the platform with very fine sand beyond (Wolfson et al. 1979). These grain size changes are very important to the benthic biological community in these zones as depth and median grain size are the major drivers of species distribution patterns, and Wolfson et al. (1979) observed changes in epifaunal and infaunal invertebrates with distance from the platform. Studies of offshore platforms in the Mediterranean similarly observed that benthic infaunal assemblages varied with distance from the platform and that the spatial extents of these differences varied with depth of the platform (30 m versus 90 m; see Terlizzi et al. 2008) and over time (Manoukian 2010). In terms of the energy removal, it is not yet known what the spatial extent of the energy removal will be; that is, how far the energy removal 'shadow' will extend. Baseline characterization of benthic habitat at the proposed test site showed that distinct infaunal invertebrate assemblages were found in the silty sand (30m) that were different from the deeper (40-50 m) sand-dominated stations (Henkel 2011).

Pinnipeds would likely be attracted to the project structures as in-water structures can act as fish aggregation devices, and thus, constitute a potential foraging area. However, the short duration of the proposed deployments would limit this potential. The Ocean Sentinel is not likely to serve as a pinniped haul-out due to its small size and spherical shape. Use of the WET-NZ device and other future WEC devices tested as a haul-out is unlikely, again in view of its small size above water. Passive deterrents would be added to the device if necessary to prevent use as haul-out, as detailed in the NAMF and WAMP. Project features would also create a matrix of cables, buoys, floats, and other lines associated with the WEC devices, Ocean Sentinel and TRIAYXS wave measurement buoys as described in Section 1.3. This matrix and derelict gear which may become snared by project features pose an entanglement risk for marine mammals.

2.4.5.1 Physical Structures Effects on ESA-listed Fishes

Based on the information provided in Sections 2.2 and 2.3, the following life-stages and species are likely to be in the action area during these activities and therefore exposed to the stressor "physical structures:" juvenile and adult LCR Chinook, UWR Chinook, UCR spring-run Chinook, SR spring/summer run Chinook, SR fall-run Chinook, CC Chinook, SAC winter-run Chinook, CV spring-run Chinook, LCR coho, OC coho, SONCC coho, and CCC coho, adult eulachon, and adult and sub-adult southern green sturgeon.

There are competing hypotheses and a great deal of uncertainty about the likely effects of anthropogenic structures in the water column on ESA-listed species and benthic habitat, such as those in the proposed action. Changes in benthic habitat that result in changes to the availability of prey or change in the prey type may result in a change in forage opportunities for salmonids, eulachon and green sturgeon. The changes in habitat from anchor installation and the resulting loss of forage opportunities would likely result in reduced use of the test site by ESA-listed marine fishes. For example, the buoys, cables, and anchors could act as fish aggregation devices (FAD). The features created by the proposed action, particularly the anchors and cables, could also provide habitat for a variety of plants and invertebrates including algae, barnacles, mussels, bryozoans, corals, tunicates, and tube dwelling worms and crustaceans (Boehlert et al., 2008), some of which are eaten by or are part of the food webs for salmon, green sturgeon, and eulachon, potentially increasing forage opportunties. If the structures do act as an FAD, they could also attract fish-eating birds and pinnipeds which could increase predation on salmonids, eulachon and green sturgeon. However, because the total footprint of the structures would be small (about 0.085 km^2) the individual structures would be dispersed (about 50 to 100 meters between each device), and the duration of the deployments is limited, the array might not add enough habitat complexity to support aggregations of the listed fish or cause changes to habitat that would limit prey availability. Further, the buoys would be moving up and down, creating noise (and potentially, EMF), which fish might perceive as a disturbance and thus avoid the test site.

Risk of Negative Effects
Changes to the substrate in the test site from the introduction of physical structures in the water column may result in changes to the benthic communities and forage opportunities for ESA-listed marine fishes. Although the magnitude of the effect is uncertain the size of the structure created by the deployment of the WET-NZ test components and relatively small size of the test site when compared to the availability of similar nearshore habitat along the Oregon coast indicate that the regardless of the direction (increase or decrease), any effect would be very small. Changes in foraging habitat or opportunities could adversely affect ESA-listed marine fishes. To address the uncertainties, NNMREC has conducted baseline benthic habitat monitoring and proposes to continue Benthic Monitoring Studies as described in the monitoring plans (Appendix A). The benthic habitat monitoring would (1) determine how benthic organisms respond to WEC-induced changes to the habitat; (2) investigate whether the introduction of these kinds of hard surfaces encourages colonization by marine invertebrates and attracts fish and whether fishes that may be attracted to the structures affect those considered "resident;" and (3) monitor for derelict gear which may become entangled on project structures and pose an entanglement risk for marine species[24].

As detailed in the NAMF and WAMP, results of benthic monitoring will provided to the AMC annually. If monitoring results indicate that the effects of the proposed action have met a benthic habitat management or mitigation threshold, adaptive management and mitigation measures addressing the effect(s), as detailed in the NAMF and WAMP, will be carried out by NNMREC. All recommended adaptive management and mitigation actions are subject to review and approval by NMFS to ensure compliance with ESA, MSA, MMPA and other relevant federal statutes.

Therefore, as a result of the proposed monitoring and the use of the adaptive management framework and adaptive mitigation plan to address any identified changes to benthic habitat that meet the thresholds identified (Section 1.3.6.6), the likelihood that any ESA-listed marine fishes would be injured or killed by the habitat alteration from physical structures in the water column is very small. Habitat alteration from physical structures in the water column resulting from the proposed action is therefore not likely to affect the numbers, reproduction, or distribution of ESA-listed salmon, green sturgeon, or eulachon at the population level.

2.4.5.2 Effects on Marine Mammals

Entanglement and Collision
The deployment of the WET-NZ device, Ocean Sentinel and TRIAXYS™ buoy with individual mooring systems places anthropogenic objects in the open ocean 2 miles offshore of Newport, OR, in waters about 150 feet deep. Collectively, the project components would have a footprint of about 0.085km^2, about 2% of the test site. Over the course of the 10-year project, additional tests would be conducted with up to two WEC devices, the Ocean Sentinel, TRIAXYS™ buoy, and other monitoring devices, which may occupy about 5% of the test site. The configuration

[24] Effects on ESA-listed species from the proposed Benthic Monitoring Studies are not analyzed in this opinion; as in prior years, NMFS will continue to analyze and permit take applications for these programs under an ESA Section 10 research permit or the State of Oregon's 4(d) limit for research.

and anchoring and mooring systems for future tests would go through authorization by the Corps and associated section 7 consultations under the ESA. The WET-NZ test and future WEC device tests will include structures that could cause a collision or entanglement hazard for whales that come in contact with it. Additionally, derelict fishing gear could potentially become caught on the devices or mooring lines, contributing to the entanglement risk. Baleen whales, including humpback whales, would be at risk of entanglement in the mouth or baleen if engaged in feeding near the system.

Design features of the system are likely to reduce the risk of entanglement or injury. Loops are not likely to form in the lines of the mooring system, because of the large diameter (four to five-inch) of the synthetic lines and tension on the system (ICF 2012). Positive buoyancy components of the anchoring system create tension on the lines such that pressure exerted against the lines would cause the system to bounce back in the opposite direction of pressure exerted while maintaining tension (OSU 2012). Force exerted on the system, including the force of a potential whale encounter, would therefore be unlikely to result in the formation of entangling loops or slack lines.

For the WET-NZ test, NNMREC will use underwater cameras to look for and note any derelict fishing gear caught on the test structures or mooring lines via cameras as described in the WAMP. If derelict gear is observed and could entangle organisms, NMFS will be notified, the gear will be removed as soon as feasible, and the project or monitoring plan will be modified to prevent further risk, if necessary. If monitoring shows marine mammals entangled in fishing gear or marine debris, NNMREC will report the incident as soon as practical and remove the gear consistent with the Reporting Protocol for Injured or Stranded Marine Mammals described in the WAMP. The project or monitoring plan will be modified if necessary to prevent or reduce entanglement risk.

Additionally, observations of marine mammals will be recorded during vessel based monitoring and maintenance activities to gather information on presence and behavior of whales and other marine mammals in the vicinity and any interactions with and responses to the proposed action. Marine mammal observations and derelict gear information will also be evaluated as part of the Adaptive Management Framework to inform and potentially modify future tests and specific adaptive mitigation plans for those tests.

Creation of Haulout Habitat

Steller sea lions may use WEC devices or monitoring platforms as haulouts. For the WET-NZ test, NNMREC will monitor project structures for hauled out pinnipeds and will conduct monitoring and maintenance activities at least 100 yards from hauled out pinnipeds to avoid harassment. NNMREC may deter non-ESA listed pinnipeds (*i.e.*, California sea lions) in compliance with MMPA, Section 101(a)(4)(A) using non-lethal methods[25]. If NNMREC needs to perform emergency maintenance that requires immediate attention (e.g. closing an opened hatch, repairing a failed mooring or electrical fault) and deterrence of a listed species is necessary for its protection or welfare, the protection of the public health and welfare, or as the nonlethal removal of nuisance animals, NNMREC staff will request assistance from a Federal or

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[25] http://www.nwr.noaa.gov/marine-mammals/seals-and-sea-lions/deterring-pinnipeds.cfm

state government official (e.g. a representative from the ODFW in accordance with section 109(h) of the MMPA as detailed in the NAMF and WAMP.

For future WEC device tests, specific adaptive mitigation plans will be developed to deter or address hauled out pinnipeds as appropriate. As identified in the NAMF and WAMP, if annual reports indicate pinnipeds are hauling out on project structures NNMREC may, in consultation with the NMFS, modify the project to reduce haul out activity (i.e., install fencing) or apply for an Incidental Harassment Authorization under the MMPA if needed for deterrence or removal of hauled-out pinnipeds.

2.4.6 Vessel Encounters

Vessels and gear associated with installation of the WECs, Ocean Sentinel and TRIAXYS™ structures, as well as vessels used for monitoring, maintenance, and project-related studies, including tug/barge, small vessels, and research ships, would cause short-term increases in marine traffic in the vicinity of the action area. Vessels would be slow moving or idle in the action area. The vessels are of size and type commonly in use in the action area. As noted in the environmental baseline the action area is already used by recreational and commercial vessels for transport, fishing, whale watching and other vessel activities.

2.4.6.1 Vessel Encounter Effects on Marine Mammals

Vessels in the action area may pose a strike risk to marine mammals however, vessels engaged in carrying out the proposed action would be slow moving or anchored, would not target whales, and should be easily detected by whales. Further, the PME includes a requirement that all vessels engaged in activities to support the proposed action will comply with NMFS marine mammal viewing guidelines. Thus, vessel strikes are so unlikely as to be discountable. Potential non-strike encounters will be sporadic with transitory behavioral effects and therefore would be insignificant.

2.4.7 Effects of the proposed action on Critical Habitat

NMFS has designated critical habitat within the action area for Southern DPS green sturgeon and leatherback sea turtles. Effects of the critical habitat for leatherback sea turtles is discussed in Section 2.11 Not Likely to Adversely Affect Conclusions.

2.4.7.1 Effects of the proposed action on Critical Habitat for Southern DPS Green Sturgeon

NMFS has designated critical habitat in the action area for southern DPS green sturgeon (within the 110-meter depth contour of coastal waters). The physical and biological features of critical habitat required to support successful subadult and adult migration and the maturation of subadults to the adult life stage include water quality, food resources, and safe passage, all of which would be affected by the proposed action. The impacts are described below.

1. **Water Quality.** Suspended sediment levels would temporarily increase over background when sand and some fine sediment were disturbed during installation and removal of

anchors. Suspended sediments would increase for a short time, with the highest concentrations occurring in the immediate vicinity of each anchor, and then rapidly disperse with local ocean currents. Copper leachate from antifouling coatings is not expected to result in copper concentrations, which would exceed thresholds for aquatic species in the action area. NNMREC, WET-NZ and its contractors would be required to provide and implement either an approved Spill Prevention, Control, and Countermeasure plans or a Spill Contingency and Emergency Response plan, a process designed to significantly reduce the likelihood of a spill and chemical contamination in the action area. The plans would include actions to ensure that any spills that do occur are quickly contained. Therefore, due to the short duration of exposure to suspended sediment levels, the reduced risk of chemical contamination, and the pre-planning for rapid detection and cleanup of any spills that do occur, the proposed action is not likely to negatively affect the function of water quality in areas used by sturgeon for migration or maturation within the action area.

2. **Food Resources.** Food resources for green sturgeon are likely to be altered within the 3.4 km^2 test site over the 10-year operation of the test center as the installation and removal of anchors creates local erosional and depositional fields in an otherwise uniform sandy seabed. Green sturgeon appear to be opportunistic predators, feeding on various motile invertebrates such as sand shrimp and fishes such as lingcod (Dumbauld et al. 2008), herring (Erickson and Hightower 2007), and sand lance and anchovies (Moyle 2002). Because impacts to forage base would be highly localized and short term, the potential for net decrease in the abundance of prey is likely to be insignificant compared to the total food resources available to green sturgeon in the action area. Thus, the function of food resources in designated critical habitat used for migration and maturation would not be negatively affected.

3. **Safe Passage.** Adult and subadult green sturgeon from the Southern DPS are likely to occupy or pass through the action area during offshore movements or while migrating from their natal river in central California to estuaries in Oregon and Washington. Southern DPS green sturgeon are thought to use the Yaquina River estuary, which is near the action area for this consultation. Green sturgeon typically occupy depths between 20m and 70m in the water column within the 100m depth contour of coastal waters. Individual green sturgeon could be attracted to or avoid the action area due to EMF generated by the proposed action, but we consider this unlikely because: (1) the proposed project footprint which would generate and propagate EMF is small (an estimated maximum of about 5% of the 3.4 km^2 test site), and (2) EMF generated by the project would be near the surface, suspended by surface floats, and thus unlikely to affect the entire 55m depth water column in the area. Further, the proposed spacing between the anchors on the sea floor is a minimum of about 150 feet. This dispersed pattern would not create a continuous physical barrier to passage. Based on the above considerations, the function of safe passage in designated critical habitat is not likely to be negatively affected by the proposed action.

In summary, three essential functions of designated critical habitat will be affected, but will not be negatively changed by the proposed action. Any effects that do occur will be over a small area and short term.

2.5 Cumulative Effects

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

Within the action area, some state, tribal, and local government actions contribute to negative cumulative effects. Those that are currently ongoing or occurred frequently in the recent past can also be considered reasonably certain to occur in the future, especially if authorizations or permits have not yet expired. Climate change is likely to continue to affect the coastal marine environment as noted in the baseline. Private activities are likely to include continuing boating, floating navigational and fishing devices, derelict gear, fishing, sonar, contaminant leaks and disposal, and submarines, as described in the baseline. Although these factors are ongoing and likely to continue in the future, past occurrence is not a guarantee of a continuing at the same level of activity. The negative effects depend on whether there are economic, administrative, and legal impediments (or in the case of contaminants, safeguards). Therefore, the cumulative effects of these activities will be commensurate to those of similar past activities analyzed in the baseline.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to listed species and critical habitat as a result of implementing the proposed action. In this section, we will consider the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 2.2), and determine whether the proposed action is likely to jeopardize the continued existence of the listed species, or result in the destruction or adverse modification of critical habitat.

2.6.1 Salmonids

Individuals from the LCR Chinook, UWR Chinook, UCR spring-run Chinook, SR spring/summer Chinook, SR fall Chinook, CC Chinook, SAC winter-run Chinook and CV spring-run Chinook salmon and the LCR coho, OC coho, SONCC coho and CCC coho salmon ESUs are likely to pass through the action area and some individuals from these ESUs are likely to be exposed to project effects (anthropogenic noise, EMF, short-term sediment plumes, benthic and pelagic habitat alterations, and potential chemical contamination). However, as described in this opinion, the best available scientific and commercial information indicates that very few ESA-listed Chinook or coho salmon are likely to be injured or killed through these exposure/response pathways because so few individuals will be exposed, and the effects on them should be minimal.

Uncertainties about exposure pathways and salmonid responses will be resolved through the proposed studies, which are designed to identify and evaluate project effects. The results of these studies, and any other new relevant information on effects of ocean energy facilities from other sources, will be reviewed by the AMC annually. Potential adaptive management and mitigation actions as detailed in the NAMF and the WAMP include short- and long-term design changes, operational changes, structural changes, changes in maintenance or other management, changes in monitoring or studies, new monitoring or studies, temporary suspension of tests or operations, or removal of one or more structures or other appropriate forms of mitigation. All mitigation and management actions are subject to NMFS' review and approval as described in the NAMF and the WAMP. Further, NMFS may seek different or additional measures pursuant to statutory or regulatory authorities.

Over the 10-year lifetime of test center operations funded by DOE, the Corps is likely to receive requests for permits to test a number of WEC devices. Due to the uncertain nature of any future installations, we are able to consider only their general effects on listed marine organisms in this opinion. In each case, NNMREC and the WEC developer interested in testing at the site would apply to the Corps and other agencies for permits to moor, deploy, and test at the test site, and thus the specific effects of each test would be considered by NMFS in future Section 7 consultations.

All future deployments of the Ocean Sentinel, TRIAXYS™ wave monitoring buoy and other equipment not associated with the WET-NZ test would be required to obtain the necessary permits and authorizations (e.g. Corps Nationwide permit and any other applicable state and Federal authorizations). Effects of deployment of the Ocean Sentinel, TRIAXYS™ wave monitoring buoy and other equipment beyond the scope of the WET-NZ test are not considered in this opinion.

In the following sections, we first look at effects on the most vulnerable species, the endangered UCR spring-run and SAC winter-run Chinook ESUs. We then evaluate effects on the threatened OC coho salmon ESU, which is of special concern to NMFS because the species' Yaquina River population (in the Mid-Coast stratum) is located near the action area, and then evaluate the remaining species of Chinook and coho that are likely to be in the action area during WEC testing. Effects on critical habitat are not discussed for any Chinook or coho ESU because NMFS has not designated critical habitat for these species in the action area.

2.6.1.1 Upper Columbia River (UCR) Spring-run Chinook Salmon

Individuals from this ESU are affected by manmade and natural factors including altered flow regimes, upstream and downstream passage barriers, degraded water quality, and degraded freshwater and estuarine habitat function (Species Status - Section 2.2.1). Once juveniles reach the marine environment, they are also affected by natural predators and adults are taken incidental to commercial and recreational fisheries (Environmental Baseline – Section 2.3). Although future effects of climate change are uncertain, ocean conditions adverse to salmon and steelhead could be more likely under a warming climate, as would changes in stream flows (Section 2.2.3).

Effects of the existence and operation of the proposed action (including installation, operation, maintenance, monitoring, and removal of the WET-NZ plus future tests of other devices in the action area) include sound, electromagnetic field generation, short-term suspended sediment plumes, benthic and pelagic habitat alterations, and chemical contamination. Based on the best available scientific and commercial information (provided in the references section), the degree of exposure and response to these effects are uncertain but most likely very small due to the limited size of the test site and the intermittent nature of the WEC test deployments. The proposed action includes study plans and an adaptive management framework to identify negative effects, for which NNMREC, WET-NZ and future WEC developers would take appropriate action to avoid, minimize, and mitigate. These measures would ensure that injury or mortality is limited to no more than a few juveniles or adults per year across eight Chinook salmon ESUs, including endangered UCR Spring-run Chinook salmon. This very slight degree of impact is not likely to affect abundance or productivity at the population, MPG, or ESU level even though this ESU is at moderate to high risk of extinction. Further, although we assume otherwise for the purposes of this opinion, there is no evidence that fish from any of the three extant populations (from a single MPG) would be affected disproportionately (i.e., no pathway for risk to spatial structure) or that natural-origin fish would be more susceptible than those from a hatchery stock (a pathway for risk to diversity). Finally, there are no ongoing or future threats to UCR spring Chinook in the action area (i.e., in the environmental baseline which is in good condition or as cumulative effects which are minimal) that would be added to the very small impacts of the proposed action to reduce the viability of this species.

Therefore, after considering the rangewide status of species (endangered, Section 2.2.1), the environmental baseline (good condition Section, 2.3), cumulative effects (minimal, Section 2.5), and the expected effects of the proposed action (very slight, Section 2.4), NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of the UCR Spring-run Chinook salmon ESU.

2.6.1.2 Sacramento River winter-run Chinook Salmon

Individuals from this ESU are affected by manmade and natural factors including habitat degradation, water quality, loss of riparian and estuarine habitat, loss of access to upstream spawning habitat, impaired passage, and alteration of the natural hydrograph and the influence of hatchery fish (Species Status - Section 2.2.1). Once juveniles reach the marine environment, endangered SAC winter-run Chinook salmon are also affected by natural predators and adults are taken incidental to commercial and recreational fisheries (Environmental Baseline – Section 2.3). Although future effects of climate change are uncertain, ocean conditions adverse to salmon and steelhead could be more likely under a warming climate, as would changes in stream flows (Section 2.2.3).

Effects of the existence and operation of the proposed action (including installation, operation, maintenance, monitoring, and removal of the WET-NZ plus future tests of other devices in the action area) include sound, electromagnetic field generation, short-term suspended sediment plumes, benthic and pelagic habitat alterations, and chemical contamination. Based on the best available scientific and commercial information (provided in the references section), the degree of exposure and response to these effects are uncertain but most likely very small due to the limited size of the test site and the intermittent nature of the WEC test deployments. The proposed action includes study plans and an adaptive management framework to identify negative effects, for which NNMREC, WET-NZ and future WEC developers would take appropriate action to avoid, minimize, and mitigate. These measures would ensure that injury or mortality is limited to no more than a few juveniles or adults per year across eight Chinook salmon ESUs, including endangered SAC winter-run Chinook. This very slight degree of impact is not likely to affect abundance or productivity at the population, MPG, or ESU level even though this ESU is at very high risk of extinction. Further, there is only a single extant population (i.e., no pathway for risk to spatial structure) and although we assume otherwise for the purposes of this opinion, no evidence that natural-origin fish would be more susceptible than those from the hatchery-origin stock (a pathway for risk to diversity). Finally, there are no ongoing or future threats to SAC winter-run Chinook in the action area (i.e., in the environmental baseline or as cumulative effects) that would be added to the very small impacts of the proposed action to reduce the viability of this species.

Therefore, after considering the rangewide status of species (endangered, Section 2.2.1), the environmental baseline (good condition Section, 2.3), cumulative effects (minimal, Section 2.5), and the expected effects of the proposed action (very slight, Section 2.4), NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of the Sacramento River winter-run Chinook salmon ESU.

2.6.1.3 Oregon Coast (OC) Coho Salmon

Individuals from this ESU are affected by manmade and natural factors in the freshwater environment including habitat degradation, water quality, water quantity, and migration barriers (Species Status Section 2.2.1). Once juveniles reach the marine environment, Oregon coast coho salmon are also affected by natural predators and adults are taken incidental to recreational and commercial fisheries (Environmental Baseline – Section 2.3). Although future effects of climate change are uncertain, ocean conditions adverse to salmon and steelhead could be more likely under a warming climate, as would changes in stream flows (Section 2.2.3).

Effects of the existence and operation of the proposed action (including installation, operation, maintenance, monitoring, and removal of the WET-NZ plus future tests of other devices in the action area) include sound, electromagnetic field generation, short-term suspended sediment plumes, benthic and pelagic habitat alterations, and chemical contamination. Based on the best available scientific and commercial information (provided in the references section), the degree of exposure and response to these effects are uncertain but most likely very small due to the limited size of the test site and the intermittent nature of the WEC test deployments. If unanticipated significant risk does occur, the proposed action could affect the Yaquina River population in the Mid-Coast stratum more than others due to its vicinity to the action area. That is, juveniles from this population are more likely than others to be in or near the action area during early ocean residency as are adults returning to their natal rivers. The proposed action includes study plans and an adaptive management framework to identify negative effects, for which NNMREC, WET-NZ and future WEC developers would take appropriate action to avoid, minimize, and mitigate. These measures would ensure that injury or mortality is limited to no more than a few juveniles or adults per year across four coho ESUs, including threatened Oregon Coast coho salmon. This very slight degree of impact is not likely to affect abundance or productivity at the population, stratum, or ESU level even though this species is at moderate to high risk of extinction. Effects on spatial structure would be very small and there is no evidence that natural-origin fish would be more susceptible than those from a hatchery stock (a pathway for risk to diversity). Finally, there are no ongoing or future threats in the action area (i.e., in the environmental baseline or as cumulative effects) that would be added to the small effects of the proposed action to reduce the viability of this species.

Therefore, after considering the rangewide status of species (threatened, Section 2.2.1), the environmental baseline (good condition Section, 2.3), cumulative effects (minimal, Section 2.5), and the expected effects of the proposed action (very slight, Section 2.4), NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of the OC coho salmon ESU.

2.6.1.4 Lower Columbia River (LCR) Chinook Salmon

Individuals from this ESU are affected by manmade and natural factors in the freshwater environment including altered flow regimes, degraded water quality, degraded habitat and harvest (Species Status - Section 2.2.1). Once juveniles reach the marine environment, LCR Chinook salmon are also affected by natural predators and adults are taken incidental to commercial and recreational fisheries (Environmental Baseline – Section 2.3). Although future effects of climate change are uncertain, ocean conditions adverse to salmon and steelhead could be more likely under a warming climate, as would changes in stream flows (Section 2.2.3).

Effects of the existence and operation of the proposed action (including installation, operation, maintenance, monitoring, and removal of the WET-NZ plus future tests of other devices in the action area) include sound, electromagnetic field generation, short-term suspended sediment plumes, benthic and pelagic habitat alterations, and chemical contamination. Based on the best available scientific and commercial information (provided in the references section), the degree of exposure and response to these effects are uncertain but most likely very small due to the limited size of the test site and the intermittent nature of the WEC test deployments. The proposed action includes study plans and an adaptive management framework to identify negative effects, for which NNMREC, WET-NZ and future WEC developers would take appropriate action to avoid, minimize, and mitigate. These measures would ensure that injury or mortality is limited to no more than a few juveniles or adults per year across eight Chinook ESUs, including threatened LCR Chinook salmon. This very slight degree of impact is not likely to affect abundance or productivity at the population, MPG, or ESU level even though this ESU is at high risk of extinction. Further, although we assume otherwise for the purposes of this opinion, there is no evidence that fish from any of the extant populations (from three ecoregions or strata) would be affected disproportionately (i.e., no pathway for risk to spatial structure) or that natural-origin fish would be more susceptible than those from a hatchery stock (a pathway for risk to diversity). Finally, there are no ongoing or future threats to LCR Chinook in the action area (i.e., in the environmental baseline or as cumulative effects) that would be added to the very small impacts of the proposed action to reduce the viability of this species.

Therefore, after considering the rangewide status of species (threatened, Section 2.2.1), the environmental baseline (good condition, Section 2.3), cumulative effects (minimal, Section 2.5), and the expected effects of the proposed action (very slight, Section 2.4), NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of the LCR Chinook salmon ESU.

2.6.1.5 Upper Willamette River (UWR) Chinook Salmon

Individuals from this ESU are affected by manmade and natural factors in the freshwater environment including altered flow regimes, passage barriers, degraded water quality (including altered temperatures), degraded habitat, competition and predation from non-native species and out of basin salmonid introductions, and historical harvest rates (Species Status, Section 2.2.1). Once juveniles reach the marine environment, UWR Chinook salmon are also affected by natural predators and adults are taken incidental to recreational and commercial fisheries (Environmental Baseline – Section 2.3). Although future effects of climate change are uncertain, ocean conditions adverse to salmon and steelhead could be more likely under a warming climate, as would changes in stream flows (Section 2.2.3).

Effects of the existence and operation of the proposed action (including installation, operation, maintenance, monitoring, and removal of the WET-NZ plus future tests of other devices in the action area) include sound, electromagnetic field generation, short-term suspended sediment plumes, benthic and pelagic habitat alterations, and chemical contamination. Based on the best available scientific and commercial information (provided in the references section), the degree of exposure and response to these effects are uncertain but most likely very small due to the limited size of the test site and the intermittent nature of the WEC test deployments. The proposed action includes study plans and an adaptive management framework to identify negative effects, for which NNMREC, WET-NZ and future WEC developers would take appropriate action to avoid, minimize, and mitigate. These measures would ensure that injury or mortality is limited to no more than a few juveniles or adults per year across eight Chinook salmon ESUs, including threatened UWR Chinook salmon. This very slight degree of impact is not likely to affect abundance or productivity at the population, MPG, or ESU level even though this ESU is at very high risk of extinction. Further, although we assume otherwise for the purposes of this opinion, there is no evidence that fish from any of the extant populations (which are from a single stratum) would be affected disproportionately (i.e., no pathway for risk to spatial structure) or that natural-origin fish would be more susceptible than those from a hatchery stock (a pathway for risk to diversity) Finally, there are no ongoing or future threats to UWR Chinook in the action area (i.e., in the environmental baseline or as cumulative effects) that would be added to the very small impacts of the proposed action to reduce the viability of this species.

Therefore, after considering the rangewide status of species (threatened, Section 2.2.1), the environmental baseline (good condition Section, 2.3), cumulative effects (minimal, Section 2.5), and the expected effects of the proposed action (very slight, Section 2.4), NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of the UWR Chinook salmon ESU.

2.6.1.6 Snake River (SR) Spring/summer Chinook Salmon

Individuals from this ESU are affected by manmade and natural factors in the freshwater environment including altered flow regimes, degraded water quality, degraded habitat, increased predation and harvest (Species Status, Section 2.2.1). Once juveniles reach the marine environment, SR spring/summer Chinook salmon are also affected by natural predators and adults are taken incidental to commercial and recreational fisheries (Environmental Baseline – Section 2.3). Although future effects of climate change are uncertain, ocean conditions adverse to salmon and steelhead could be more likely under a warming climate, as would changes in stream flows (Section 2.2.3).

Effects of the existence and operation of the proposed action (including installation, operation, maintenance, monitoring, and removal of the WET-NZ plus future tests of other devices in the action area) include sound, electromagnetic field generation, short-term suspended sediment plumes, benthic and pelagic habitat alterations, and chemical contamination. Based on the best available scientific and commercial information (provided in the references section), the degree of exposure and response to these effects are uncertain but most likely very small due to the limited size of the test site and the intermittent nature of the WEC test deployments. The proposed action includes study plans and an adaptive management framework to identify negative effects, for which NNMREC, WET-NZ and future WEC developers would take appropriate action to avoid, minimize, and mitigate. These measures would ensure that injury or mortality is limited to no more than a few juveniles or adults per year across eight Chinook ESUs, including threatened SR spring/summer Chinook salmon. This very slight degree of impact is not likely to affect abundance or productivity at the population, MPG, or ESU level even though this ESU is at high risk of extinction. Further, although we assume otherwise for the purposes of this opinion, there is no evidence that fish from any of the extant populations (from five MPGs) would be affected disproportionately (i.e., no pathway for risk to spatial structure) or that natural-origin fish would be more susceptible than those from a hatchery stock (a pathway for risk to diversity). Finally, there are no ongoing or future threats to SR spring/summer-run Chinook in the action area (i.e., in the environmental baseline or as cumulative effects) that would be added to the very small impacts of the proposed action to reduce the viability of this species.

Therefore, after considering the rangewide status of species (threatened, Section 2.2.1), the environmental baseline (good condition Section, 2.3), cumulative effects (minimal, Section 2.5), and the expected effects of the proposed action (very slight, Section 2.4), NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of the SR Spring/summer-run Chinook salmon ESU.

2.6.1.7 Snake River (SR) Fall-run Chinook Salmon

Individuals from this ESU are affected by manmade and natural factors in the freshwater environment including altered flow regimes, passage barriers, degraded water quality, degraded freshwater and estuarine habitat, hatchery influences and harvest (Species Status, Section 2.2.1). Once juveniles reach the marine environment, SR fall-run Chinook salmon are also affected by natural predators and adults are taken in commercial and recreational fisheries (Environmental Baseline – Section 2.3). Although future effects of climate change are uncertain, ocean conditions adverse to salmon and steelhead could be more likely under a warming climate, as would changes in stream flows (Section 2.2.3).

Effects of the existence and operation of the proposed action (including installation, operation, maintenance, monitoring, and removal of the WET-NZ plus future tests of other devices in the action area) include sound, electromagnetic field generation, short-term suspended sediment plumes, benthic and pelagic habitat alterations, and chemical contamination. Based on the best available scientific and commercial information (provided in the references section), the degree of exposure and response to these effects are uncertain but most likely very small due to the limited size of the test site and the intermittent nature of the WEC test deployments. The proposed action includes study plans and an adaptive management framework to identify negative effects, for which NNMREC, WET-NZ and future WEC developers would take appropriate action to avoid, minimize, and mitigate. These measures would ensure that injury or mortality is limited to no more than a few juveniles or adults per year across eight Chinook ESUs, including threatened SR fall-run Chinook salmon. This very slight degree of impact is not likely to affect abundance or productivity at the population, MPG, or ESU level even though this ESU is at moderate risk of extinction. Further, there is only a single extant population (i.e., no pathway for risk to spatial structure) and although we assume otherwise for the purposes of this opinion, no evidence that natural-origin fish would be more susceptible than those from a hatchery stock (a pathway for risk to diversity). Finally, there are no ongoing or future threats to SR fall-run Chinook in the action area (i.e., in the environmental baseline or as cumulative effects) that would be added to the very small impacts of the proposed action to reduce the viability of this species.

Therefore, after considering the rangewide status of species (threatened, Section 2.2.1), the environmental baseline (good condition Section, 2.3), cumulative effects (minimal, Section 2.5), and the expected effects of the proposed action (very slight, Section 2.4), NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of the SR Fall-run Chinook salmon ESU.

2.6.1.8 California Coastal (CC) Chinook Salmon

Individuals from this ESU are affected by manmade and natural factors in the freshwater environment including destruction and modification of habitat, blocked access to habitat and recreational harvest (Species Status, Section 2.2.1). Once juveniles reach the marine environment, CC Chinook salmon are also affected by natural predators and adults are taken incidental to commercial and recreational fisheries (Environmental Baseline – Section 2.3). Although future effects of climate change are uncertain, ocean conditions adverse to salmon and steelhead could be more likely under a warming climate, as would changes in stream flows (Section 2.2.3).

Effects of the existence and operation of the proposed action (including installation, operation, maintenance, monitoring, and removal of the WET-NZ plus future tests of other devices in the action area) include sound, electromagnetic field generation, short-term suspended sediment plumes, benthic and pelagic habitat alterations, and chemical contamination. Based on the best available scientific and commercial information (provided in the references section), the degree of exposure and response to these effects are uncertain but most likely very small due to the limited size of the test site and the intermittent nature of the WEC test deployments. The proposed action includes study plans and an adaptive management framework to identify negative effects, for which NNMREC, WET-NZ and future WEC developers would take appropriate action to avoid, minimize, and mitigate. These measures would ensure that injury or mortality is limited to no more than a few juveniles or adults per year across eight Chinook ESUs, including threatened CC Chinook salmon. This very slight degree of impact is not likely to affect abundance or productivity at the population, MPG, or ESU level even though this ESU is at moderate to high risk of extinction. Further, although we assume otherwise for the purposes of this opinion, there is no evidence that fish from any of the extant populations (from four geographic strata) would be affected disproportionately (i.e., no pathway for risk to spatial structure) or that natural-origin fish would be more susceptible than those from a hatchery stock (a pathway for risk to diversity). Finally, there are no ongoing or future threats to CC Chinook in the action area (i.e., in the environmental baseline or as cumulative effects) that would be added to the very small effects of the proposed action to reduce the viability of this species.

Therefore, after considering the rangewide status of species (threatened, Section 2.2.1), the environmental baseline (good condition Section, 2.3), cumulative effects (minimal, Section 2.5), and the expected effects of the proposed action (very slight, Section 2.4), NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of the CC Chinook salmon ESU.

2.6.1.9 Central Valley (CV) Spring-run Chinook Salmon

Individuals from this ESU are affected by manmade and natural factors in the freshwater environment including hatchery production, climate change, elevated water temperatures, predation, and water diversions (Species Status, Section 2.2.1). Once juveniles reach the marine environment, CV spring-run Chinook salmon are also affected by natural predators and adults are taken incidental to commercial and recreational fisheries (Environmental Baseline – Section 2.3). Although future effects of climate change are uncertain, ocean conditions adverse to salmon and steelhead could be more likely under a warming climate, as would changes in stream flows (Section 2.2.3).

Effects of the existence and operation of the proposed action (including installation, operation, maintenance, monitoring, and removal of the WET-NZ plus future tests of other devices in the action area) include sound, electromagnetic field generation, short-term suspended sediment plumes, benthic and pelagic habitat alterations, and chemical contamination. Based on the best available scientific and commercial information (provided in the references section), the degree of exposure and response to these effects are uncertain but most likely very small due to the limited size of the test site and the intermittent nature of the WEC test deployments. The proposed action includes study plans and an adaptive management framework to identify negative effects, for which NNMREC, WET-NZ and future WEC developers would take appropriate action to avoid, minimize, and mitigate. These measures would ensure that injury or mortality is limited to no more than a few juveniles or adults per year across eight Chinook ESUs, including threatened CV spring-run Chinook salmon. This very slight degree of impact is not likely to affect abundance or productivity at the population, MPG, or ESU level even though this ESU is at moderate to high risk of extinction. Further, although we assume otherwise for the purposes of this opinion, there is no evidence that fish from any of the extant populations (from a single diversity group) would be affected disproportionately (i.e., no pathway for risk to spatial structure) or that natural-origin fish would be more susceptible than those from a hatchery stock (a pathway for risk to diversity).Finally, there are no ongoing or future threats to CV spring-run Chinook in the action area (i.e., in the environmental baseline or as cumulative effects) that would be added to the very small impacts of the proposed action to reduce the viability of the species.

Therefore, after considering the rangewide status of species (threatened, Section 2.2.1), the environmental baseline (good condition Section, 2.3), cumulative effects (minimal, Section 2.5), and the expected effects of the proposed action (very slight, Section 2.4), NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of the CV spring-run Chinook salmon ESU.

2.6.1.10 Lower Columbia River (LCR) Coho Salmon

Individuals from this ESU are affected by manmade and natural factors in the freshwater environment including altered flow regimes, degraded water quality, degraded habitat, hatchery influences, passage barriers and harvest (Species Status, Section 2.2.1). Once juveniles reach the marine environment, LCR coho salmon are also affected by natural predators and adults are taken incidental to commercial and recreational fisheries (Environmental Baseline – Section 2.3). Although future effects of climate change are uncertain, ocean conditions adverse to salmon and steelhead could be more likely under a warming climate, as would changes in stream flows (Section 2.2.3).

Effects of the existence and operation of the proposed action (including installation, operation, maintenance, monitoring, and removal of the WET-NZ plus future tests of other devices in the action area) include sound, electromagnetic field generation, short-term suspended sediment plumes, benthic and pelagic habitat alterations, and chemical contamination. Based on the best available scientific and commercial information (provided in the references section), the degree of exposure and response to these effects are uncertain but most likely very small due to the limited size of the test site and the intermittent nature of the WEC test deployments. The proposed action includes study plans and an adaptive management framework to identify negative effects, for which NNMREC, WET-NZ and future WEC developers would take appropriate action to avoid, minimize, and mitigate. These measures would ensure that injury or mortality is limited to no more than a few juveniles or adults per year four coho ESUs, including threatened LCR coho salmon. This very slight degree of impact is not likely to affect abundance or productivity at the population, MPG, or ESU level even though this ESU is at high risk of extinction. Further, although we assume otherwise for the purposes of this opinion, there is no evidence that fish from any of the extant populations (from three strata) would be affected disproportionately (i.e., no pathway for risk to spatial structure) or that natural-origin fish would be more susceptible than those from a hatchery stock (a pathway for risk to diversity). Finally, there are no ongoing or future threats to LCR coho in the action area (i.e., in the environmental baseline or as cumulative effects) that would be added to the very small impacts of the proposed action to reduce the viability of this species.

Therefore, after considering the rangewide status of species (threatened, Section 2.2.1), the environmental baseline (good condition Section, 2.3), cumulative effects (minimal, Section 2.5), and the expected effects of the proposed action (very slight, Section 2.4), NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of the LCR coho salmon ESU.

2.6.1.11 Southern Oregon – Northern California Coast (SONCC) Coho Salmon

Individuals from this ESU are affected by manmade and natural factors in the freshwater environment including altered flow regimes, degraded water quality, and degraded freshwater and estuarine habitat, hatchery influences, passage barriers, predation and harvest (Species Status, Section 2.2.1). Once juveniles reach the marine environment, SONCC coho salmon are also affected by natural predators and adults are taken incidental to commercial and recreational harvest (Environmental Baseline – Section 2.3). Although future effects of climate change are uncertain, ocean conditions adverse to salmon and steelhead could be more likely under a warming climate, as would changes in stream flows (Section 2.2.3).

Effects of the existence and operation of the proposed action (including installation, operation, maintenance, monitoring, and removal of the WET-NZ plus future tests of other devices in the action area) include sound, electromagnetic field generation, short-term suspended sediment plumes, benthic and pelagic habitat alterations, and chemical contamination. Based on the best available scientific and commercial information (provided in the references section), the degree of exposure and response to these effects are uncertain but most likely very small due to the limited size of the test site and the intermittent nature of the WEC test deployments. The proposed action includes study plans and an adaptive management framework to identify negative effects, for which NNMREC, WET-NZ and future WEC developers would take appropriate action to avoid, minimize, and mitigate. These measures would ensure that injury or mortality is limited to no more than a few juveniles or adults per year across four coho ESUs, including threatened SONCC coho salmon. This very slight degree of impact is not likely to affect abundance or productivity at the population, MPG, or ESU level even though this ESU is likely to become endangered. Further, although we assume otherwise for the purposes of this opinion, there is no evidence that fish from any of the extant populations (from seven strata) would be affected disproportionately (i.e., no pathway for risk to spatial structure) or that natural-origin fish would be more susceptible than those from a hatchery stock (a pathway for risk to diversity).Finally, there are no ongoing or future threats to SONCC coho in the action area (i.e., in the environmental baseline or as cumulative effects) that would be added to the small impacts of the proposed action to reduce the viability of this species.

Therefore, after considering the rangewide status of species (threatened, Section 2.2.1), the environmental baseline (good condition Section, 2.3), cumulative effects (minimal, Section 2.5), and the expected effects of the proposed action (very slight, Section 2.4), NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of the SONCC coho salmon ESU.

2.6.1.12 Central California Coast (CCC) Coho Salmon

Individuals from this ESU are affected by manmade and natural factors in the freshwater environment including habitat degradation, water quality, and loss of riparian and estuarine habitat, alteration of the hydrograph (Species Status, Section 2.2.1). Once juveniles reach the marine environment, CCC coho salmon are also affected by natural predators and adults are taken incidental to commercial and recreational fisheries (Environmental Baseline – Section 2.3). Although future effects of climate change are uncertain, ocean conditions adverse to salmon and steelhead could be more likely under a warming climate, as would changes in stream flows (Section 2.2.3).

Effects of the existence and operation of the proposed action (including installation, operation, maintenance, monitoring, and removal of the WET-NZ plus future tests of other devices in the action area) include sound, electromagnetic field generation, short-term suspended sediment plumes, benthic and pelagic habitat alterations, and chemical contamination. Based on the best available scientific and commercial information (provided in the references section), the degree of exposure and response to these effects are uncertain but most likely very small due to the limited size of the test site and the intermittent nature of the WEC test deployments. The proposed action includes study plans and an adaptive management framework to identify negative effects, for which NNMREC, WET-NZ and future WEC developers would take appropriate action to avoid, minimize, and mitigate. These measures would ensure that injury or mortality is limited to no more than a few juveniles or adults per year across four coho ESUs, including threatened CCC coho salmon. This very slight degree of impact is not likely to affect abundance or productivity at the population, MPG, or ESU level even though this ESU is at very high risk of extinction. Further, although we assume otherwise for the purposes of this opinion, there is no evidence that fish from any of the extant populations (from five diversity strata) would be affected disproportionately (i.e., no pathway for risk to spatial structure) or that natural-origin fish would be more susceptible than those from a hatchery stock (a pathway for risk to diversity). Finally, there are no ongoing or future threats to CCC coho in the action area (i.e., in the environmental baseline or as cumulative effects) that would be added to the very small effects of the proposed action to reduce the viability of this species.

Therefore, after considering the rangewide status of species (threatened, Section 2.2.1), the environmental baseline (good condition Section, 2.3), cumulative effects (minimal, Section 2.5), and the expected effects of the proposed action (very slight, Section 2.4), NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of the CCC coho salmon ESU.

2.6.1.13 Salmonid Recovery Plan Consideration

NMFS reviewed the recovery criteria for the ESA-listed salmonids considered in the sections above. Recovery plans for the ESA-listed salmonids primarily identify limiting factors (detailed in the sections above) related to freshwater and estuarine habitats although some recovery plans also identify ocean harvest as a limiting factor. Ocean conditions which affect the growth and survival of salmonids during their ocean residency are influenced by climate change and other large scale processes that would not be affected by the small scale of effects from the proposed action. Recovery plans do not provide recommended actions for improving ocean conditions thus; the proposed action would not adversely affect recovery actions. The proposed action would not have adverse effects on ocean survival and would not harm ocean habitat significantly, therefore the proposed action would not appreciably reduce the likelihood of recovery for the ESA-listed salmonids discussed above.

2.6.2 Eulachon

Although the proposed action includes a number of activities which are likely to adversely affect eulachon, such as anthropogenic noise and EMF, short-term sediment plumes, benthic and pelagic habitat alterations (addition to and removal of structures in the water column and on the sea floor), and chemical contamination, the degree of exposure and response to these effects are uncertain but most likely very small. Therefore, the proposed action includes study plans and an adaptive management framework to identify negative effects, for which NNMREC, WET-NZ and future WEC developers would take appropriate action to avoid, minimize, and mitigate. There are no ongoing or future threats to eulachon in the action area (i.e., in the environmental baseline or as cumulative effects) that would be added to the very small impacts of the proposed action to reduce the viability of this species. Therefore, after considering the rangewide status of the species (threatened, Section 2.2.1), the environmental baseline (good condition, Section 2.3.), cumulative effects (minimal, Section 2.5), and the expected effects of the proposed action (very slight, Section 2.4), NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of eulachon at the species level. A recovery plan has not been developed for eulachon and very little information is known about the factors necessary for recovery of eulachon. Information about the specific biological requirements of eulachon during their ocean residency is very limited (Species Status, Section 2.2.1, Environmeental Baseline, and Section 2.3), safe passage is likely required for migration and foraging. The proposed action will have a very small footprint and would not constitute a barrier to passage (Section 2.4) thus, NMFS finds there are no adverse affects on the recovery of eulachon from proposed action.

2.6.3 Green Sturgeon

Although the proposed action includes a number of activities which are likely to adversely affect southern green sturgeon such as anthropogenic noise and EMF, addition of structures to the water column and sea floor, and chemical contamination, the degree of exposure and responses to these effects are uncertain but most likely very small. Therefore, the proposed action includes study plans and an adaptive management framework to identify unanticipated negative effects, for which NNMREC, WET-NZ and future WEC developers would take appropriate action to avoid and minimize in the future, including mitigate. There are no ongoing or future threats to green sturgeon in the action area (i.e., in the environmental baseline or as cumulative effects) that would be added to the very small impacts of the proposed action to reduce the viability of this species. Therefore, after considering the rangewide status of the species, the environmental baseline, and cumulative effects and the expected effects of the proposed action, NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of Southern DPS green sturgeon at the species level.

While we have not developed a recovery plan for green sturgeon the draft outline (NMFS 2010c) identifies "activities that impact spawning, rearing, and feeding habitats" as an important threat to abate. This is the only threat listed which applies to the action area. Although data are very limited on green sturgeon use of the action area, the availability of prey species indicates that forage opportunities exist in the action area. The proposed action will not significantly affect forage opportunities for green sturgeon (Analysis of Effects, Section 2.4). Further, habitat conditions in the test site lacks complexity sturgeon are reported to prefer (Species Status, Section 2.2.1, and Environmental Baseline Section 2.3). Therefore, NMFS has determined that the proposed action would not prevent the recovery of green sturgeon.

2.6.4 Green Sturgeon Critical Habitat

Likely effects of the proposed action on primary constituent elements (PCE)'s (water quality, food resources, and safe passage in areas used for growth and migration) would be small scale and short term because the less than 5% of the test site (3.4 km^2) would be occupied during WEC tests and the deployments would occur intermittently over the 10-year operation of the test center. Therefore, the proposed action would not appreciably diminish the value of designated critical habitat for the species' conservation, thus not destroying or adversely modifying critical habitat.

2.6.5 Marine Mammals (Southern Resident Killer Whales, Humpback Whales and Steller Sea Lions)

There were 85 whales in the Southern Resident Killer Whales (KW) population, as of June 2012. Over the last 28 years, population growth has been variable, with an average annual population growth rate of 0.3 percent and standard deviation of ± 3.2 percent (NMFS 2011c). Several of the population's demographic factors are cause for concern as well as habitat conditions that may be limiting recovery. These are quantity and quality of prey (particularly their primary prey, Chinook salmon), exposure to toxic chemicals that accumulate in top predators, and disturbance from sound and vessels. Chemical contamination from oil spills are also a risk factor (Species Status Section 2.2.1).

Humpback whales have been increasing globally, and the recent annual growth rate of North Pacific populations was estimated at 6.8%. Humpback whales face a variety of threats including entrapment and entanglement in fishing gear, collisions with ships, acoustic disturbance, habitat degradation, and competition for resources with humans (Species Status Section 2.2.1).

The Eastern DPS of Steller sea lions is a large population, which over the past 30 years has increased about 3% per year. Steller sea lions are generalist predators, and able to respond to changes in prey abundance. There are no substantial threats to the species, and the final recovery plan identifies the need to initiate a status review and consider removing the Eastern DPS from the Federal List of Endangered Wildlife and Plants. On April 18, 2012, NMFS issued a proposed rule to remove the eastern DPS of Steller sea lions from the List of Endangered and Threatened Wildlife (Species Status Section 2.2.1).

Given the general tendency of Southern Residents and humpback whales to occupy coastal waters near shore when foraging and traveling, and that the action area is within the foraging range of known haulouts for Steller sea lions, these species are likely to pass through the action area. However, we do not have information about their resource use specifically within the action area.

Potential adverse effects to these marine mammals from exposure to sound associated with the proposed action are likely. NMFS will be able to evaluate the risk of marine mammal interactions with the WET-NZ device, Ocean Sentinel, and TRIAXYS™ buoy, as data are collected through the observations as detailed in the NAMF and WAMP and for future WEC device tests and other associated research and monitoring instrumentation through the NAMF, as well as through specific adaptive mitigation plans developed for future device tests. If ESA-listed marine mammals are observed hauling out on or otherwise interacting with the WET-NZ device, Ocean Sentinel or TRIAXYS™ buoy, NMFS will be notified and the information will be assessed through the WAMP. All other potential effects (i.e., acoustics, EMF, chemical contamination, reduced prey availability) are likely to be very small, as described in their specific effects sections, above (Section 2.4). The NAMF provides opportunity to reassess potential effects over time as appropriate, based on the collection and evaluation of data from individual device tests.

For the purposes of this ESA consultation, the maximum extent of effects from sound would be a deflection of affected individuals around the WET-NZ device, Ocean Sentinel, and TRIAXYS™ buoy, if project sound exceeds the 120 decibel (dB) acoustic disturbance threshold for marine mammals. It is likely that these marine mammals will at most experience short-term and localized displacement from passing through or foraging within the action area during periodic device tests. Because marine mammals are relatively long-lived, it is likely that some individuals would be exposed repeatedly over the 10-year operation of the test center. However, there is no information available to suggest that the action area is an important foraging area for these species, and there are alternate foraging areas available.

If individuals are exposed to sounds above the 120 dB threshold, they are likely to deflect around the action area instead of passing through the area; however, the additional distance traveled is unlikely to cause a significant increase in an individual's energy budget, and effects would therefore be short-term. In either case, the likely behavioral responses, even considering potential for repeat exposures of individuals over the 10-year life of the project, are not anticipated to reduce the reproductive success or increase the risk of injury or mortality for any affected individuals of the marine mammal species evaluated. There are no ongoing or future threats to the listed species of marine mammals in the action area (i.e., in the environmental baseline or as cumulative effects) that would be added to the effects of the proposed action to reduce the viability of these species. Therefore, after considering the rangewide status of the species (Southern resident killer whale and humpback whale – endangered and Steller sea lion – threatened, Section 2.2.1), the environmental baseline (good condition, Section 2.3), and cumulative effects (minimal, Section 2.5), and the expected effects of the proposed action (very slight, Section 2.4), NMFS finds that the proposed DOE funding and Corps' issuance of the NWP #5 for the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of Southern Resident killer whales, humpback whales, or Stellar sea lions at the species level.

2.7 Conclusions

After considering the rangewide status of the listed species which range from threatened to endangered and moderate to very high risk of extinction (Section 2.2.1), the environmental baseline within the action area (good condition Section 2.3), the effects of the proposed action (very slight Section 2.4), and cumulative effects (minimal, Section 2.5), it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of Lower Columbia River, Upper Willamette River, Upper Columbia River spring-run, Snake River spring/summer, Snake River fall, California Coastal, Sacramento River winter-run, or Central Valley spring-run Chinook salmon; Lower Columbia River, Oregon Coast, Southern Oregon/Northern California Coast, or Central California Coast coho salmon; Southern Distinct Population Segment (DPS) of North American green sturgeon; Southern DPS eulachon; Southern Resident killer whales; Steller sea lions; or humpback whales, or result in the destruction or adverse modification of their respective designated critical habitats.

See Section 2.11 for the rationale for NMFS's concurrence with DOE and the Corps' Not Likely to Adversely Affect conclusions for SR steelhead, UCR steelhead, MCR steelhead, LCR steelhead, UWR steelhead, SCCC steelhead, CCC steelhead, NC steelhead, CCV steelhead, SR sockeye, and CR chum salmon, Sei Whales, Blue Whales, Fin Whales, Sperm Whales, Leatherback Sea Turtles, Green Sea Turtles, Olive Turtles Ridley Sea Turtles, and Loggerhead Sea Turtles, and not likely to adversely affect conclusions for critical habitat designated for Leatherback Sea Turtles.

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. For this consultation, we interpret "harass" to mean an intentional or negligent action that has the potential to injure an animal or disrupt its normal behaviors to a point where such behaviors are abandoned or significantly altered.[26] Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of an incidental take statement.

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[26] NMFS has not adopted a regulatory definition of harassment under the ESA. The World English Dictionary defines harass as "to trouble, torment, or confuse by continual persistent attacks, questions, etc." The U.S. Fish and Wildlife Service defines "harass" in its regulations as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). The interpretation we adopt in this consultation is consistent with our understanding of the dictionary definition of harass and is consistent with the Service's interpretation of the term.

2.8.1 Amount or Extent of Take

2.8.1.1 Marine Mammals

NMFS is not including an incidental take exemption for marine mammals at this time because the incidental take of marine mammals has not been authorized under section 101(a)(5) of the Marine Mammal Protection Act. Following issuance of such regulations or authorizations, NMFS may amend this ITS to include an incidental take statement for marine mammals, as appropriate.

2.8.1.2 Marine Fishes

The proposed action will affect ESA-listed adult and juvenile salmonids, adult eulachon and adult and sub-adult green sturgeon, as described in the opinion. While not unique, the action area is potential foraging and migration habitat for all these marine fishes. The proposed action is likely to cause the harm or harassment through behavioral avoidance of the area (and thus loss of foraging opportunities in the tests site) during the WET-NZ WEC device test and future tests as a result of:

1. Sound pressure from operation of deployed WEC devices and testing equipment

2. EMF from operation of deployed WEC devices and testing equipment

3. Benthic habitat alteration from installation and operation of deployed WEC devices and testing equipment

The very small amount of take likely to be caused by the effects of the proposed action cannot be accurately quantified as an amount of fish because the distribution and abundance of each species that is likely to occur within an action area during a WEC device test is affected by environmental and biotic factors including upwelling, water chemistry, water temperature and ocean currents that are highly variable and unpredictable (Section 2.3). Thus, there is no practical way to predict the distribution and abundance of listed fishes in the action area nor would we be able to accurately observe or count the fish incidentally harmed or harrassed by the proposed action to see if a predicted level of take was exceeded. In these circumstances, NMFS uses a causal link between the activity and the expected level of habitat disturbance to describe the extent rather than the amount of take.

Sound Pressure

The best available indicator for the extent of incidental take associated with sound pressure is the decibel measurements from WEC devices deployed in the test site. Although formal guidance is not yet available, NMFS uses conservative exposure thresholds of sound pressure levels from impulse sounds that have been shown to cause behavioral disturbance (a negative effect) in marine fishes; 183 dB (SEL) re: 1 µPa for fishes weighing up to 2 g and 187 dB (SEL) re: 1 µPa for fishes weighing over 2g and a peak sound level of 206 dB (Peak) re: 1 µPa (FHWG 2008). NNMREC will conduct monitoring to characterize the acoustic signature of WEC devices under test. If monitoring results indicate that the sound produced by the proposed action have exceeded the levels noted above at a distance of 100m from a WEC device, the reinitiation provisions of this opinion will be triggered.

EMF

The best available indicator for the extent of incidental take associated with EMF is measurements of EMF more than 500 meters from a WEC device deployed in the test site. More specifically, NNMREC will conduct monitoring to evaluate the ability to detect EMF generated from the proposed action and measure the levels produced at various distances. If monitoring results indicate that EMF attributable to the project components is in excess of levels documented to have an adverse impact on marine life beyond a 500m radius from deployed WEC test components the reinitiation provisions of this opinion will be triggered.

Benthic Habitat Alteration

The installation of project features at the test site would alter habitat in the action area by creating structure and hard surfaces in the water column and on the bottom. These factors would alter hydraulics around the anchors, changing the distribution of sediment grain sizes due to scour/erosion and/or deposition. These changes, which would be in place intermittently over the 10-year operation of the test center, are likely to affect the composition of ecological communities within the 3.4-km2 test site over the duration of each test, with associated impacts to foraging.

The best available indicator for the extent of incidental take associated with changes to benthic habitat is changes in substrate grain size and distribution over 50 percent of the test site. More specifically, NMFS defines the extent of take for benthic habitat modification by the change in substrate type (grain size and distribution) from baseline conditions (188 µm to 462 µm (fine to coarse sand) with small to median sizes occurring more frequently in the 30 m depth stations and the larger sizes being more prevalent at the 40-50m depth stations(Henkel 2011)) to another state (e.g., from a fine grained to a coarse sand, or vice versa; Table 5) over a substantial portion (50%), of the test site, as estimated by representative sampling (Appendix A). Exceeding this threshold will trigger the reinitiation provisions of this opinion.

Table 5. Standard grain size classification scheme, the Wentworth scale (Wentworth 1922)

Median Diameter	Wentworth Grade	Phi (Φ) Scale
>256 mm	Boulder	–8
>64 mm	Cobble	–6
>4 mm	Pebble	–2
>2 mm	Granule	–1
>1 mm	Very coarse sand	0
> 500 μm	Coarse sand	1
>250 μm	Medium sand	2
>125 μm	Fine sand	3
>62.5 μm	Very fine sand	4
>31.3 μm	Coarse silt	5
>15.6 μm	Medium silt	6
>7.8 μm	Fine silt	7
>3.9 μm	Very fine silt	8
<3.9 μm	Clay	>8

2.8.2 Effect of the Take

In section 2.7, NMFS determined that the level of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species, destruction, or adverse modification of critical habitat (Section 2.7).

2.8.3 Reasonable and Prudent Measures

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

To minimize the extent of incidental take from the proposed action the DOE and Corps will address uncertainties surrounding the effects of the proposed action through monitoring and minimize and mitigate for the effects of the proposed action by conducting appropriate mitigation measures through an adaptive management process which will ensure that proper mitigation is carried out and is effective.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the US Department of Energy and The US Army Corps of Engineers or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The US Department of Energy and The US Army Corps of Engineers or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the following terms and conditions are not complied with, the protective coverage of section 7(o)(2) will likely lapse.

To implement the reasonable and prudent measure described above the DOE will:

1. Ensure that all proposed monitoring is carried out as described in Appendix A of this opinion and incorporated here by reference.

2. Ensure that the NNMREC Adaptive Management Framework (Appendix B) is carried out for the 10-year operation of the test center to avoid, minimize and mitigate any adverse effects from the proposed action.

3. Require that all future WEC device or Ocean Sentinel tests prepare and carry out an Adaptive Mitigation Plan approved by NMFS to avoid, minimize and mitigate any adverse effects from the proposed action.

4. Require that all future WEC device or Ocean Sentinel tests obtain a Corps permit and conduct ESA consultation for all future WEC device tests.

5. Obtain documented approval from the designated NMFS representative for all changes to the NNMREC Adaptive Management Framework (Appendix A) that affect ESA-listed species or NMFS authorities.

To implement the reasonable and prudent measures described above the Corps will:

1. Include as a condition of the NWP permit that the applicant (NNMREC or its assigns) complete all monitoring associated with the WET-NZ tests as described in the monitoring plans, Appendix A of this opinion and incorporated here by reference.

2. Include as a condition of the NWP permit that the applicant (NNMREC or its assigns) follow the WET-NZ Adaptive Mitigation Plan (Appendix C) and carry out all mitigation actions determined by NMFS to be necessary for compliance with the ESA.

3. Include as a condition of the NWP permit that the applicant (NNMREC or its assigns) obtain documented approval from the designated NMFS representative for all changes to the WET-NZ Adaptive Mitigation Plan (Appendix C) that affect ESA-listed species or NMFS authorities.

4. Require that all future Corps permits (Nationwide or Individual) for future WEC device tests include ESA Section 7 consultation with NMFS.

2.9 Conservation Recommendations

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

NMFS has no conservation recommendations at this time.

2.10 Reinitiation of Consultation

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

2.11 "Not Likely to Adversely Affect" Determinations

For purposes of the ESA, "effects of the action" means the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (see 50 CFR 402.02). The applicable standard to find that a proposed action is NLAA listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Discountable effects cannot be reasonably expected to occur. Insignificant effects are so mild that the effect cannot be meaningfully measured, detected, or evaluated as take. Beneficial effects are contemporaneous positive effects without any adverse effect to the listed species or critical habitat, even if the long-term effects are beneficial.

We first discuss the likelihood of occurrence for ESA-listed marine mammals in the project vicinity, and second discuss the potential effects of the proposed action. The proposed action is likely to affect ESA-listed species through the following direct and indirect pathways detailed in Section 2.4 above: (1) sound; (2) electromagnetic fields; (3) habitat alteration; (4) chemical contamination; (5) entanglement and collision; (6) creation of haulout habitat; and (7) prey availability as described in the following sections. Effects of these pathways are described specific to fishes and marine mammals, separately. Where a pathway is specific to one group or the other, potential effects are described only for the relevant species.

2.11.1 ESA-listed Fishes

Individuals from a number ESA-listed fish species, in addition to those considered in the opinion above could occasionally be found in the action area, but their occurrence is likely to be rare. The far southern extent of the species range for chum and sockeye salmon is documented to occur on the central Oregon Coast (45° N) for chum salmon (Salo 1991, NPAFC 2012) and southward to 44°29'N for sockeye salmon (NPAFC 2012), all of which are north of the action area. Juvenile steelhead have been shown to move quickly from freshwater to areas beyond the continental shelf, often to the far western Pacific Ocean and along mid-ocean and northern areas of the Pacific, far from the action area (Burgner et al 1992, Myers et al 2007). Based on this information the likelihood of occurrence of these species in the nearshore Oregon coast is very unlikely and occurrence within the small area of the test site (3.4 km^2) is even more remote.

Sound

The proposed action may produce sound within the hearing range of salmonids and other marine fishes as described in section 2.4.1. It is likely that continuous, non-impulse sound emissions from WET-NZ or future WEC device tests will result in behavioral avoidance of the action area. However, as described above, the occurrence of ESA-listed chum and sockeye salmon, and steelhead species in the action area is unlikely. Therefore, since the sound levels will be mitigated and the presence of these species in the action area is very unlikely, the effect of sound on ESA-listed chum and sockeye salmon, and steelhead species is insignificant and discountable.

EMF

The proposed action may produce EMF above the naturally occurring level in the action area as described in Section 2.4.2. However, as described above in Section 2.4.2 actual power generation levels are expected to be low, all cables carrying current would be shielded, and the footprint of WEC device tests would to be very small (0.085km^2) due to the 100 kW capacity of the Ocean Sentinel. There is a great deal of uncertainty regarding the effects of EMF on salmonids, including ESA-listed chum and sockeye salmon and steelhead. We do not have fine-scale information about their use of the action area but, as described above, the occurrence of ESA-listed chum and sockeye salmon species and steelhead species in the action area is very unlikely, therefore the effect of EMF on ESA-listed chum and sockeye salmon, and steelhead species is insignificant and discountable.

Habitat Alteration

The proposed action would result in habitat alteration in the action area through a number of pathways (chemical contamination, suspended sediments, and physical structures in the water column) all detailed in Sections 2.4.3 – 2.4.5.

Suspended sediment levels would temporarily increase over background when sand and some fine sediment were disturbed during installation and removal of anchors. Suspended sediments would increase for a short time, with the highest concentrations occurring in the immediate vicinity of each anchor, and then rapidly disperse with local ocean currents (Section 2.4.4). Copper leaching from antifouling coatings is not expected to result in copper concentrations which would exceed thresholds for aquatic species in the action area due to the small surface area, the moderate ocean currents and the saline environment which reduces the bio-availability of copper (Section 2.4.3). Although project components would carry hazardous fluids (e.g. diesel, bio-diesel, and hydraulic fluids) the proposed action includes a Spill Prevention, Control, and Countermeasure plans or a Spill Contingency and Emergency Response plan for each WEC device test. The plans would include actions to ensure that any spills that do occur are quickly contained. Thus, due to the very unlikely occurrence of ESA-listed chum and sockeye salmon species and steelhead species in the action, the short duration of potential exposure to suspended sediment levels, the low risk of chemical contamination from copper leachate, and the pre-planning for rapid detection and cleanup of any spills that occur, any direct effects from exposure to chemical contamination are insignificant and discountable.

The deployment of WEC devices and associated monitoring buoys would alter habitat in the action area by creating structure and hard surfaces in the water column and on the sea bottom. These factors would be likely to alter hydraulics around the anchors, changing the distribution of sediment grain sizes due to scour/erosion and/or deposition (removal of energy from the water column). The structures could also act as fish attraction devices (FADs). Both of these effects are likely to affect the composition of ecological communities within the test site. Changes to the substrate, in the test site, from the introduction of physical structures in the water column may result in changes to the benthic communities and forage opportunities for ESA-listed marine fishes. Although the magnitude of the effect is uncertain, a reduction in foraging habitat or opportunity could adversely affect ESA-listed marine fishes. To address these uncertainties, NNMREC has conducted baseline benthic habitat monitoring and proposes to continue Benthic Monitoring Studies. However, as described above, the occurrence of ESA-listed chum and sockeye salmon, and steelhead species in the action area is very unlikely. Therefore, since changes to benthic habitat and ecological communities will be mitigated and the presence of ESA-listed chum and sockeye salmon, and steelhead species in the action area is unlikely, the effect of sound on ESA-listed chum and sockeye salmon, and steelhead species is insignificant and discountable.

Conclusion

Therefore, NMFS has determined that the proposed action "may affect," but is "not likely to adversely affect" the following ESA-listed fish species: Snake River steelhead, Upper Columbia River steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, Upper Willamette River steelhead, South-Central California Coast steelhead, Central California Coastal steelhead, Northern California steelhead, California Central Valley steelhead, Snake River sockeye, and Columbia River chum. These ESA-listed species are extremely unlikely to occur in the action area where they could be exposed to potential stressors from the proposed activities.

2.11.2 ESA-listed Marine Mammals

Whales (Sei Whales, Blue Whales, Fin Whales, and Sperm Whales) and Sea Turtles (Leatherback Sea Turtles, Green Sea Turtles, Olive Turtles Ridley Sea Turtles, and Loggerhead Sea Turtles) are unlikely to be in the action area where they could be exposed to the effects of sound, EMF emissions, habitat alteration, and chemical contamination associated with the proposed action. These whale species are more likely to occur further offshore (although within the West Coast exclusive economic zone [EEZ], three to 200 miles from shore) than within the action area. However, these species are occasionally (fin whales) or rarely (blue whales, Sei whales and sperm whales) sighted in waters closer to shore (Carretta et al. 2010), which could overlap with the action area. Green, olive ridley and loggerhead sea turtles are rarely observed in the West Coast EEZ (NMFS and USFWS 2007a, b, c), and leatherback sea turtles are more likely to occur further offshore than the action area (NMFS and USFWS 2007d). NMFS considers any species rarely or only occasionally sighted within the 3-mile limit extremely unlikely to occur in the action area; a relatively small patch of ocean and seafloor (1 square nautical mile) located about 2 miles from shore.

In addition to the potential direct and indirect effects to species discussed above, the proposed action may affect critical habitat for leatherback sea turtles. Based on the natural history of the species and their habitat needs, NMFS designated critical habitat based on occurrence of prey species (jellyfish) of sufficient condition, distribution, diversity, and abundance and density necessary to support individual as well as population growth, reproduction, and development (NMFS 2011b). Hypothetically, sound, EMF, structural habitat alterations, and/or chemical contamination related to the WET-NZ device test and future tests of other WEC devices in the action area could result in intermittent, localized changes to the aquatic species community, directly or indirectly affecting jellyfish prey (e.g., if other species that prey on jellyfish are attracted to or deterred from the site). However, these sea turtles are not anticipated to forage or spend extended amounts of time in the action area. Thus, any effects to jellyfish (their preferred prey) in the action area are unlikely to affect the conservation value of their critical habitat. Additional information on the aquatic species community will be collected as part of the monitoring plan and any potential effects would be avoided, minimized, and/or mitigated using the adaptive management process.

Therefore, NMFS finds that the potential effects of proposed action on the above species and critical habitat are discountable and that although the proposed action may affect, it is not likely to adversely affect Sei whales, blue whales, fin whales, sperm whales, leatherback sea turtles, green sea turtles, olive ridley sea turtles, loggerhead sea turtles, or critical habitat designated for leatherback sea turtles.

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

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

This analysis is based, in part, on the EFH assessment provided by the DOE and the Corps, and EFH provisions in fishery management plans for Pacific coast groundfish (PFMC 2005), coastal pelagic species (PFMC 1998), highly migratory species (PFMC 2003), and Pacific coast salmon (PFMC 1999).

3.1 Essential Fish Habitat Affected by the Project

The proposed action is described in the Introduction to the opinion (Section 1.3). The action affects areas designated as EFH for certain life stages of the following species of groundfish, coastal pelagics, Pacific salmon, and highly migratory species (Table 6).

Table 6. Species with designated EFH in the action area

Groundfish				
Common Name	*Scientific Name*	Lifestage	Activity	Prey Name
Arrowtooth flounder	*Atheresthes stomias*	Adults	All[27]	Clupeids, gadids, krill, shrimp, *Theragra chalcogramma*
		Eggs		
		Larvae		Copepod eggs, Copepod nauplii, copepods
Big skate	*Raja binoculata*	Adults	All	Crustaceans, fish
Black rockfish	*Sebastes melanops*	Adults	All	Amphipods, Cephalopods, Clupeids, Euphausiids, Mysids, polychaetes, salps
	Sebastes melanops	Juveniles	Feeding, Growth to maturity	Amphipods, barnacle cypriots, Copepods, crustacean zoea, fish larvae, Mysids, polychaetes
Blue rockfish	*Sebastes mystinus*	Adults	All	algae, crab, fish juveniles, fish larvae, hydroids, jellyfish, krill, salps, tunicates
		Juveniles	All	algae, Copepods, Euphausiids, fish juveniles, hydroids, krill, tunicates, algae, copepods, crab,
		Larvae	Feeding	
Bocaccio	*Sebastes paucispinis*	Adults	Feeding, Growth to maturity	Juvenile rockfish, molluscs, small fishes
		Juveniles	Feeding, Growth to maturity	Copepods, euphausiids
Flathead sole	*Sebastes auriculatus*	Adults	All	Crabs, fish, isopods, polychaetes, shrimp
		Juveniles	Feeding, Growth to maturity	Amphipods, Copepods, crabs, fish
Butter sole	*Isopsetta isolepis*	Adults		Amphipods, decapod crustaceans, fish, molluscs, polychaetes, sea stars, shrimp
Cabezon	*Scorpaenichthys marmoratus*	Adults		Crabs, fish eggs, lobsters, molluscs, small fishes
California skate	*Raja inornata*	Eggs	Unknown	
Chilipepper	*Sebastes goodei*	Juveniles	Feeding, Growth to maturity	Copepods, euphausiids
Curlfin sole	*Pleuronichthys decurrens*	Adults	All	Crustacean eggs, Echiurid proboscises, nudibranchs, polychaetes
Darkblotched rockfish	*Sebastes crameri*	Adults and Juveniles		Amphipods, Euphausiids, octopi, salps, small fishes
		Larvae		
English sole	*Parophrys vetulus*	Adults	All	Amphipods, crustaceans, cumaceans, mollluscs, ophiuroids, polychaetes
		Juveniles	Feedging, Growth to maturity	Amphipods, copepods, cumaceans, molluscs, mysids, polychaetes
Flathead sole	*Hippoglossoides elassodon*	Adults	All	Clupeids, fish, molluscs, mysids, polychaetes, shrimp

[27] "All" refers to spawning, breeding, and feeding.

Groundfish				
Common Name	*Scientific Name*	Lifestage	Activity	Prey Name
Greenstriped rockfish	*Sebastes elongatus*	Adults	All	Copepods, euphausiids, shrimp, small fishes, squids, tunicates
Kelp greenling	*Hexagrammos decagrammus*	Adults	All	Brittle Stars, crabs, octopi, shrimp, small fishes, snails, worms
		Larvae		Amphipods, brachyuran, copepod nauplii, copepods, euphausiids, fish larvae
Lingcod	*Ophiodon elongatus*	Adults	All	Demersal fish, juvenile crab, octopi, squids
		Larvae	Feeding	Amphipods, copepods eggs, copepod nauplii, copepods, decapod larvae, euphausiids
Longnose skate	*Raja rhina*	Adults	All	
		Eggs		
		Juveniles	Growth to Maturity	
Pacific cod	*Gadus macrocephalus*	Adults	All	Amphipods, crabs, mysids, sandlance, shrimp, *Theragra chalcogramma*
		Juveniles		Amphipods, copepods, crabs, shrimp
		Larvae		Copepods
Pacific hake	*Merluccius productus*	Adults	All	Amphipods, clupeids, crabs, Merluccius productus, rockfish, squids
		Juveniles		Euphausiids
Pacific ocean perch	*Sebastes alutus*	Adults	All	Copepods, euphausiids, mysids, shrimp, small fishes, squids
		Juveniles		Copepods, euphausiids
Pacific sanddab	*Citharichthys sordidus*	Adults	All	Clupeids, crab larvae, octopi, squids
Petrale sole	*Eopsetta jordani*	Adults	All	*Eopsetta jordani*, Euphausiids, Ophiuroids, pelagic fishes, shrimp
Quillback rockfish	*Sebastes maliger*	Adults	all	Amphipods, clupeids, crabs, euphausiids, fish juveniles, molluscs, polychaetes, shrimp
Redbanded rockfish	*Sebastes babcocki*	Adults	All	
Redstripe rockfish	*Sebastes proriger*	Adults	All	Clupeids, fish juveniles, squids
Rex sole	*Glyptocephalus zachirus*	Adults	All	Cumaceans, euphausiids, larvacea, polychaetes
Rock sole	*Lepidopsetta bilineata*	Adults	All	echinoderms, echiurans, fish, molluscs, polychaetes, tunicates,
Rosethorn rockfish	*Sebastes helvomaculatus*	Adults	All	amphipods, copepods, euphausiids
Rosy rockfish	*Sebastes rosaceus*	Adults	All	crabs, shrimp
Rougheye rockfish	*Sebastes aleutianus*	Adults	All	
		Juveniles	Growth to Maturity, Feeding	
Sablefish	*Anoplopoma fimbria*	Adults	Growth to Maturity	Clupeids, euphausiids, octopi, rockfish, shrimp

Groundfish				
Common Name	*Scientific Name*	Lifestage	Activity	Prey Name
		Juveniles	Growth to Maturity	Amphipods, Cephalopods, copepods, demersal fish, Euphausiids, krill, small fishes, squids, tunicates
		Larvae	Feeding	Copepod eggs, Copepod nauplii, copepods
Sand sole	*Psettichthys melanostictus*	Adults	All	Clupeids, crabs, fish, molluscs, mysids, polychaetes, shrimp
		Juveniles	Feeding, Growth to maturity	Euphausiids, molluscs, mysids, polychaetes, shrimp
Sharpchin rockfish	*Sebastes zacentrus*	Adults	All	Amphipods, copepods, euphausiids, shrimp, small fishes
		Juveniles	Feeding, Growth to maturity	Amphipods, copepods, euphausiids, shrimp, small fishes
Shortbelly rockfish	*Sebastes jordani*	Adults	All	Copepods, euphausiids
Shortraker rockfish	*Sebastes borealis*	Adults	All	Bathylagids, Cephalopods, Decapod crustaceans, fish, molluscs, myctophids, mysids, shrimp
Shortspine thornyhead	*Sebastolobus alascanus*	Adults	All	Amphipods, copepods, crabs, fish, polychaetes, *Sebastolobus alascanus*, *Sebastolobus altivelis*, shrimp
Silvergray rockfish	*Sebastes brevispinis*	Adults	All	
Soupfin shark	*Galeorhinus galeus*	Adults	All	Fish, invertebrates
		Juveniles	Growth to Maturity	Invertebrates, Fish
Spiny dogfish	*Squalus acanthias*	Adults	All	Invertebrates, pelagic fishes, invertebrates, pelagic fishes,
Splitnose rockfish	*Sebastes diploproa*	Juveniles	Feeding	Amphipods, cladocerans, copepods
		Larvae		
Spotted ratfish	*Hydrolagus colliei*	Adults	All	algae, Amphipods, Annelids, Brittle Stars, fish, hydrolagus colliei, molluscs, nudibranchs, opisthobranchs, ostracods, small crustacea, squids
		Juveniles	Growth to Maturity	algae, Amphipods, Annelids, Brittle Stars, fish, hydrolagus colliei, molluscs, nudibranchs, opisthobranchs, ostracods, small crustacea, squids
Starry flounder	*Platichthys stellatus*	Adults	Growth to Maturity	Crabs, fish juveniles, molluscs, polychaetes
		Juveniles	Feeding	Amphipods, copepods, polychaetes
Stripetail rockfish	*Sebastes saxicola*	Adults	All	Copepods, euphausiids
		Juveniles	Feeding, Growth to maturity	copepods
Tiger rockfish	*Sebastes nigrocinctus*	Adults	All	Amphipods, clupeids, crabs, fish juveniles, juvenile rockfish, shrimp

Groundfish				
Common Name	*Scientific Name*	Lifestage	Activity	Prey Name
Vermilion rockfish	*Sebastes miniatus*	Adults	All	Clupeids, juvenile rockfish, krill, octopi, squids
Widow rockfish	*Sebastes entomelas*	Adults	All	Amphipods, Copepods, Euphausiids, Merluccius productus, salps, shrimp, squids
		Juveniles	Feeding, Growth to maturity	Copepod eggs, Copepods, Euphausiid eggs
Yelloweye rockfish	*Sebastes ruberrimus*	Adults	All	Clupeids, cottids, crabs, gadids, juvenile rockfish, sea urchin, shrimp, snails
Yellowtail rockfish	*Sebastes flavidus*	Adults	All	Clupeids, Euphausiids, krill, Merluccius productus, Mysids, salps, Squids, tunicates
Coastal Pelagic Species				
Common Name	*Scientific Name*			
Northern Anchovy	*Engraulis mordax*			
Pacific Sardine	*Sardinops sagax*			
Pacific (Chub) Mackerel	*Scomber japonicus*			
Market squid	*Loligo opalescens*			
Jack Mackerel	*Trachurus symmetricus*			
Pacific Salmon				
Common Name	*Scientific Name*			
Coho Salmon	*Oncorhynchus kisutch*			
Chinook Salmon	*Oncorhynchus tshawytscha*			
Highly Migratory Species				
Common Name	*Scientific Name*			
Common Thresher Shark	*Alopias vulpinus*			

3.2 Adverse Effects on Essential Fish Habitat

The adverse effects to Chinook and coho salmon and their habitat from the proposed action are described in detail in this opinion and analysis of effects on habitat used by Chinook and coho salmon is relevant to components of EFH designated for other species of marine fishes and invertebrates. The proposed action will have the following adverse effects on EFH designated for coastal pelagic and highly migratory species, groundfish, and Pacific salmon:

1. **Water Quality.** Suspended sediment levels would temporarily increase over background when sand and some fine sediment were disturbed during installation and removal of anchors. Suspended sediments would increase for a short time, with the highest concentrations occurring in the immediate vicinity of each anchor, and then rapidly disperse with local ocean currents. Some species with EFH in the action area (e.g., spotted ratfish and starry flounder) are less sensitive to suspended solids than salmonids (Wilber and Clarke 2001). It is also likely that groundfish and coastal pelagic species found nearshore will be of sufficient age and size to initiate avoidance behavior and move out of the turbidity plume and will not experience adverse effects from the elevated

turbidity. Due to the local distribution and short duration of this stressor, the effect of elevated suspended sediments on EFH would be insignificant.

The proposed action includes the use of anti-fouling coatings, which would leach copper into the area immediately surrounding the coated structures. The amount of copper leached would diminish over time as well as be diluted by the strong currents in the action area. The proposed WET-NZ device is a one-half scale model and is significantly smaller than a single PowerBuoy[28]. Antifouling paint used on the PowerBuoys contains copper which would leach into the surrounding seawater, similar to the WET-NZ device. A total of 10 PowerBuoys will be deployed for the Reedsport OPT Wave Park and were considered in the 401 Water Quality Certification for the Reedsport OPT Wave Park,29 where the Oregon Department of Environmental Quality (ODEQ 2011) calculated the concentrations of copper expected to occur within the Reedsport action area as 0.02 µg/L/day and 0.08 µg/L/4 days. This level is well below the 2.9 µg/L levels established for buildup of toxic material that affects aquatic life or human uses and also below the levels considered lethal to juvenile and adult salmonids (range: 21 µg/L over 60 days to 57 µg/L over 72 hours; (Hecht et al 2007). Further, copper ions bind with dissolved organic material in seawater, decreasing its bioavailability and partially protecting organisms against copper's neurotoxicity (Hecht et al.2007, City of San Jose 2005). Therefore, due to the very low levels of copper anticipated to result from the use of antifouling coatings, the habitat value of the EFH for groundfish and pacific salmon would not be altered.

Although many components of the proposed action will include hydraulic, diesel and other potentially harmful fluids NNMREC, WET-NZ and its contractors would be required to provide and carry out either an approved Spill Prevention, Control, and Countermeasure plan or a Spill Contingency and Emergency Response plan. The plans are intended to significantly reduce the likelihood of a spill and chemical contamination in the action area and would include actions to ensure that any spills that do occur are quickly contained. The proposed action includes conservation measures to remotely monitor the deployed project components and response plans to facilitate removal of a leaking device in a timely manner. Therefore, due to the pre-planning for rapid detection and cleanup of any spills that do occur, the proposed action is not likely to negatively affect more than a few individual fish, or to affect EFH for groundfish, coastal pelagic species, Pacific salmon, and highly migratory species.

2. **Food resources.** Benthic habitat and subsequently food resources in the action area could be altered within the 3.4 km^2 test site over the 10-year operation of the test center. This would occur due to the installation and removal of anchors which creates local erosional and depositional fields in the sandy seabed potentially altering the benthic community. The action area is typical of a moderate energy, disturbance-based nearshore

[28] WET-NZ device has a draft of 15m and displacement volume of 50 metric tons. A single powerbuoy has a draft of 35m and a displacement volume of 272 metric tons. The wetted surface area is not readily available for these devices.
[29] The Reedsport OPT Wave Park is located less than 75 miles south of the test site, is a matrix of 10 WEC devices and associated moorings coated with antifouling paints that are expected to leach copper into the surrounding environment.

environment. The exposure, response, and risks to forage fish species (both as a food resource and managed coastal pelagic fishes) and groundfish are likely to be similar to those described for ESA-listed salmon and eulachon. Because these impacts to the forage base would be highly localized, the potential for a decrease in forage to be insignificant compared to the total food resources available to EFH managed species in the action area.

3. **Safe Passage.**Safe passage for species with designated EFH would be affected by anthropogenic noise and EMF generated by the project and the presence of structures in the water column and on the seafloor. The degree of negative effect on safe passage is uncertain because responses could vary from attraction to structures to avoidance of sound or EMF. The proposed action would create some risk to safe passage, but only in about 3.4 km^2 of the coastal Pacific Ocean. Therefore, safe passage for managed species would not be functionally changed by the proposed action.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS has no conservation recommendations for EFH because the potential effects are so remote as to be insignificant.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the U.S. Department of Energy and the U.S. Army Corps of Engineers must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. However, because NMFS has not provided any conservation recommendations in this case, no response is required.

3.5 Supplemental Consultation

The US Department of Energy and The US Army Corps of Engineers must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the US Department of Energy and The US Army Corps of Engineers. Other interested users could include permit applicants, citizens of affected areas, and others interested in the conservation of the affected ESUs/DPS. Individual copies of this opinion were provided to the US Department of Energy and The US Army Corps of Engineers. This opinion will be posted on the NMFS

Northwest Region web site (http://www.nwr.noaa.gov). The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

5. REFERENCES

Adams, P. B., C. B. Grimes, S. T. Lindley, and M. L. Moser. 2002. Status review for North American green sturgeon, Acipenser medirostris. NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA. 50 p.

Allen, B.M, and R. P. Angliss. 2011. Steller sea lion (*Eumetopias jubatus*): Eastern U. S. Stock. In: Alaska marine mammal stock assessments, 2010. U.S. Department Commerce, NOAA Technical Memorandum NMFS-AFSC-223. 292 pages.

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

Austin, M., N. Chorney, J. Ferguson, D. Leary, C. O'Neill, and H. Sneddon. 2009. Assessment of underwater noise generated by wave energy devices. Tech Report prepared for Oregon Wave Energy Trust

Baker C. S., L. Medrano-Gonzalez, J. Calambokidis, A. Perry, F. Pichler, H. Rosenbaum, J. M. Straley, J. Urban-Ramirez, M. Yamaguchi, and O. Von Ziegesar. 1998. Population structure of nuclear and mitochondrial DNA variation among humpback whales in the North Pacific. Molecular Ecology 7:695-707.

Baker C.S, and D. Steel. 2010. geneSPLASH: genetic differentiation of 'ecostocks' and 'breeding stocks' in North Pacific humpback whales. In: Symposium on the results of SPLASH humpback whale study. Final report and recommendations (Calambokidis J, ed). Quebec City, Canada; 58-59.

Barlow J, J. Calambokidis, E. A. Falcone, C. S. Baker, A. Burdin, P. Clapham, J. K. B. Ford, C. Gabriele, R. LeDuc, D. Mattila, T. I. Quinn, L. Rojas-Bracho, J. M. Straley, B. Taylor, J. Urbán R, P. Wade, D. Weller, B. Witteveen, and M. Yamaguchi. 2011. Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. Marine Mammal Science Early online.

Barlow J, M. Ferguson, E. Becker, J. Redfern, K. A. Forney, I. Vilchis, P. Fiedler, T. Gerrodette, and L. Balance. 2009. Predictive modeling of cetacean densities in the eastern Pacific Ocean. NOAA Technical Memorandum NMFS-SWFSC-TM-444:206 pp.

Basov, B.M. 1999. Behavior of sterlet sturgeon and Russian sturgeon in low-frequency electric fields. Journal of Ichthyology 39: 782-787.

Bassett, C., J. Thomson, B. Polagye and K. Rhinefrank. 2011. Underwater noise measurements of a 1/7th scale wave energy converter.

Benson S.R, 2002. Ecosystem Studies of Marine Mammals and Seabirds in Monterey Bay, CA, 1996-1999. M.S. Thesis. : San Jose State University.

Benson S.R, D. A. Croll, B. Marinovic, F. P. Chavez, and J. T. Harvey. 2002. Changes in the cetacean assemblage of a coastal upwelling ecosystem during El Niño 1997-98 and the La Niña 1999. Progress in Oceanography 54:279-291.

Bi, H., R.E. Ruppel, and W.T. Peterson 2007 – Modeling the pelagic habitat of salmon off the Pacific Northwest (USA) coast using logistic regression Marine Ecology Progress Series Vol. 336: 249–265, 2007

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(6):463-476.

Bindoff, N.L., J. Willebrand, V. Artale, A, Cazenave, J. Gregory, S. Gulev, K. Hanawa, C. Le Quéré, S. Levitus, Y. Nojiri, C.K. Shum, L.D. Talley, and A. Unnikrishnan. 2007. Observations: oceanic climate change and sea level. In: Climate change 2007: The physical science basis. Contribution of Working Group I to the fourth assessment report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY.

Bjorkstedt, E. P., B. C. Spence, J. C. Garza, D. G. Hankin, D. Fuller, W. E. Jones, J. J. Smith, and R. Macedo. 2005. An analysis of historic population structure for evolutionarily significant units of Chinook salmon, coho salmon, and steelhead in the North-Central California Coast recovery domain. NOAA-TM-NMFS-SWFSC-382

Boehlert, G.W., G.R. McMurray, and C.E. Tortorici (editors). 2008. Ecological effects of wave energy in the Pacific Northwest. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-F/SPO-92.

Brodeur, R.D., J.P. Fisher, D.J. Teel, R.L. Emmett, E. Casillas, and T.W. Miller. 2004. Juvenile salmonid distribution, growth, condition, origin, and environmental and species associations in Northern California Current. Fishery Bulletin 102:25–46.

Burgner, R. L., J. T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins of steelhead trout (Oncorhynchus mykiss) in offshore waters of the North Pacific Ocean. Int. N. Pac. Fish. Comm. Bull. 51:1-92.

Busch, S., P. McElhany, and M. Ruckelshaus. 2008. A comparison of the viability criteria developed for management of ESA listed Pacific salmon and steelhead. Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, Washington.

Calambokidis J, E. A. Falcone, T. Quinn, A. Burdin, P. Clapham, J. K. B. Ford, C. Gabriele, R. LeDuc, D. Matillia, L. Rojas-Bracho, J. M. Straley, B. Taylor, J. Urban-Ramirez, D. Weller, B. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. R. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of populations, levels of abundance and status of humpback whales in the North Pacific. Final report for contract AB133F-03-RP-00078. Olympia, Washington: Cascadia Research.

Calambokidis J, G. Steiger, D. Ellifrit, B. Troutman, and C. Bowlby. 2004. Distribution and abundance of humpback whales and other marine mammals off the northern Washington coast. Fisheries Bulletin 102:563-580.

Carretta J, K. A. Forney, E. Oleson, K. Martien, M. Muto, M. Lowry, J. Barlow, J. Baker, M. B. Hanson, D. Lynch, L. Carswell, R. J. Brownell, J. Robbins, D. Mattila, K. Ralls, and M. Hill. 2010. Draft U.S. Pacific marine mammal stock assessments: 2010. NOAA Technical Memorandum.

City of San Jose. 2005. Review of the Effects of Copper on Salmonid Olfaction. Prepared for the San Francisco Bay Copper Site-Specific Objective Workgroup by Watershed Investigations Section, Watershed Protection, Environmental Services Department, City of San Jose.

Dalla Rosa, L. 2010. Modeling the foraging habitat of humpback whales. PhD thesis, University of British Columbia, Vancouver. 185 pp.

Davis, N., G.R. VanBlaricom and P.K. Dayton. 1982. Man-made structures on marine sediments: Effects on adjacent benthic communities. Marine Biology 70:295-303

Dumbauld, B.R., D.L. Holden, and O.P. Langness. 2008. Do sturgeon limit burrowing shrimp populations in Pacific Northwest estuaries? Environmental Biology of Fishes 83:283–296

Emmett, R.L., S.L. Stone, S.A. Hinton, and M.E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in west coast estuaries, Volume II: Species life history summaries. ELMR Report No. 8. NOAA/NOS Strategic Environmental Assessments Division, Rockville, MD, 329 p.

Erickson, D.L. and J.E. Hightower. 2007. Ocean distribution and behavior of green sturgeon. American Fisheries Society Symposium 56:197-211.

Farr, R. A. and J. C. Kern. 2004. Green sturgeon population characteristics in Oregon. Annual progress report. Sport Fish Restoration Project F-178-R Oregon Department of Fish and Wildlife, Portland, Oregon. 32 pp.

Farr, R. A. and T. A. Rien. 2002. Green sturgeon population characteristics in Oregon. Annual progress report. Sport Fish Restoration Project F-178-R, Oregon Department of Fish and Wildlife Portland, Oregon. 46 pp.

Farr, R. A. and T. A. Rien. 2003. Green sturgeon population characteristics in Oregon. Annual progress report. Sport Fish Restoration Project F-178-R, Oregon Department of Fish and Wildlife, Portland, Oregon. 29 pp.

Farr, R. A., M. L. Hughes, and T. A. Rien. 2001. Green sturgeon population characteristics in Oregon. Annual progress report. Sport Fish Restoration Project F-178-R, Oregon Department of Fish and Wildlife, Portland, Oregon. 31 pp.

Fisheries Hydroacoustic Working Group (FHWG). 2008. Joint FHWG Memorandum to Applicable Agency Staff RE: Agreement in principle for interim criteria for injury to fish from pile driving activities.

Fleming A, and J. Jackson. 2011. Global review of the humpback whale (Megaptera novaeangliae). NOAA-NMFS-SWFSC Tech Memo NMFS-SWFSC-474.

Ford M.J. (ed.). 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-113, 281 p.

Ford, J.K.B. and G.M. Ellis. 2006. Selective foraging by fish-eating killer whales Orcinus orca in British Columbia. Marine Ecology Progress Series 316:185-199.

Ford, M.J., M.B. Hanson, J.A. Hempelmann, K.L. Ayres, C.K. Emmons, G.S. Schorr, R.W. Baird, K.C. Balcomb, S.K. Wasser, K.M. Parsons, and K. Balcomb-Bartok. 2011. Inferred paternity and male reproductive success in a killer whale (*Orcinus orca*) population. Journal of Heredity 102: 537-553.

Forney, K.A. 2007. Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-406. 27p.

Forney, K.A. and J. Barlow. 1998. Seasonal Patterns in the Abundance and Distribution of California Cetaceans, 1991-1992. Marine Mammal Science 14(3): 460-489.

Gill, A.B., I. Gloyne-Phillips, K.J. Neal, and J.A. Kimber. 2005. The potential effects of electromagnetic fields generated by sub-sea power cables associated with offshore wind farm developments on electrically and magnetically sensitive marine organisms - a review. Institute of Water & Environment, Cranfield University, Silsoe, and Centre for Marine and Coastal Studies, Ltd. Cammell Lairds Waterfront Park, Campbeltown Road, Birkenhead, Merseyside for COWRIE.

Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of west coast salmon and steelhead. West Coast Salmon Biological Review Team. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-66, 598 p.

Green, G.A., J.J. Brueggeman, C.E. Bowlby, R.A. Grotefendt, M.L. Bonnell, and K.T. Balcomb, III. 1992. Cetacean Distribution and Abundance Off Oregon and Washington, 1989-1990. Chapter I. In Oregon and Washington marine mammal and seabird surveys, J.J. Brueggeman (ed.). Final Report prepared for the Minerals Management Service, Pacific OCS Region. OCS Study MMS 91-0093. 400 pp

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

Gustafson, R.G., M.J. Ford, P.B. Adams, J.S. Drake, R.L. Emmett, K.L. Fresh, M. Rowse, E.A.K. Spangler, R.E. Spangler, D.J. Teel, and M.T. Wilson. 2011. Conservation status of eulachon in the California Current. Fish and Fisheries. DOI: 10.1111/j.1467-2979.2011.00418.x

Hanson, B., R.W. Baird, J.K.B. Ford, J. Hempelmann-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 southern resident killer whales in their summer range. Endangered Species Research 11:69-82.

Hastings, M.C. and A.N. Popper. 2005. Effects of sound on fish. Prepared for Jones & Stokes under California Department of Transportation Contract No. 43A0139, Task Order 1.Sacramento, California. January 28, 2005.

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 pgs.

Hay, D. and P. B. McCarter. 2000. Status of the eulachon *Thaleichthys pacificus* in Canada. Canadian Stock Assessment Secretariat Research Document 2000/145

Hecht, S.A., D.H. Baldwin, C.A. Mebane, T. Hawkes, S.J. Gross and N.L. Scholz. 2007An overview of sensory effects on juvenile salmonids exposed to dissolved copper: Applying a benchmark concentration approach to evaluate sublethal neurobehavorial toxicity.

Henkel, S. 2011. Baseline Characterization and Monitoring of the OSU Mobile Ocean Test Berth Site: Benthic Habitat Characteristics and Organisms on the Central Oregon Coast. Prepared for Oregon Wave Energy Trust (OWET)

Huff D.D., S.T. Lindley, P.S. Rankin, and E.A. Mora. 2011. Green Sturgeon Physical Habitat Use in the Coastal Pacific Ocean. PLoS ONE 6(9): e25156. doi:10.1371/journal.pone.0025156

ICF International (ICF). 2012. Biological Assessment. Northwest National Marine Renewable Energy Center and Oregon State University Wave Energy Test Project. May. Portland, OR. Prepared for U.S. Department of Energy, Golden, CO.

IC-TRT (Interior Columbia Technical Recovery Team). 2003. Exhibit F: Independent Populations of Chinook, Steelhead, and Sockey for List Evolutionary Significant Units within the Interior Columbia River Domain (Working Draft), 7/1/2003.

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

Israel, J.A. and B. May. 2007. Mixed stock analysis of green sturgeon from Washington State coastal aggregations. Final Report. Genomic Variation Laboratory, University of California-Davis, Davis, CA.

Israel, JA., JF. Cordes, M A. Blumberg and B. May (2004): Geographic Patterns of Genetic Differentiation among Collections of Green Sturgeon, North American Journal of Fisheries Management, 24:3, 922-931

Kieckhefer T, 1992. Feeding ecology of humpack whales in continental shelf waters near Cordell Bank, California. Master's thesis. Moss Landing, CA: Moss Landing Marine Laboratories.

Krahn, M.M., M.B. Hanson, R.W. Baird, R.H. Boyer, D.G. Burrows, C.K. Emmons, J.K.B. Ford, L.L. Jones, D.P. Noren, P.S. Ross, G.S. Schorr, and T.K. Collier. 2007. Persistent organic pollutants and stable isotopes in biopsy samples (2004/2006) from Southern Resident killer whales. Marine Pollution Bulletin 54:1903-1911

Krahn, M.M., M.J. Ford, W.F. Perrin, P.R. Wade, R.B. Angliss, M.B. Hanson, B.L. Taylor, G.M. Ylitalo, M.E. Dahlheim, J.E. Stein, and R.S. Waples. 2004. 2004 status review of Southern Resident killer whales (*Orincus orca*) under the Endangered Species Act, U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-62, 73p.

Krahn, M.M., P.R. Wade, S.T. Kalinowski, M.E. Dahlheim, B.L. Taylor, M.B. Hanson, G.M. Ylitalo, R.B. Angliss, J.E. Stein, and R.S. Waples. 2002. Status review of Southern Resident killer whales (*Orcinus orca*) under the Endangered Species Act, U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-54, 133p.

Lagerquist B, Mate B, Ortega-Ortiz J, Winsor M, Urbán-Ramirez J, 2008. Migratory movements and surfacing rates of humpback whales (*Megaptera novaeangliae*) satellite tagged at Socorro Island, Mexico. Marine Mammal Science 24:815-830.

Lagerquist, B. and B. Mate. 2002. Humpback whale sightings off the Oregon and northern California coast, during summer 2002. Hatfield Marine Science Center, Oregon State University.

Lawson, P.W., E.P. Bjorkstedt, M.W. Chilcote, C.W. Huntington, J.S. Mills, K.M.S. Moore, T.E. Nickelson, G.H. Reeves, H.A. Stout, T.C. Wainwright, and L.A. Weitkamp. 2007. Identification of historical populations of Coho salmon (*Oncorhynchus kisutch*) in the Oregon coast evolutionarily significant unit. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-79, 129 p.

Lindley, S. T., R. Schick, B. P. May, J. J. Anderson, S. Greene, C. Hanson, A. Low, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G.Williams. 2004. Population structure of threatened and endangered Chinook salmon ESUs in California’s Central Valley basin. NOAA-TM-NM FS-SWFSC-360

Lindley, S.T., M.L. Moser, D.L. Erickson, M. Belchik, D.W. Welch, E. Rechisky, J.T. Kelly, J.C. 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., M.S. Mohr, W.T. Peterson, C.B. Grimes, J.Stein, J.J. Anderson, L.W. Botsford, D.L. Bottom, C.A. Busack, T.K. Collier, J.Ferguson, J.C. Garza, A.M. Grover, D.G. Hankin, R.G. Kope, P.W. Lawson, A.Low, R.B. MacFarlane, K.Moore, M.Palmer-Zwahlen, F.B. Schwing, J.Smith, C.Tracy, R.S. Webb, B.K. Wells, and T.H. Williams. 2009. What caused the Sacramento River fall Chinook stock collapse? U.S. Department of Commerce, NOAA Technical Memorandum NMFSSWFSC-447.

Lindley, S.T., R.S. Schick, E. Mora, P.B. Adams, J.J. Anderson, S. Greene, C. Hanson, B.P. May, D.R. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2007. Framework for assessing viability of threatened and endangered salmon and steelhead in the Sacramento-San Joaquin basin. San Francisco Estuary and Watershed Science 5:1 (February 2007). California Bay-Delta Authority Science Program and the John Muir Institute of the Environment, Article 4

Lower Columbia Fish Recover Board (LCFRB). 2010. Washington Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan Final; Chapters 1-4.

Manoukian, S., A. Spagnolo, G. Scarcella, E. Punzo, R. Angelini, and G. Fabi. 2010. Effects of two offshore gas platforms on soft-bottom benthic communities (northwestern Adriatic Sea, Italy). Marine Environmental Research 70:402-410

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-42, Seattle, Washington, 156 p.

MMS (Minerals Management Service). 2007. Programmatic environmental impact statement for alternative energy development and production and alternate use of facilities on the outer continental shelf. Final environmental impact statement. October 2007. OCS EIS/EA MMS 2007-046.

Moyle, P. B. 2002. Inland Fishes of California. Revised and Expanded. Univ. Calif. Press, Berkeley and Los Angeles, CA.

Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. Fish Species of Special Concern in California. Second edition. Final report to CA Department of Fish and Game, contract 2128IF.

Myers, J., C. Busack, D. Rawding, A. Marshall, D. Teel, D.M. Van Doornik, and M.T. Maher. 2006. Historical population structure of Pacific salmonids in the Willamette River and lower Columbia River basins. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-73, 311 p.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, 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.

Myers, K.W., N. Klovach, O. Gritsenko, S. Urawa and T. C. Royer. 2007. Stock-Specific Distributions of Asian and North American Salmon in the Open Ocean, Interannual Changes, and Oceanographic Conditions. North Pacific Anadromous Fish Commission Bulletin No. 4: 159–177

NMFS and USFWS (National Marine Fisheries Service and U.S. Fish and Wildlife Service). 2007a. Green sea turtle (*Chelonia mydas*). 5-Year review: Summary and Evaluation.

NMFS and USFWS . 2007b. Olive Ridley sea turtle (*Lepidochelys olivacea*). 5-Year review: Summary and Evaluation.

NMFS and USFWS. 2007c. Loggerhead sea turtle (*Carretta Carretta*). 5-Year review: Summary and Evaluation.

NMFS and USFWS. 2007d. Leatherback sea turtle. 5-Year review: Summary and Evaluation.

NMFS. 1970. Title 50—Wildlife and Fisheries, Chapter I—Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, Department of the Interior, Part 17—Conservation of endangered species and other fish and wildlife; list of endangered foreign fish and wildlife. Federal Register 35:233(2 December 1970):18319-18322.

NMFS. 1978. Title 50—Wildlife and Fisheries, Chapter I—U.S. Fish and Wildlife Service, Department of the Interior, Chapter II--National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Department of Commerce. Listing and protecting loggerhead sea turtles as "Threatened Species" and populations of green and olive Ridley Sea turtles as “Threatened Species or Endangered Species.” Final rule. Federal Register 43:146(28 July 1978):32800-32811.

NMFS. 1990. Listing of Steller sea lions as threatened under the Endangered Species Act. Final rule. Federal Register 55:227(26 November 1990):49204-49241.

NMFS. 1991. Final Recovery Plan for the humpback whale (*Megaptera novaeangliae*). November 1991. U.S. Department of Commerice. National Oceanic and Atmospheric Administration. National Marine Fisheries Service. Office of Protected Resources; 105 pp.

NMFS. 1993a. Designated critical habitat; Snake River sockeye salmon, Snake River spring/summer Chinook salmon, and Snake River fall Chinook salmon. Final rule. Federal Register 58:247(28 December 1993):68543-68554.

NMFS. 1993b. Designated critical habitat; Sacramento River winter-run Chinook salmon. Final rule. Federal Register 58:114(16 June 1993):33212-33219.

NMFS. 1993c. Designated critical habitat; Steller sea lion. Final rule. Federal Register 58:165(27 August 1993):45269-45285.

NMFS. 1999a. Designated critical habitat; revision of critical habitat for Snake River spring/summer Chinook salmon. Final rule. Federal Register 64:205(25 October 1999):57399-57403.

NMFS. 1999b. Designated critical habitat; Central California Coast and Southern Oregon/Northern California Coasts Coho Salmon. Final rule. Federal Register 46:86(5 May 1999):24049-24062.

NMFS. 2003. Endangered and threatened species: regulations governing the taking and importing of marine mammals; Eastern North Pacific Southern Resident Killer Whales. Final rule. Federal Register 68:103 (29 May 2003): 31980-31983

NMFS. 2005a. Endangered and threatened species; final listing determinations for 16 evolutionarily significant units of West Coast salmon, and final 4(d) protective regulations for threatened salmonid ESUs. Final rule. Federal Register 70:123(28 June 2005):37160-37204.

NMFS. 2005b. Endangered and threatened species; designation of critical habitat for 12 evolutionarily significant units of West Coast salmon and steelhead in Washington, Oregon, and California. Final rule. Federal Register 70:170(2 September 2005):52630-52858.

NMFS. 2005c. Endangered and threatened wildlife and plants: Endangered Status for Southern Resident Killer Whales. Final rule. Federal Register 70:222(18 November 2005):69903-69912.

NMFS. 2005d. Endangered Fish and Wildlife; Notice of intent to prepare an environmental impact statement. 70:7 (11 January 2005):1871-1975.

NMFS. 2006a. Endangered and threatened species: final listing determinations for 10 distinct population segments of West Coast steelhead. Final rule. Federal Register 71:3(5 January 2006):834-862.

NMFS. 2006b. Endangered and threatened wildlife and plants: threatened status for Southern distinct population segment of North American Green Sturgeon. Final rule. Federal Register 71:67(7 April 2006):17757-17766.

NMFS. 2006c. Endangered and threatened species; designation of critical habitat for Southern Resident killer whale. Final rule. Federal Register 71:229(29 November 2006): 69054-69070.

NMFS. 2008a. Endangered and threatened species: final threatened listing determination, final protective regulations, and final designation of critical habitat for the Oregon Coast Evolutionarily Significant Unit of coho salmon. Final rule. Federal Register 73:29(11 February 2008):7816-7873.

NMFS. 2008b. Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*). National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS. 2008c. Recovery Plan for the Steller sea lion (*Eumetopias jubatus*). Revision. National Marine Fisheries Service, Silver Spring, MD. 325 pp.

NMFS. 2009a. Endangered and threatened wildlife and plants: final rulemaking to designate critical habitat for the threatened Southern Distinct Population Segment of North American green sturgeon. Final rule. Federal Register 74:195(9 October 2009):52300-52351.

NMFS. 2010a. Endangered and threatened wildlife and plants: threatened status for Southern Distinct Population Segment of eulachon. Final rule. Federal Register 75:52(18 March 2010):13012-13024.

NMFS. 2010b. Endangered and threatened species; 90-Day Finding on Petitions to Delist the Eastern Distinct Population Segment of the Steller Sea Lion. Notice of 90-day petition. Federal Register 75:238 (13 December 2010):77602-77605

NMFS. 2010c. Federal Recovery Outline North American Green Sturgeon Southern Distinct Population Segment prepared by NMFS Southwest Region, December 2010

NMFS. 2011a. Endangered and threatened species; designation of critical habitat for the Southern Distinct Population Segment of eulachon. Final rule. Federal Register 76:203(20 October 2011):65324-65352.

NMFS. 2011b. Endangered and threatened species: final rule to revise the critical habitat designation for the Endangered leatherback sea turtle. Final rule. Federal Register 77:17(26 January 2012):4170-4201

NMFS. 2011c. Southern Resident Killer Whales (Orcinus orca) 5-year Status Review: Summary and Evaluation. National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS. 2012. Endangered and Threatened Species;Proposed Delisting of Eastern DPS of Steller Sea Lions. Proposed Rule. Federal Register. 77:75 (18 April 2012):23209-23220

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

NOAA. 2012. Coast Pilot 7- Forty-fourth Edition. Office of Coast Survey, National Ocean Service, Silver Springs, MD.

Normandeau Associates, Exponent Inc, T. Tricas and A. Gill. 2011. Effects of EMFs from undersea power cables on elasmobranchs and other marine species. Final Report prepared for U.S. Department of the Interior Bureau of Ocean Energy Management, Regulation and Enforcement Pacific OCS Region. OCS Study BOEMRE 2011-09

North Pacific Anadromous Fish Comission (NPAFC). 2012, High Seas Salmon Program - Known Ocean Ranges of Pacific Salmon and Steelhead from High Seas Tagging Research

Northwest Fisheries Science Center (NWFSC). 2011. Risk assessment of U.S. West Coast groundfish fisheries to threatened and endangered marine species. Northwest Fisheries Science Center, National Marine Fisheries Service. 2725 Montlake Blvd E, Seattle, WA.

ODFW and NMFS. 2011. Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead Final- August 5, 2011

Olesiuk, P.F., M.A. Bigg, and G.M. Ellis.1990. Life history and population dynamics of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Report of the International Whaling Community (special issue).

Olsen, E., P. Budgell, E. Head, L. Kleivane, L. Nøttestad, R. Prieto, M. A. Silva, H. Skov, G. A. Víkingsson, G. Waring, and N. Øien . 2009. First satellite-tracked long-distance movement of a sei whale (*Balaenoptera borealis*) in the North Atlantic. Aquatic Mammals 35(3):313-318.

Oregon Climate Change Research Initiative (OCCRI). 2012. Climate Change Impacts the the Coastal an Marine Environment. July 19, 2012.

Oregon Department of Environmental Quality (ODEQ). 2003. LASAR database Station information for Station ID 30244. 4pgs.

Oregon Department of Environmental Quality (ODEQ). 2011. Reedsport OPT Wave Park Evaluation and Findings Report December 2, 2011.

Oregon State University (OSU), National Northwest Marine Renewable Energy Center (NNMREC). 2012. Letter dated June 14, 2012 to L. Margason (DOE) and D. Henry (Corps) re: NMFS request for additional information. 5 pgs

Pacific Energy Ventures (PEV). 2012. Nationwide Permit #5 application: Wave energy test project at the Northwest National Marine Renewable Energey Center. March 27, 2012. Prepared for Northwest National Marine Renewable Energy Center, Oregon State University.Peterson, W., C. Morgan, J. 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 19:6, 508-525

PFMC (Pacific Fishery Management Council). 1998. Description and identification of essential fish habitat for the Coastal Pelagic Species Fishery Management Plan. Appendix D to Amendment 8 to the Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council, Portland, Oregon. December.

PFMC. 1999. Description and identification of essential fish habitat, adverse impacts and recommended conservation measures for salmon. Appendix A to Amendment 14 to the

Pacific Coast Salmon Plan. Pacific Fishery Management Council, Portland, Oregon. March.

PFMC. 2003. U.S. West Coast highly migratory species: Life history accounts and essential fish habitat descriptions. Appendix F to the Fishery Management Plan for the U.S. West Coast Fisheries for Highly Migratory Species. U.S. West Coast Highly Migratory Species Plan Development Team. Pacific Fishery Management Council, Portland, Oregon. January.

PFMC. 2005. Amendment 18 (bycatch mitigation program), Amendment 19 (essential fish habitat) to the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington groundfish fishery. Pacific Fishery Management Council, Portland, Oregon. November.

Pitcher, K. W., P. F. Olesiuk, R. F. Brown, M. S. Lowry, S. J. Jeffries, J. L. Sease, W. L. Perryman, C. E. Stinchcomb, and L. F. Lowry. 2007. Status and trends in abundance and distribution of the eastern Steller sea lion (Eumetopias jubatus) population. Fish. Bull. 107(1):102-115.

Pool, S.S., D.C. Reese, and R.D. Brodeur. MS. 2011. Defining marine habitat of juvenile Chinook salmon (Oncorhynchus tshawytscha) and coho salmon (O. kisutch) in the northern California Current System. Environ Biol Fish (2012) 93:233–243

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

Quinn, T.P. and E. Brannon. 1982. The use of celestial and magnetic cues by orienting sockeye salmon smolts. Journal of Comparative Physiology A: Neuroethology, Sensory, Neural, and Behavioral Physiology 147:(4) 547–552. December 1982.

Rice, D.W. 1977. The humpback whale in the North Pacific: Distribution, exploitation, and numbers. In K.S. Norris & R. Reeves (Eds.), Report on a workshop on problems related to humpback whales (*Megaptera novaeangliae*), in Hawaii,Report to the U.S. Marine Mammal Commission, Washington, D.C., pp. 29-44)

Richardson, W.J., C.R Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise. Academic Press, New York, NY.

Salo, E. O. 1991. Life history of chum salmon (*Oncorhynchus keta*). In Pacific salmon life histories. Edited by C. Groot and L. Margolis. UBC Press, Vancouver. pp 233-309

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

Scottish Executive. 2007. Scottish Marine Renewables Strategic Environmental Assessment Environmental Report Section C SEA Assessment: Chapter C18 EMF. Faber Maunsell and METOC PLC, 26p. March 2007.

Shaffer, M. 1987. Minimum viable populations: coping with uncertainty. Pages 69-86 in M. Soulé, editor. Viable populations for conservation. Cambridge University Press, Cambridge.

Slater, M., A. Schultz, R. Jones, and C. Fisher. 2010. Electromagnetic Field Study. Prepared for Oregon Wave Energy Trust.

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

Spence, B. C., E. P. Bjorkstedt, J. C. Garza, J. J. Smith, D. G. Hankin, D. Fuller, W. E. Jones, R. Macedo, T. H. Williams, E. Mora. 2008. A framework for assessing the viability of threatened and endangered salmon and steelhead in the North-Central California Coast Recovery Domain. NOAA Technical Memorandum NMFS-SWFSC- 423.

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 (2006) 240–252

Stevick, P., J. Allen, P. Clapham, N. Friday, S. Katona, F. Larson, J. Lien, D. Mattila, P. Palsboll, J. Sigurjonsson, T. Smith, N. Oien, and P. S. Hammond. 2003. North Atlantic humpback whale abundance and rate of increase four decades after protection from whaling. Marine Ecology-Progress Series 258:263-273.

Stout, H.A., P.W. Lawson, D. Bottom, T. Cooney, M. Ford, C. Jordan, R. Kope, L. Kruzic, G. Pess, G. Reeves, M. Scheuerell, T. Wainwright, R. Waples, L. Weitkamp, J. Williams and T. Williams. 2011. Scientific conclusions of the status review for Oregon Coast coho salmon (Oncorhynchus kisutch). Draft revised report of the Oregon Coast Coho Salmon Biological Review Team. NOAA/NMFS/NWFSC, Seattle, Washington.

Terlizzi, A., S. Bevilacqua, D. Scuderi, D. Fiorentino, G. Guarnieri, A. Giangrande, M. Licciano, S. Felline, and S. Fraschetti. 2008. Effects of offshore platforms on soft-bottom macro-benthic assemblages: A case study in a Mediterranean gas field. Marine Pollution Bulletin 56:1303-1309

Thomsen, F., K. Ludemann, R. Kafemann, and W. Piper. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg, Germany on behalf of COWRIE Ltd.

Tynan C, D. Ainley, J. Barth, T. Cowles, S. Pierce, and L. Spear. 2005. Cetacean distributions relative to ocean processes in the northern California Current system. Deep-Sea Res II 52:145-167.

UCSRB (Upper Columbia Salmon Recovery Board). 2007. Upper Columbia spring Chinook salmon and steelhead recovery plan. Available at: http://www.nwr.noaa.gov/Salmon-

Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/upload/UC_Plan.pdf

USGCRP (U.S. Global Change Research Program). 2009. Global Climate Change Impacts in the U.S. USGCRP, Suite 250, 1717 Pennsylvania Ave., NW, Washington, DC 20006.

Valkirs, A.O., P.F. Seligman, E. Haslbeck, and J.S. Caso. 2003. Measurement of copper release rates from antifouling paint under laboratory and in situ conditions: implications for loading estimation to marine water bodies. Marine Pollution Bulletin Volume 46, Issue 6, June 2003, Pages 763-779

Wainwright, T.C., M.W. Chilcote, P.W. Lawson, T.E. Nickelson, C.W. Huntington, J.S. Mills, K.M.S. Moore, G.H. Reeves, H.A. Stout, and L.A. Weitkamp. 2008. Biological recovery criteria for the Oregon Coast coho salmon evolutionarily significant unit. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-91, 199 p.

Ward, E.J., E.E. Holmes, K.C. Balcomb. 2009. Quantifying the effects of prey abundance on killer whale reproduction. Journal of Applied Ecology 46: 632-640.

Wardle, C.S., T.J. Carter, G.G. Urquhart, A.D.F. Johnstone, A.M. Ziolkowski, G. Hampson, D. Mackie. 2001. Effects of seismic air guns on marine fish. Continental Shelf Research 21 (2001) 1005–1027

Weitkamp, L. 2010 –Marine distributions of Chinook salmon (*Oncorhynchus tshawytscha*) from the west coast of North America determined by coded wire tag recoveries. Transactions of the American Fisheries Society, 139:1, 147-170

Weitkamp, L. and K. Neely. 2002. Coho salmon (*Oncorhynchus kisutch*) ocean migration patterns: insight from marine coded-wire tag recoveries. Canadian Journal of Fisheries and Aquatic Sciences 59: 1100–1115.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.K. Teel, R.G. Kope, and R.S. Waples. 1995. Status Review of Coho Salmon from Washington, Oregon, and California. September 1995.

Wentworth, C.K. 1922. A scale of grade and class terms for clastic sediments. The Journal of Geology 30(5): 377-392

Wilber, D.H. and D.G. Clarke. 2001. Biological effects of suspended sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Management 21: 855-875.

Williams, T.H., S.T. Lindley, B.C. Spence, and D.A. Boughton. 2011. Status review update for pacific salmon and steelhead listed under the endangered species act: Southwest; 17 May 2011 – Update to 5 January 2011 report. Draft. National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division, Santa Cruz, California.

Wolfson, A. G. Van Blaricom, N. Davis and G.S Lewbel. 1979. The Marine Life of an Offshore Oil Platform. Marine Ecology Progress Series 1:81-89

Yano, A., M. Ogura, A. Sato, Y. Shimizu, N. Baba, K. Nagasawa. 1997. Effect of modified magnetic field on the ocean migration of maturing chum salmon, *Oncorhynchus keta*. Marine Biology 129(3). September 1997.

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

Zerbini A., P. Clapham, and P. Wade. 2010. Assessing plausible rates of population growth in humpback whales from life-history data. Marine Biology 157:1225-1236.

(6. APPENDICES)

Monitoring Plans

NNMNREC Adaptive Management Framework

WET-NZ Adaptive Mitigation Plan

NNMREC Ocean Test Facility (OTF) Short-term Acoustic Test
(03/14/2012)

Title: Short-term acoustic assessment of wave energy conversion at OSU's OTF

Principle Investigators: Joe Haxel, Robert Dziak, and Haru Matsumoto – Oregon State University/ Cooperative Institute for Marine Resources Studies (CIMRS)

Background: Continuous long-term passive measurements of ambient sound levels (1 Hz – 2 kHz) have been collected from March 2010 – April 2011 at two sites within the MOTB providing a characterization of background acoustic levels (*Haxel et al., in press & in prep.*) over a range of sea states and environmental conditions. Ambient sound in the ocean is composed of a complexamalgam of sources. Despite prior knowledge of probablesound sources within an oceanic region, a distinguishingcharacteristic of marine ambient sound is that no individualsignal dominates or can be readily identified within thereceived field. Analogous to the background "hum"emanating from a large city, ambient sound in the ocean is thebackground sound resulting from remote and near-fieldcontributions of a multitude of anthropogenic and naturalsources. At the MOTB site, theambient noise field consists primarily of sounds emanatingfrom breaking waves, winds, vessel traffic, marine mammals, and fish.

Root mean square (rms) maximum and minimum total sound pressure levels (SPL_{rms}) from the 1Hz-2kHz band calculated over 1 minute intervals during the experiment reached 136 dB re 1 μPa and 95dB re 1 μPa respectively. Meanwhile, the time averaged SPL_{rms} value for the year-long deployment was 113 dB re1μPa.

$$SPL_{rms} \text{ (dB re } 1\mu\text{Pa)} = 20 \log_{10}(p_{rms}/p_{ref})$$

Peak SPL_{rms} values were encountered during heavy surf conditions recorded at a nearby offshore NOAA NDBC buoy (http://www.ndbc.noaa.gov/station_page.php?station=46050).

Underwater sounds generated by the operations of the mobile ocean test berth (MOTB)instrumentation buoy (Ocean Sentinel) and wave energy converter (WEC)this summer (2012) are expected to contribute to the local noise budget. The purpose of this study is to provide a rapid measurement of the maximum, root mean square (rms), and minimum absolute sound pressure levels (SPL) received at a range of 10 m – 200 m distance from the WEC device. These observations will provide the necessary information to evaluate the acoustic impact of the operational WEC on marine mammals based on NMFS criteria for harassment (120 dB) and injury (180 dB).

Project Objectives: Little information is knows about the sound impact of WECs. The objective of the acoustic monitoring is to determine if the device under test transmits acoustic energy above mammal harassment thresholds.

Project Description: The methods and instrumentation will be similar with techniques used by Bassett et al. (*in press*) to perform a similar evaluation of a WEC in Puget Sound operated by Columbia Power Technologies. Unlike the drifter used in the Bassett et al. (*in press*) study, we propose to deploy a calibrated cabled hydrophonefrom a vessel. Each recording will begin and end ~200 m up and down drift of the WEC device. The hydrophone will be dropped to ~10 m below the sea surface and the vessel's engines will be shut down in order to eliminate noise contamination. The calibrated hydrophone system will record continuously at a sample rate of 50 kHz, providing reliable power spectral density estimates up to 20 kHz. A series of 4 drifts will be made past the WEC device during each recording cruise session.

Initial baseline near surface acoustic recordings using the protocol outlined above will be performed in May prior to any MOTB mooring installations in the area designated by Oregon State University for the WEC test. These baseline measurements will provide background for comparison of operational acoustic transmissions from the WEC, as well a test of our recording procedure prior to WEC installation and operation. Additionally, these initial recordings may indicate pre-existing ambient sound conditions above NMFS threshold criteria prior to MOTB activity. A subsequent recording cruise mission will be carried out after the WEC device has been deployed and is in operation.

Reporting: Data from each recording session will be processed and analyzed in a timely manner to provide NMFS and ODFW regulatory personnel with the necessary received SPL measurement information in order to assess acoustic levels produced by the WEC test.

Adaptive Management: Upon review of the initial results, and in coordination with NMFS and ODFW, NNMREC scientists may recommend further recording or no further recording upon satisfactory completion of the acoustic monitoring required by the WEC test permit.

If confirmed testing indicates that sound levels are above Level A (180dB SPL for cetaceans and 190dB for pinnipeds) or Level B (120dB SPL) harassment threshold criteria, and that the sound levels are attributable to the WEC test, NNMREC scientists and Ocean Test Facility Manager, in coordination with NMFS and ODFW, will determine the appropriate action. Action may include:

- Further recording to confirm acoustic pressure levels;
- Modifying the operation of the WEC or Ocean Sentinel;
- Ceasing operation and performing necessary modifications to minimize noise levels. Testing would be conducted to verify that the noise associated with the test has been abated; and/or
- Applying for an Incidental Harassment Authorization.

<u>Schedule:</u>

May 2012–baseline recording

July 2012 **–** initial recording of WEC (within 2 weeks of installation, weather permitting)
(initial results provided within 1 week)

August 2012 **–** continued recording of WEC (if necessary)

NNMREC OTF Benthic Monitoring Studies

Title: Monitoring of benthic habitat, invertebrates, and fishes at OSU's ocean test facility

Principle Investigator: Sarah Henkel – Oregon State University, Northwest National Marine Renewable Energy Center and Hatfield Marine Science Center

Background: Pre-installation baseline sampling of benthic habitats and species was conducted at and around the future ocean test facility location from May 2010 to December 2011. After exploratory video sled surveys in May 2010, sample stations were established on a regular grid. Twelve stations were established: two transects north of Yaquina Head, two transects south of the Head, and stations at approximately 30, 40, and 50 m on each of the transects. These transects are designated as (north to south): BB (Beverly Beach), MB (Moolack Beach), NH (Newport Hydrographic Line), and NS (Newport-South). All 12 stations were sampled ~bi-monthly for sediment and infaunal organisms using a box corer. For beam trawl surveys, only 9 stations were sampled on each visit. Those stations along the southern-most transect lie at the edge of a reef, and it is too risky for the net and the reef organisms to sample those stations. Video footage from the beam trawl was effectively captured in summer months; winter videography (attempted in February 2011) did not yield useful footage. Although not a primary objective of the videography, evidence of derelict gear did not show up on any of the transects. Wayward crab pots and research gear are anticipated to be the predominate type of derelict gear in the test area.

Project Objectives:

1. The presence of anchors and the potential for changes in benthic habitat may affect the distributions of benthic fishes and invertebrates. To investigate this hypothesis, benthic species and habitat monitoring will be conducted in to determine how benthic organisms will respond to WEC-induced changes to the habitat.

2. The introduction of hard surfaces may encourage colonization by marine invertebrates and fish attraction. To investigate this hypothesis, visual observations of the introduced surfaces to assess colonization will be conducted. Additionally, the ongoing benthic sampling conducted under objective (1) will investigate whether resident species are being affected by those attracted to the structures.

3. Marine mammals could become entangled or entrapped by derelict gear that has been ensnared on any Project structure. To investigate this hypothesis, derelict gear monitoring will be conducted to determine if gear is being ensnared by the anchors and mooring lines.

Project Description: The OTF is planned to be located approximately on the MB sampling transect in 45 m of water, so it will be in between the 40 and 50 m sampling stations on that line. Post installation monitoring of the NNMREC Ocean Test Facility (OTF) for assessing interactions with benthic habitats and species will be carried out in much the same manner as pre-installation baseline sampling. Table 1 indicates the pre-installation sampling already conducted (black text) and planned future monitoring, generally at the permitted site and for the 2012 test (blue text).

Table 1: Sampling visits and gear types.

	Box Core	Trawl	Trawl Video	Lander Video
June 2010	✔	✔		
August 2010	✔	✔	✔	
October 2010	✔	✔		
February 2011		✔	✔	
April/May 2011	✔	✔	✔	
June 2011	✔	✔	✔	
August 2011	✔	✔		
October 2011	✔	✔	✔	
December 2011	✔	✔		
June 2012	✔	✔	✔	✔
August 2012	✔	✔	✔	✔
October 2012	✔	✔	✔	✔

We will visit the site in June 2012, once more prior to deployment since it will have been 6 months since our last visit. After the Sentinel Buoy and associated WEC device under test are deployed in July, we will visit the site again in August 2012 for an assessment while the devices are operational. Weather permitting, we will again visit the site after the Sentinel Buoy and WEC device are removed to assess if there are 'decommissioning' effects or if site characteristics are similar to pre-test conditions and/or baseline observations. Sample collection and data analysis methods are described in detail below.

Sample Collection Methods

i. Box core. One box core will be taken at each beam trawl station. The box core is a 0.1 m^2 modified Gray-O'Hare box corer. Upon landing the corer, a subsample of sediment from the undisturbed surface will be collected and preserved for grain size and total organic carbon analysis. The sample will then be sieved onboard through a 1 mm mesh screen; samples will be stained and preserved for later identification and enumeration. Samples will be sorted into major taxonomic groups by lower level staff; these major taxonomic groups will be weighed for biomass determination. The laboratory manager will identify the echinoderms and molluscs to species and crustaceans and polychaetes to family (lower if possible).

ii. Beam trawl with mounted video camera. The beam trawl is 2 m wide by 0.5 m high with 20 mm wall netting and 3 mm cod end netting. The duration of beam trawls will be kept to 10 min from contact with bottom to retrieval. We will collect and preserve (freeze with dry ice and store at -20 ^{o}C) fish and invertebrates from the net catches for later taxonomic identification. In the laboratory, all fish will be analyzed for size and morphometric body condition as well as their gut contents identified. This will enable us to investigate if the condition of the fish or their feeding habits has changed from what we observed in our 18 months of pre-installation baseline monitoring. Invertebrates will be sorted to species and each species' biomass determined. Videos will be viewed to determine the densities of sessile and mobile invertebrates (e.g. sea pens, crabs, sea stars) that are not well captured with the net.

iii. Video lander (drop-video camera). This is a sampling tool that was not used for baseline monitoring but will be valuable for assessing potential fish aggregating effects of anchors. The video lander is an aluminum frame with two sets of video cameras with lights mounted on the frame. The two cameras are oriented 180° from each other so that they are facing opposite directions. The lander will be deployed at the 40 and 50 m stations on the BB and MB lines as reference locations as well as dropped near each anchor of the Ocean Sentinel (n = 3; ~45 m depth) and at each anchor of the WEC under test (as appropriate for each device type). The lander will be left on the bottom for a total of 15 minutes at each drop station. The number of each species or taxa of fish observed over time by each camera will be counted and the primary (mostly sand) and secondary (potentially anchor) substrate observed will be recorded. Counts will be compared to determine if more fish are observed at anchor locations than at reference locations and if more fish are observed by the camera facing the anchor than facing away. Since the anchors for the Ocean Sentinel are planned to be left in the water, video lander sampling of Ocean Sentinel anchors and reference locations will continue for the duration of the project, regardless if whether there is a WEC device under test. This sample method will also provide for monitoring of derelict gear that may become tangled on the anchors and animal entanglement. For derelict gear, the location (lat/lon in decimal degrees), type of gear, and condition (approximate size, line color, number and color of floats, if attached, presence or absence of pots or webbing) will be recorded. For entanglement, the species, its condition of entanglement and location will be recorded.

iv. CTD-DO with chl a, and alkalinity. We will sample properties of the full water column with a SeaBird CTD profiler (SBE 25) with DO (SBE 43), pH, transmissivity and chlorophyll a sensors at every sampling station on each visit.

Data Analysis

For species assemblage analyses (conducted separately for box core invertebrates, trawl invertebrates, trawl fishes, and video lander fishes), taxa for which there is just one individual collected/observed for the entire dataset will be removed so as not to skew the data based on rare species. Cluster analysis will be conducted on transformed density datasets for each assemblage in order to produce groups of similar stations based on species abundances. The SIMPROF routine will be run in Primer 6. This routine conducts a series of permutation tests to determine if clusters in a dendrogram have statistically significant structure. Samples within a cluster that cannot be significantly differentiated are considered to be a genuine group. The SIMPER procedure in Primer then will be used to identify species contributing most to similarities within clusters and differences between clusters. This analysis will be used to determine if there are unique communities within each assemblage found across the site. Analysis of the pre-installation collections indicated that there was strong spatial heterogeneity in the invertebrate collections that were stable over time. The spatial distributions of significantly different species groups from the post-installation surveys will be compared to the pre-installation surveys. Analysis of the fish data from pre-installations collections did not elucidate any spatial patterns of species presence or abundance; thus it will be interesting to see if we observe spatial differences in fish distributions post-installation. There was however, strong temporal variability in species present across seasons. We will determine if those patterns are consistent post-installation.

Multivariate analysis of the combined pre- and post-installation datasets will be conducted in Primer. Multidimensional Scaling (MDS) will be used to analyze the transformed density data to examine species composition and proportions across stations. MDS is an ordination technique where a small number of axes are selected prior to analysis and data are fitted to those dimensions, Data will be displayed in MDS plots such that samples that form a genuine cluster, as determined using the SIMPROF routine, have the same symbol on the plot. Thus, we will be able to visually determine if samples from the same season before and after installation cluster together or if post-installation samples are significantly different from pre-installation. Following MDS analysis of the organism data, the BEST function in Primer will be used. The BEST function is based on the BIO-ENV procedure, which uses all the available potential 'explanatory' (usually environmental) variables to find the combination that corresponds best to the patterns in the biological data. A correlation value is given for each comparison of the biological assemblage patterns and every combination of environmental variables. We will include a binary factor indicating pre- or post-installation in the environmental matrix in order to determine if that factor contributes to observed distinctions among collections.

In addition to multivariate analyses at the species level, we will compare our observations of infaunal invertebrates and fishes to longer time series by comparing summary statistics. The US Army Corps of Engineers samples the dredge spoils from Yaquina Bay for infaunal invertebrates and occasionally fishes. The location of the North Disposal Site and sampling area falls within the NNMREC sampling area (Figure 1); thus we are able to compare densities of major taxonomic groups (Polychaetes, Molluscs, Crustaceans, Echinoderms) to the USACE to expand our reference dataset, enabling us to put post-installation observations in the context of longer term, inter-annual trends and variability. Various Oregon State University researchers have been sampling flatfish along the MB and NH transects at various time since the mid-1970s. While direct density comparisons may not be possible due to differences in gear types, we will compare the relative abundances of different flatfish species in our pre- and post-installation observations to those observed over the past few decades.

Drop camera footage will be viewed to determine if more fish are observed at anchor locations than at reference locations and if more fish are observed by the camera facing the anchor than facing away. Derelict gear and incidents of entanglement will also be recorded if found on the footage.

Reporting

Following each WEC test, a summary report of the pre-, during-, and post-test surveys will be prepared and submitted to NMFS and ODFW for review of both sampling procedures and findings. The report will include findings related to derelict gear and animal entanglement. This reporting will be in compliance with NNMRECs Mobile Ocean Test Berth Operations and Maintenance Plan, Section 9: Marine Mammal Consideration, Reporting Protocol for Injured or Stranded Marine Mammals. The presence of derelict gear itself will be reported to the Oregon Department of Fish and Wildlife. If marine mammal entanglement is observed the Oregon Marine Mammal Stranding Network, which is based at the Hatfield Marine Science Center, will be contacted as well.

The approach described above is that which will be used for the NNMREC Ocean Test Facility site, generally, as well as what is proposed for the 2012 test, which will commence in July 2012. Changes to the timing of deployment for future tests may necessitate slight changes to the sampling schedule. Study plans for the following year and subsequent tests will be submitted to NMFS and ODFW, particularly in the event that any changes from the previous sampling are proposed. If adaptive measures are planned (see below), they will be reflected in the report.

Adaptive Management

We believe it will be difficult to detect measureable changes in most of the sampled populations due to project effects of the Ocean Sentinel and a single WEC device under test. The ‘baseline’ sampling for the Ocean Power Technologies project off Reedsport, OR, is scheduled to commence when they have the first buoy in the water, as this is still considered ‘pre-installation’, and no measureable changes are expected with the deployment of the single buoy. Thus, for benthic monitoring at the NNMREC Ocean Test Facility site, there are few scenarios we can anticipate that would trigger a change in sampling strategy or test operations based on benthic changes.

If monitoring shows that derelict gear has become ensnared or collected on any Project structure, the NNMREC Ocean Test Facility Manager will be notified by the NNMREC scientist to review the footage and evaluate whether the gear has the potential to endanger the safety of species and/or the devices in the area. This may include taking additional photos or footage to characterize the gear more, if necessary. Action will depend on the severity of the derelict gear entanglement and the risk the gear poses to the safety of the test or entanglement of animals. If the gear poses no threat to safety or animals, it will be removed during removal of the project. Gear removal planning and coordination will be initiated by the Ocean Test Facility Manager if deemed appropriate.

Figure 1: Map of project area. Repeat sampling locations are indicated with blue pins. The Ocean Test Facility project area is indicated by the light blue box. The planned location for the first test is indicated with the red star. US ACE dredge spoils sampling area is indicated by the white outline.

PROPOSED STUDY

Electric and Magnetic Field (EMF) Monitoring of WET-NZ 1/2 scale Wave Energy Generator at NNMREC Ocean Test Facility

PI: Dr. Adam Schultz, College of Earth, Ocean and Atmospheric Sciences, Oregon State University, Corvallis OR 97331-5503

Proposed Project Start Date: 1-April-2012
Proposed Project Duration: 24 months

Background

The proposed project involves deploying the WET-NZ ½ scale wave energy converter (WEC) with the Ocean Sentinel instrumentation buoy at the Northwest National Marine Renewable Energy Center (NNMREC) Newport test site offshore Yaquina Head, Oregon. Deployment of the Ocean Sentinel and the WEC unit is planned for July, 2012. We propose to carry out measurements of electric and magnetic fields on the seafloor within and adjacent to the test site during periods when the Ocean Sentinel and WEC are installed and energized. To characterize background, baseline EMF levels, we propose to carry out measurements of EMF during periods when the devices have been removed.

EMF monitoring is not a yet a fully defined science for marine renewable energy applications, and mission-specific instrumentation is needed for the industry. OSU is in the process of developing this instrumentation and will be applying it for the first time to this project in an experimental mode. The National Science Foundation (NSF)-supported National Geoelectromagnetic Facility (NGF) at Oregon State University, led by the PI of this proposal, operates the US national academic instrument pool for terrestrial geoelectromagnetic instruments. The NGF pool currently consists of 46 transportable long-period magnetotelluric (magnetic and electric field) geophysical measuring instruments, as well as 7 such instruments that are permanently deployed at sites across the continental US. The NGF is also currently constructing the first 10 geoelectromagnetic instruments of a new type – termed “ultra-wideband”. This collection of instruments is used extensively in geophysical investigations on land, both to image the electrical resistivity structure of the Earth’s shallow near surface, crust and mantle, and to characterize both natural and anthropogenic electric and magnetic fields (EMFs).

Under Oregon Wave Energy Trust support, the PI of this proposal collaborated with M. Slater of SAIC in construction of a first generation marine EMF sensing platform that was a marine adapted direct offshoot and functional copy of the NGF ultra-wideband instruments that the PI developed under separate NSF support, in collaboration with Zonge, International, Inc. In July 2010, this instrument was successfully used by the PI, NGF technician A.T. Peery and M. Slater, to detect EMFs on the bottom of Yaquina Bay Oregon. The NGF team induced an artificial EMF in a buried, submerged pipeline under the bay by using a Zonge International, Inc., controlled source electromagnetic generator connected to the pipeline. In addition to detecting the location of the buried pipeline, this team also characterized the background natural and anthropomorphic EMFs at the waterline and on the seafloor in Yaquina Bay.

In 2011, under Oregon State University support, and with contributions from Zonge International, Inc. (and more recently through additional NNMREC/DOE support), the PI began the development and construction of a more advanced, 2nd generation "multi-physics bottom lander" (MPBL) system that incorporates a significantly improved EMF sensor package, a wideband ocean bottom seismometer, auxiliary sensors including pressure, accelerometers, etc., capabilities for acoustic telemetry of sensor data from the seafloor to a surface vessel, a trawl resistant cowling to protect the instrument from damage due to fishing activity, and the capability for autonomous deployment of the sensor platform from the deck of a ship and buoyant return of the platform to the surface, by acoustic command.

The MPBL has been carefully designed to characterize EMFs associated with Ocean Sentinel and WEC installations (and, with the addition of its ground motion sensors/seismometers/accelerometers, it is also well suited to environmental monitoring of offshore wind energy installations, as well as to a variety of marine geophysical investigations). The sensors have been designed following guidance found in Slater, Schultz, Jones and Fischer, *Electromagnetic Field Study* (2010), Oregon Wave Energy Trust (346 pages).

The MPBL system consists of an EMF sensor package in a trawl-resistant conical capsule approximately 2m in diameter and 1.5m tall. The lander is hoisted overboard using a vessel-mounted winch at the locations indicated in the survey lines. After approximately 10-20 minutes of recording, it is winched back on to the vessel to be deployed at the next location. Operating in this deployment mode, a single MPBL can be used to characterize the EMF signature of a WEC/Ocean Sentinel installation. In future, the MPBL will also be configurable for an autonomous long-term monitoring mode, where it is deployed at a fixed position on the seabed to monitor EMFs and other environmental parameters over periods of days-to-weeks or longer.

The magnetic field sensors have been custom developed for the MPBL, with a noise floor of approximately 0.05 pT/√Hz at 1 Hz and 0.002 pT/√Hz at 50 Hz (where 1 pT = 10^{-12} Tesla). The Earth's magnetic field intensity as measured by a compass is about 50,000 nT (1 nT = 10^{-9} Tesla). In addition to their extraordinary sensitivity, the MPBL's magnetic field sensors have a flat frequency response from 0.1 Hz to 1 kHz, which makes them ideally suited to detecting even extremely small levels of 50/60 Hz power line noise at the fundamental frequency and its significant harmonics.

We have also developed a custom marine electric field detection system that is matched to the sensitivity of the magnetic field sensors, and both electric and magnetic field sensors detect both the amplitude and the direction of the EMFs, which is critically important during a survey in discriminating between several geographically disparate sources of EMFs (i.e. to determine which cable/installation is the origin of a given signal at a given location). These sensors have been coupled to the first portable, low power geophysical data acquisition system employing a digitizer with 32 bits of precision, providing the ability to digitize the MPBL's sensor signals with extraordinary fidelity (e.g. with a signal-to-noise ratio of 3.2 million:1 for signals at 250 Hz). This extended fidelity is important in efforts to detect the sometimes-subtle EMFs of interest that may be otherwise overwhelmed by signals (natural and anthropogenic) that may come from other sources such as the shore-side power grid.

Such a degree of sensitivity to, and ability to distinguish the sources of, EMFs is required if we are to match the known and postulated electro- and magneto-sensitivity of indicated species, some of which are endangered within this range, as detailed in Slater, et al (2010). That report also indicates that with appropriate conditions (bathymetry, seafloor rock type), it is possible for electrically resistive sub-seafloor geologic formations to act as a type of waveguide, extending the distance range over which potentially biologically significant EMFs may propagate, relative to the more rapid attenuation of such fields in electrically conductive seawater. It is therefore necessary to carry out a program of EMF monitoring of WEC sites in order to characterize background and induced EMFs from such installations. Ideally such monitoring efforts will be coupled with numerical modeling of EMF propagation using a realistic 3D model of the electrical resistivity structure of the seafloor, water column and coastline.

Our current development plan calls for completion of the data acquisition, power supply, magnetic and electric field sections of the MBL, and fabrication of a survey frame to mount these components to so they are field deployable for pre-deployment acceptance testing in Yaquina Bay Oregon, by early August 2012.

Monitoring Objectives:

1. Marine EMF monitoring for marine renewable energy is a newly emerging application of this method, and mission-specific instrumentation is needed for the industry. To increase our understanding of EMF monitoring, OSU has designed and will carry out the first deployment of an advanced 2nd generation EMF monitoring instrument.
2. It is hypothesized that the proposed project is highly unlikely to generate EMF at levels that would adversely impact endangered species. To investigate this hypothesis EMF monitoring will be conducted to characterize EMF during an energized WEC test.

Proposed EMF Monitoring

We propose to carry out two EMF surveys within and immediately surrounding the NNMREC ocean test site. It will be necessary to map the seafloor EMFs surrounding the Ocean Sentinel/WEC installation when that system is operational and energized, and also to repeat the survey after the Ocean Sentinel/WEC system has been removed or powered down. Given the MPBL's acceptance testing schedule, we propose to begin monitoring operations in August 2012, while the Ocean Sentinel/WEC is in its energized configuration. Following its removal and before any new deployments of the Ocean Sentinel take place during the spring/summer of 2013, we will return to ocean test site and repeat the survey to obtain baseline EMF measurements.

During each survey, we plan to acquire data using a 4 kHz sampling rate, so we may resolve power line frequencies up to the 16^{th} harmonic (960 Hz) of the 60 Hz fundamental frequency and beyond. The survey will be capable of detecting both AC EMFs originating at the WEC generator (at ocean swell frequencies of ~0.07 Hz and harmonics, as well as at 60 Hz power line frequencies and harmonics) as well as DC power line transmission related electric fields that might arise in the event of faulty/damaged/cut cable insulation or connector failures..

Survey Configuration

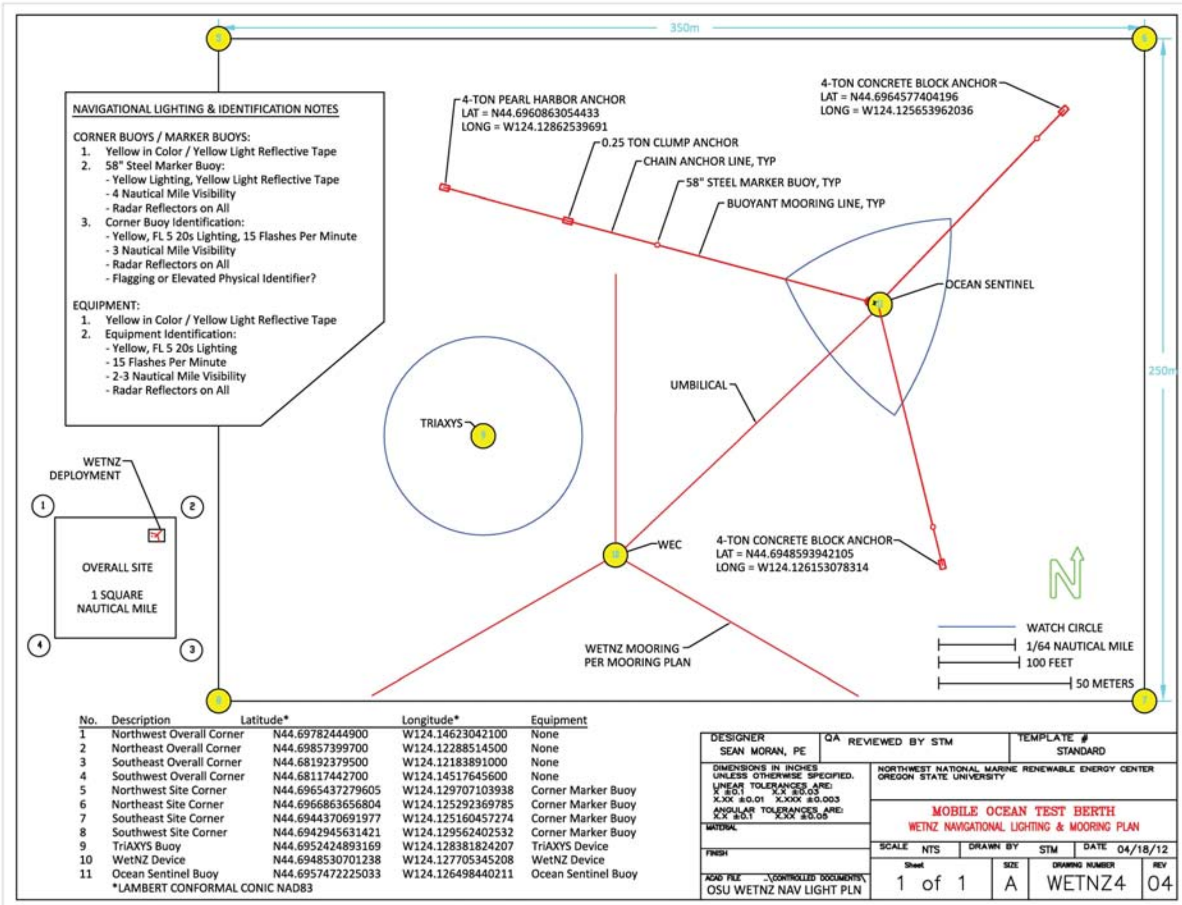
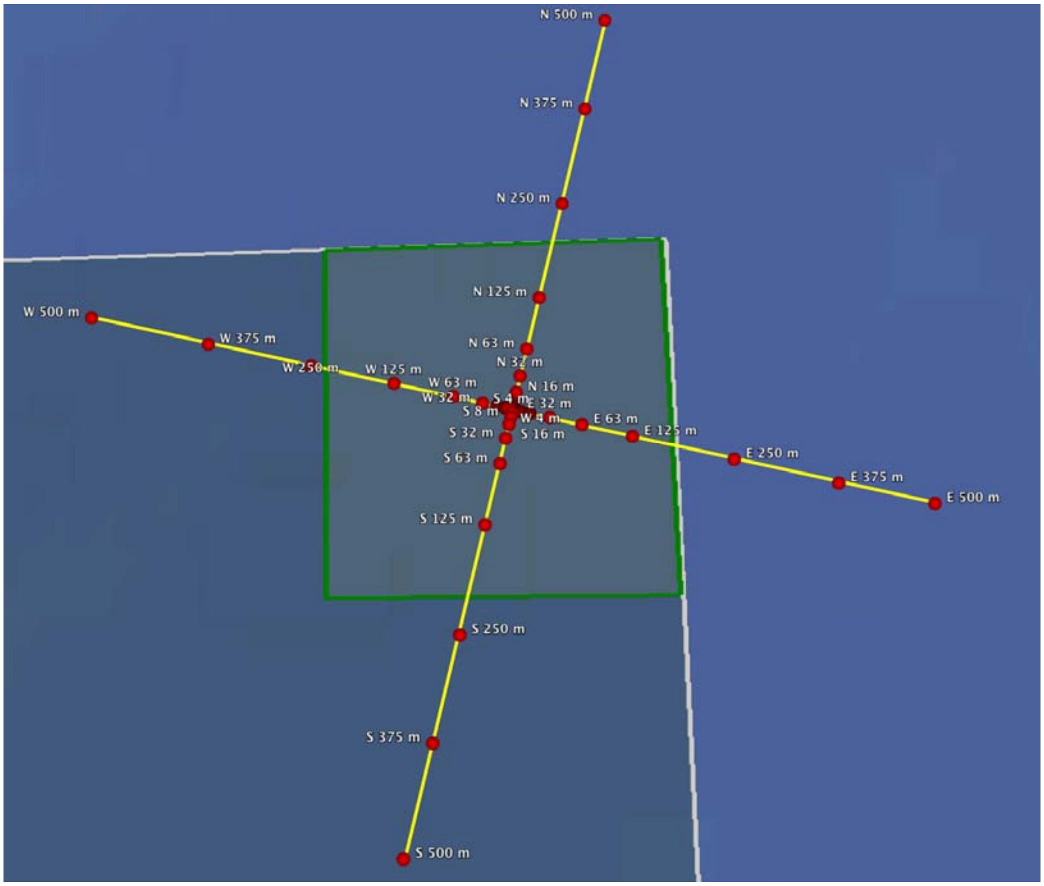


Figure 1. Map view of the Ocean Sentinel/WEC installation mooring lines and watch circle. The distance scale is marked in feet.

Our survey configuration is shown in Figure 2. This survey configuration will be repeated twice; first in August 2012 while the Ocean Sentinel/WEC system is positioned and energized, and again in the spring/summer of 2013 when it has been removed and prior to the reinstallation of the Ocean Sentinel. In the event of delays on the part of the WEC or Ocean Sentinel operators in deploying the system, we will adapt our schedule accordingly, reserving the ability to carry out all survey in 2013 if required. During each of these surveys the ship (the 53' Oregon State University coastal research vessel R/V Elakha) will deploy the EMF sensor platform on the seafloor at the positions indicated in Figure 2 (the red dots), using the vessel's winch. The positions will be navigated with reference to GPS.

36 separate survey stations are identified in Figure 2. Two 1-km long survey lines are shown. All directions are with reference to Magnetic North, a direction that in this location is close to parallel to the coastline and to lines of constant bathymetry. The first survey line is oriented to magnetic north-south and the second orthogonal line is oriented to magnetic east-west. The two lines cross near the center of the Ocean Sentinel/WEC installation midway along the umbilical between the Ocean Sentinel and WEC that is shown in Figure 1.

Figure 2. Each seafloor EMF measurement station is shown as a red dot lying along either a N-S or E-W (magnetic coordinates) survey line. Survey locations are found 4m, 8m, 16m, 32m, 63m, 125m, 250m, 375m and 500 m radially outward from the array center, in each of the four cardinal magnetic directions.



The EMF surface array is designed to tighten spacing between stations geometrically as the center of the array, i.e. the Ocean Sentinel/WEC installation is approached. Field intensity will increase geometrically with proximity to the signal source, so tighter station spacing is required closer in, while sparser EMF sampling is appropriate at greater distances. In addition to stations obtained along the cardinal directions (an approach that also increases ease of survey navigation and operational efficiency), as time allows additional EMF stations will be acquired within each of the quadrants bounded by the survey lines.

It is appropriate to monitor EMFs using such an array configuration to account for bathymetric effects on EMF propagation, and for the possibility that shallow sub-seafloor geology structure may vary in three dimensions, leading to non-uniform EMF propagation with distance from the Ocean Sentinel/WEC installation. The 500 m radius of the survey footprint allows for capture of EMFs that may have propagated along buried geologic waveguides. Experience from studies of induced EMF propagation along such waveguides, a phenomenon used in the oil industry to characterize marine oil/gas reservoirs, provides a rule of thumb: the propagation of induced EMFs due to an “electric dipole” source of a given length can be detected approximately ten dipole lengths distant, if a geologic waveguide is present. The length of the power transmission line between the Ocean Sentinel and the WEC is approximately 50 m, thus the EMF rule of thumb suggests we should monitor EMFs to distances of up to 500 m radially from that cable. In the absence of such a waveguide, we would expect much more rapid attenuation of EMFs with distance from the center, thus the denser station spacing closer in, with stations as close as practical to the center point of the cable (minimum distance to be determined by the Ocean Sentinel manager and the Elakha's captain given prevailing winds and currents. The closest stand-off distances illustrated in Figure 5 are subject to change).

EMFs are best measured from a stable platform of the seafloor. The motion of the sensor platform dragged through the water column leads to a series of technical complications. Such a scenario would move the sensor package through the Earth's magnetic field lines, inducing an electric field that is an artifact of that motion. The platform would also pitch and yaw, changing the orientation of the sensors with respect to the EMFs being measured. Such motion would need to be carefully logged so the measured EMFs could be numerically rotated into constant orientation coordinates. Finally the motion of seawater across the electric field sensor electrodes would create "streaming potentials" that lead to spurious electric field measurements. Given these complications, it is preferable to execute the survey as described above, i.e. as a series of stable bottom station measurements.

Reporting

Post monitoring data analysis will take on the order of 90 days. The results will be written up in a short monitoring summary and transmitted to NMFS and ODFW for review.

Adaptive Management

The EMF results will be compared with known values for impact on endangered species known or likely to be present in the area. If the results indicate that WEC-related EMF levels are within the documented magnetic or electric field sensitivity range of such species, NMFS, ODFW, OSU scientists and the Ocean Facilities Manager will work together on an approach to reduce EMF levels during a test. In the event that the monitoring shows EMF signatures at levels below concern, and after consulting with NMFS and ODFW, the EMF monitoring program will be modified accordingly.

Newport Open Ocean Wave Energy Test Site
Northwest National Marine Renewable Energy Center

ADAPTIVE MANAGEMENT FRAMEWORK

Revised 7/23/2012

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INTRODUCTION

The purpose of this Adaptive Management Framework (Framework) is two-fold. First, it provides a means for the broader regulatory and stakeholder communities to stay informed of and provide feedback on NNMREC test center monitoring and mitigation. The Adaptive Management Committee, described in Section 2, will receive an Annual Operations and Monitoring Report (Annual Report). The Annual Report will be a compilation of monitoring results, adaptive management thresholds, and mitigation actions taken during tests conducted at the NNMREC site. The Committee will meet on an annual basis to review results and provide guidance on future test center activities. Section 3 presents the Adaptive Management Thresholds that the Adaptive Management Committee will use in their review of monitoring results. This component of the Framework will be in place for the duration of NNMREC test center operations.

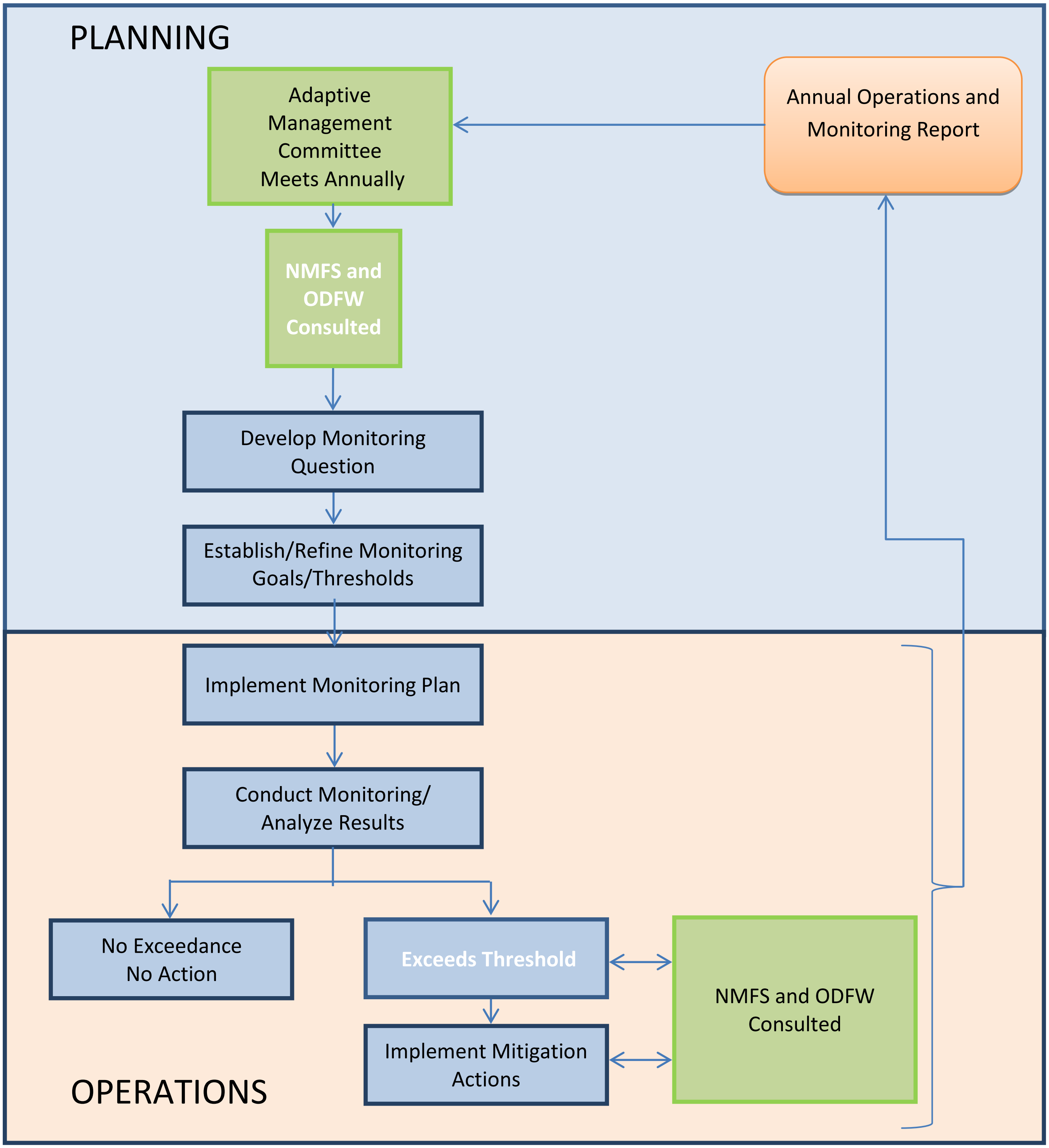
The NNMREC test center will be in operation from 2012 – 2022. Throughout this period, NNMREC will provide an opportunity for various WEC technologies to conduct short-term, non grid-connected tests within the project site, which is a 1 square-nautical-mile area in the Pacific Ocean, approximately 2 miles off the coast of Oregon near the city of Newport.

Second, this Adaptive Management Framework provides a foundation for the monitoring and adaptive management associated with individual tests at the NNMREC site. For each test performed at the NNMREC ocean site, an Adaptive Mitigation Plan will be developed that includes thresholds and mitigation actions for the particular test. The Adaptive Mitigation Plans will account for the unique attributes of that test, such as the characteristics of the technology being tested and duration of testing. In addition, results and analysis of previously completed monitoring studies will be used to inform the plans for future tests.

The Adaptive Mitigation Plan for the Ocean Sentinel/WET-NZ test (provided in Attachment 1) is included as an example of the Adaptive Mitigation Plan that will be developed for each test. Attachment 1 identifies thresholds that if exceeded may require a mitigation response. Monitoring results will be reviewed by NNMREC in real-time, whenever possible, to determine if thresholds have been exceeded. If the results show that thresholds are *not* exceeded then no action will be taken. If results show that thresholds are exceeded, NNMREC will consult with NMFS and ODFW to develop an appropriate response. Responses may include changes to monitoring methods, project operations and/or mitigation actions, as appropriate.

The general process for this Adaptive Management Framework is depicted in the figure below.

Adaptive Management Framework Flow Chart



1 ADAPTIVE MANAGEMENT COMMITTEE

The purpose of the Adaptive Management Committee ("AMC" or Committee) is to review marine resource issues (i.e. benthic habitat, derelict gear, marine mammals, acoustics, and electromagnetic fields) related to wave energy testing activities at the NNMREC Open Ocean Test Site and to make recommendations for changes in monitoring, project operations, and/or adaptive management/mitigation thresholds for the test center.

1.1 RECOMMENDATION AND REVIEW PROCESS

The timelines outlined in this section are designed to ensure that previous year's test information can be used to inform any permitting, adaptive management or other review processes for future year tests.

1.1.1 Annual Report

No later than December 1 of each year, an Annual Report will be provided to the Adaptive Management Committee for all tests conducted in the previous 12 months. The Annual Report will include a compilation of monitoring conducted (including a summary of the purpose for monitoring, the methods used, and monitoring results) and mitigation actions taken. In addition, plans for future tests will be summarized.

1.1.2 Adaptive Management Committee Meeting

No later than January 31 of each year, NNMREC will convene and facilitate an annual meeting of the Committee. The Committee will evaluate the information relative to the adaptive management thresholds and mitigation actions discussed in the sections that follow.

The Committee will also evaluate technical issues and data interpretation associated with the monitoring, as appropriate. Such evaluation will include the sufficiency and adequacy of the information provided by the monitoring, consideration of monitoring results, as well as possible adjustments to subsequent monitoring methods and frequencies. Key functions of the Committee are to:

a) Review the results of studies and monitoring conducted during the previous testing period;

b) Use study and monitoring results, as well as other sources of relevant information, if applicable, to determine whether a change to project monitoring (e.g., study design, methods, or duration) is warranted or if existing monitoring approaches continue to be appropriate;

c) Review available information about wave energy devices proposed for testing in the following test season;

d) Evaluate any changes in plans made by NNMREC in response to the studies and/or monitoring, or upcoming devices; and

e) In the event effects are identified that require modification to project operations or monitoring, provide NNMREC with recommended measures to avoid, minimize, or mitigate the effects, which may include ceasing testing and/or removal of project structures.

1.1.3 Committee Recommendations

The Annual Reports will be used by the Adaptive Management Committee to inform discussions and make recommendations to NNMREC for the monitoring, operations, and adaptive management plans associated with the NNMREC test center. The recommendations of the Adaptive Management Committee are not intended to supplant or fulfill any required permitting processes needed for future tests, but will be completed no later than February 28 of each year.

1.1.4 NNMREC and Agency Review

Upon conclusion of the Committee's review, NNMREC, in consultation with NMFS and ODFW, will consider the Committee's recommendations and determine the appropriate approach to the monitoring, operations, and adaptive management/mitigation thresholds to ensure the Project's compliance with the Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA) and other relevant federal and state statutes. NNMREC, in consultation with NMFS, USFWS and ODFW, will also consider the Committee's recommendations in determining whether any additional mitigation measures are needed no later than March 31 of each year.

1.2 COMMITTEE MEMBERSHIP AND PARTICIPATION

Participation on the Committee by state or federal agencies does not affect their statutory responsibilities and authorities. Issues involving the exercise of agencies' specific authorities can be discussed, but agency decisions are not delegated to the Committee. Representatives of the following organizations will be invited to join the Committee:

- Northwest National Marine Renewable Energy Center
- US Army Corps of Engineers
- National Marine Fisheries Service
- U.S. Fish and Wildlife Service
- Oregon Department of Fish and Wildlife
- Oregon Department of Land Conservation and Development
- Department of State Lands
- Local Tribes
- Oregon Coastal Zone Management Agency
- Fishermen Involved in Natural Energy (or other appropriate fishing organization)
- Surfrider Foundation
- Oregon Shores

Representatives from other organizations may be asked to join, as deemed appropriate by NNMREC.

1.3 MEETING PROVISIONS

NNMREC shall arrange, administer, and chair all meetings, unless otherwise agreed. The Committee shall establish protocols for Committee meetings such as agenda development, subcommittee involvement, and timely distribution of materials, location and scheduling.

NNMREC will convene and facilitate an annual meeting of the group to be schedule no later than January 31 of each year. The Committee will convene annually for the life of the test center operations, unless deemed otherwise by Members.

NNMREC shall send the Committee meeting schedule, agenda, and supporting materials directly to Committee members via e-mail and will also make it available on its web site.

NNMREC shall bear all costs associated with conducting meetings. Each Member shall bear its own cost of attendance. A Member's ongoing participation on the Committee is subject to that Member's budget and resource constraints.

2 ADAPTIVE MANAGEMENT THRESHOLDS[1]

The Adaptive Management Thresholds outlined in this section are used by the Adaptive Management Committee, NMFS, USFWS, ODFW and NNMREC in the annual review of monitoring results and other operational information. As outlined in Section 2 above, these thresholds are used to evaluate single year data and multi-year data from the test center. These Adaptive Management Thresholds do not apply to individual testing operations. Specific adaptive mitigation thresholds developed for each test will be implemented during operations of individual tests.

In addition to conducting the monitoring referenced below, NNMREC staff will make opportunistic visual observations from the water surface during installation, maintenance, monitoring and other activities at the project site, and at least bi-weekly during project deployment. NNRMEC will record all opportunistic observations of marine mammals, seabirds, listed species, and/or derelict gear and include them in the Annual Report of monitoring results provided to the Adaptive Management Committee, NMFS, USFWS and ODFW. Additionally, NNMREC will coordinate with NMFS, USFWS, and ODFW, either through their participation in the Adaptive Management Committee or otherwise, to develop a standard form to use in recording and reporting observations.

2.1 BENTHIC SPECIES AND HABITAT

Adaptive Management Threshold 1: If monitoring conducted as described in the Benthic Species and Habitat Monitoring Plan, which includes visual observation and gut analysis, shows *substantial*

[1] The use of the phrase "in consultation with" in this document does not relate to Section 7 ESA Consultation. Similarly, the use of the phrase 'approval by NMFS and ODFW" does not constitute issuance of an agency authorization of permit, nor does it limit NNMREC's decision making regarding the implementation of adaptive management/mitigation measures for permitted activities.

differences or *significant trends* as defined in consultation with ODFW and NMFS in benthic habitat or associated ecological communities between the Project-affected sites and reference sites, or at any one site over time, as defined by:

a. substrate composition; for example changes in grain size proportions;

b. species composition; for example there could be new species attracted to anchors/devices or species no longer present;

c. species relative abundances; for example, existing species becoming more common or rare; and/or

d. changes to feeding habits; for example a new prey item or disappearance of a species both from visual observation and from gut analysis.

NNMREC will, after consultation with the Adaptive Management Committee, in consultation with and after approval by NMFS and ODFW pursuant to their respective statuary authority, implement one or more of the following actions to ensure Project compliance with ESA, MMPA and other relevant federal and state statutes:

- Modify the monitoring plan and/or sampling frequency to determine if ecological interactions have negative effects on protected species, benthic habitat or associated ecological communities;
- Modify the Project to mitigate for Project effects;
- Conduct additional sampling or studies; and/or
- Make determination that no changes to monitoring plans or Project operations are needed.

2.2 DERELICT GEAR

Derelict gear monitoring and removal will be conducted in accordance with the procedures and adaptive management thresholds described below. In addition, NNMREC will participate in monthly FINE meetings, engage with members of the fishing community directly, and maintain ongoing communication with ODFW in regards to lost or entangled gear. Further, NNMREC will consult with NMFS and ODFW, either through their participation in the Adaptive Management Committee or otherwise, to ensure the efficacy of the derelict gear monitoring and response methods for the duration of Project activities. For instance, if derelict gear is routinely found caught on the mooring lines or anchors, monitoring and removal episodes may need to be increased.

General Procedures for Derelict Gear

i. **Detection:** NNMREC will perform underwater visual monitoring at least three times for each test: once prior to device deployment, once during active deployment, and once after device removal. Video lander sampling of anchors and reference locations will continue for the duration of the project (i.e., when any project related structure or equipment is in the water) weather permitting. In addition, NNMREC will make visual observations from the water surface, at least bi-weekly, during all visits to the project site to identify any derelict gear.

ii. **Notification**: If derelict gear is detected, NNMREC will contact NMFS and ODFW within two days of detection.

iii. **Removal**: Any gear entangled with project structures or moorings will be removed in spring/summer (prior to test device deployment) or in fall (immediately following test device removal). If the gear poses an entanglement risk to marine organisms, NNMREC will consult with NMFS and ODFW to determine if an earlier or more immediate response is necessary (as described in the Adaptive Management Thresholds below).

iv. **Return**: NNMREC will make every effort to return gear to owner and will be responsible for storing the gear and contacting the owner to retrieve it; ODFW can provide owner contact information.

v. **Recycle**: In the event that attempts to return gear are unsuccessful, it may be recycled at the "Fishing for Energy" project located at Newport's International Port.

Adaptive Management Threshold 1: If Annual Reports indicate that derelict gear is being ensnared on the *Ocean Sentinel* or project structures and posing harm to species, NNMREC will, after consultation with the Adaptive Management Committee, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, implement one or more of the following actions to ensure Project compliance with ESA, MMPA and other relevant federal and state statutes:

- Modify the Adaptive Mitigation Plan[2] to assure that derelict gear is addressed in a timely manner; or

Modify the Project to reduce the incidences of derelict gear being ensnared on the Ocean Sentinel and/or its mooring configuration.

Adaptive Management Threshold 2: If Annual Reports indicate that derelict gear is being ensnared on and posing harm to species during project tests on WEC devices similar to those proposed for upcoming test, NNMREC will, after consultation with the Adaptive Management Committee, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, implement one or more of the following actions to ensure Project compliance with ESA, MMPA and other relevant federal and state statutes:

- Recommend an Adaptive Mitigation Plan , which includes derelict gear removal, to the WEC developer to assure that derelict gear is addressed in a timely manner; or
- Require WEC developer to modify its device and/or mooring configuration to reduce the

[2] An individual Adaptive Mitigation Plan will be developed for each installation of any anchors, mooring lines, and devices associated with the Ocean Sentinel and WEC devices. Each Adaptive Mitigation Plan will be in effect as long as project structures are deployed.

incidences of derelict gear being ensnared.

2.3 MARINE MAMMALS

Opportunistic Observations

As a matter of practice, NNMREC staff will make visual observations from the water surface during all visits to the project site, and at least all bi-weekly during project deployment. If project devices are not deployed but anchors and mooring lines remain in place during the April/May grey whale migration, NNMREC will perform visual observations at least bi-weekly during that period. NNRMEC will record all opportunistic observations of marine mammals and other listed species and include them in the Annual Report of monitoring results provided to the Adaptive Management Committee, NMFS and ODFW. Additionally, NNMREC will coordinate with NMFS and ODFW, either through their participation in the Adaptive Management Committee or otherwise, to develop a standard form to use in recording and reporting marine mammal observations.

Adaptive Management Threshold 1: If Annual Reports indicate observations of pinnipeds hauled out on the Ocean Sentinel, NNMREC will, after consultation with the Adaptive Management Committee, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, implement one or more of the following actions to ensure Project compliance with ESA, MMPA and other relevant federal and state statutes:

- Modify the Project to reduce the potential for pinniped haul-out on the Ocean Sentinel; and/or
- Apply for an Incidental Harassment Authorization if needed for deterrence or removal of hauled-out pinnipeds.

Adaptive Management Threshold 2: If Annual Reports indicate observations of pinnipeds hauled out on WEC devices similar to those being proposed for upcoming test, NNMREC will, after consultation with the Adaptive Management Committee, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, require the WEC developer to implement one or more of the following actions:

- Require WEC developer to modify its device to reduce the potential for pinniped haul-out; and/or
- Require WEC developer to apply for an Incidental Harassment Authorization if needed for deterrence or removal of hauled-out pinnipeds.

2.4 ACOUSTICS

Adaptive Management Threshold 1: If acoustic monitoring indicates that sound pressure levels attributable to the Ocean Sentinel device at a distance[3] of 100m are above Level A injury threshold

[3] It may be ineffective to use an acoustic threshold 10 meters from the Ocean Sentinel as it not likely to result in measurements of the actual noise levels generated solely by the device. A 10-meter distance would be inside the larger project installation and

criteria (either continuous or impulse of 180dB RMS for cetaceans and 190dB RMS for pinnipeds) or Level B harassment threshold criteria (120dB RMS continuous and 160dB RMS impulse), NNMREC will, after consultation with the Adaptive Management Committee, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, implement one or more of the following actions to ensure Project compliance with ESA, MMPA and other relevant federal and state statutes:

- Design and perform additional monitoring;
- Modify the operation of the Ocean Sentinel to decrease its acoustic emissions (e.g., locking down the device during high surf, increasing controls to slow the motion of the device, or repairing the device if noise is due to device malfunction);
- Apply for an Incidental Harassment Authorization for acoustic emissions of the Ocean Sentinel.

Adaptive Management Threshold 2: If acoustic monitoring indicates that sound pressure levels attributable to a WEC device similar to the device type (e.g. buoy or attenuator) proposed for testing are above Level A injury threshold criteria (either continuous or impulse of 180dB RMS for cetaceans and 190dB RMS for pinnipeds) or Level B harassment threshold criteria (120dB RMS continuous and 160dB RMS impulse) at a distance of 100m (see footnote 4 regarding rationale for 100m), NNMREC will, after consultation with the Adaptive Management Committee, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, assure that one or more of the following is implemented during testing of the WEC device to ensure Project compliance with ESA, MMPA and other relevant federal and state statutes:

- Additional monitoring;
- Modify the operation of the WEC device to decrease its acoustic emissions (e.g., locking down the WEC device during high surf, increasing controls to slow the motion of the WEC device, or repairing the WEC device if noise is due to device malfunction);
- Applying for an Incidental Harassment Authorization for acoustic emissions of the WEC device.

Adaptive Management Threshold 3: After review of individual test results, NNMREC, in consultation with the Adaptive Management Committee, will:

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the signals received may be inaccurate due to reflections (and other interactions) with other physical structures nearby. Therefore a greater threshold distance of 100 meters is proposed. Marine mammal detections in surveys covering the Oregon-Washington coast (*Green et al. 1992*) indicate a mean incidence of 0.5 animals per square kilometer. A 100-meter radius around the device corresponds to an area of 0.03 square kilometer so the risk of marine mammal exposure within that area is 0.03/0.5 = 0.06 animals, or about a 6% risk in association with a day or an incident of elevated underwater sound generation. Since the test device would be deployed for limited periods of time, there is lower potential for such incidents to occur frequently or for a sustained long period of time. As such the risk of exposure for any marine mammal is very low, even within the 100-meter radius.

- Evaluate whether acoustic monitoring techniques are sufficient to adequately assess potential effects of different technologies;
- Assess new information about other sources of noise to confirm confidence in study ability to assess device noise; and
- Determine whether acoustic testing is required for all devices and whether previous study results can be used to support future tests.

Based on the evaluation and assessment described above, NNMREC, after consultation with the Adaptive Management Committee, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, will implement one or more of the following to ensure Project compliance with ESA, MMPA and other relevant federal and state statutes:

- Modified or additional monitoring techniques;
- Utilize data and information from existing studies to estimate acoustic emissions and perform potential effects analysis for future tests.

2.5 ELECTROMAGNETIC FIELDS

Monitoring electromagnetic fields (EMF) for marine renewable energy is a newly emerging application, and mission-specific instrumentation is needed. NNMREC has designed and will carry out the first deployment of an advanced 2nd generation EMF monitoring instrument to characterize the ambient EMF at the project site and measure the EMF during an energized WEC test. Post monitoring data analysis will take approximately 90 days. The results will be written up in a monitoring summary and provided the Adaptive Management Committee as soon as possible following the initial test.

Adaptive Management Threshold 1: NNMREC, after consultation with the Adaptive Management Committee, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, will consider the following:

- Validate the effectiveness of the EMF Propagation Model and assess its efficacy in measuring EMF for future tests. If necessary, potential modifications to the model will be recommended.
- Consider both the ability to detect and the level of EMF from the project devices and determine whether there is a meaningful source of EMF from the Project.

Adaptive Management Threshold 2: Based on the evaluation and assessment described above, NNMREC will, after consultation with the Adaptive Management Committee, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority implement one or more of the following to ensure Project compliance with ESA, MMPA and other relevant federal and state statutes:

- Modified or additional monitoring techniques;

- Compare the EMF results with known values for impact on endangered species known or likely to be present in the area.
  - If the results indicate that WEC-related EMF levels are within the documented magnetic or electric field sensitivity range of such species and could have an effect on orientation, reproduction, predator/prey dynamics, or the behaviors of any affected species or of fish aggregations either residing nearby or migrating through the project area, NMFS, ODFW, OSU scientists and the Ocean Facilities Manager will work together on an approach to reduce EMF levels during a test.
  - In the event that the monitoring shows EMF signatures at levels below concern, and after consulting with NMFS and ODFW, the EMF monitoring program will be modified accordingly; and/or

- Utilize data and information from existing studies to estimate EMF emissions and perform potential effects analysis for future tests.

Adaptive Management Threshold 3: If monitoring indicates that EMF attributable to the project components is in excess of levels known to have an adverse impact on marine life, NNMREC will, after consultation with the Adaptive Management Committee, in consultation with and upon approval by NMFS and ODFW pursuant to their respective statutory authority, develop and implement a response plan that outlines the appropriate mitigation action. Actions may include, but are not limited to:

- Additional shielding of cables or other project components;

- Delaying subsequent deployment of tests until resolution of the issue is achieved;

- Adoption of new timeframe restrictions designed to address specific resource conflicts (e.g., green sturgeon); or

- Decommissioning the site and terminating the test.

3 REFERENCES

Green, G.A., J.J. Brueggeman, C.E. Bowlby, R.A. Grotefendt, M.L. Bonnell, and K.T. Balcomb, III. 1992. Cetacean Distribution and Abundance Off Oregon and Washington, 1989-1990. Chapter I. In Oregon and Washington marine mammal and seabird surveys, J.J. Brueggeman (ed.). Final Report prepared for the Minerals Management Service, Pacific OCS Region. OCS Study MMS 91-0093. 400 pp

WET-NZ/Ocean Sentinel Adaptive Mitigation Plan

Revised 7/23/2012

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WET-NZ/Ocean Sentinel Adaptive Mitigation Plan

A) ADAPTIVE MITIGATION ACTIONS

This Adaptive Mitigation Plan outlines the thresholds and real-time mitigation actions that may be taken during the test of the NNMREC's Ocean Sentinel and the WET-NZ device. All mitigation action decisions associated with the WET-NZ and Ocean Sentinel will be made by NNMREC and Northwest Energy Innovations, Inc. (NWEI) in consultation with NMFS and ODFW. The Adaptive Management Committee (described in Section 2 of the Adaptive Management Plan) will not be convened or be used to inform real-time decisions for mitigation outlined below.

No later than December 1 following the test an Annual Report of monitoring results, adaptive management thresholds, and any mitigation actions associated with the deployment of the WET-NZ and Ocean Sentinel will be provided to the Adaptive Management Committee (as described in Section 2 of the NNMREC Test Facility Adaptive Management Framework). This report will be used to inform the Committee's discussion of monitoring and adaptive management plans associated with the NNMREC test center and future tests.

B) ADAPTIVE MITIGATION THRESHOLDS AND MEASURES

In addition to conducting the monitoring referenced below, NNMREC staff will make opportunistic visual observations from the water surface during installation, maintenance, monitoring and other activities at the project site, and at least bi-weekly during project deployment. NNRMEC will record all opportunistic observations of marine mammals, seabirds, listed species, and/or derelict gear and include them in the Annual Report of monitoring results provided to the Adaptive Management Committee, NMFS and ODFW. Additionally, NNMREC will coordinate with NMFS, USFWS and ODFW, either through their participation in the Adaptive Management Committee or otherwise, to develop a standard form to use in recording and reporting marine mammal observations.

i. BENTHIC SPECIES AND HABITAT

Consistent with the Benthic Monitoring Plan, benthic monitoring will be conducted prior to, during, and after the test. The monitoring results will be summarized and provided to the Adaptive Management Committee as outlined in Section 2 of the NNMREC Test Facility Adaptive Management Framework.

There are no adaptive mitigation thresholds for benthic habitat associated with this test.

ii. DERELICT GEAR

Derelict gear monitoring and removal will be conducted in accordance with the procedures and adaptive mitigation thresholds and measures described below.

General Procedures for Derelict Gear

i. **Detection:** NNMREC will perform underwater visual monitoring at least three times for each test: once prior to device deployment, once during active deployment, and once after device removal. Video lander sampling of anchors and reference locations will continue for the duration of the project (i.e., when any project related structure or equipment is in the water) weather permitting. In addition, NNMREC will make visual observations from the water surface, at least bi-weekly, during all visits to the project site to identify any derelict gear.

ii. **Notification**: If derelict gear is detected, NNMREC will contact NMFS and ODFW within two days of detection.

iii. **Removal**: Any gear entangled with project structures or moorings will be removed in spring/summer (prior to test device deployment) or in fall (immediately following test device removal). If the gear poses an entanglement risk to marine organisms, NNMREC will consult with NMFS and ODFW to determine if an earlier or more immediate response is necessary (as described in the Adaptive Management Thresholds below).

iv. **Return**: NNMREC will make every effort to return gear to owner and will be responsible for storing the gear and contacting the owner to retrieve it; ODFW can provide owner contact information.

v. **Recycle**: In the event that attempts to return gear are unsuccessful, it may be recycled at the "Fishing for Energy" project located at Newport's International Port.

Adaptive Mitigation Threshold and Measure 1: If monitoring shows that derelict gear has become ensnared or collected on any Project structure but no organisms are caught within it and the gear poses no threat to navigational safety or marine species, NNMREC will remove the derelict gear during removal of the test devices.

Adaptive Mitigation Threshold and Measure 2: If monitoring shows that derelict gear has become ensnared or collected on any Project structure and has entangled or poses the risk of entanglement to organisms, NNMREC will remove the derelict gear as soon as feasible, notify NMFS and ODFW within two days, and provide a report with all available information on the case. NNMREC will then, after consulting with NMFS and ODFW, modify the Project and/or monitoring plan if necessary.

Adaptive Mitigation Threshold and Measure 3: If monitoring shows marine mammals or sea turtles entangled in fishing gear or marine debris, NNMREC will report the incident as soon as practical and remove the gear consistent with the Reporting Protocol for Injured or Stranded Marine Mammals (outlined in Section iii below). NNMREC will then, after consulting with NMFS and ODFW, and approved by NOAA modify the Project and/or monitoring plan if necessary.

iii. ENTANGLED OR INJURED SPECIES

As a matter of practice, NNMREC staff will make visual observations from the water surface during all visits to the project site and at least bi-weekly during project deployment. If project devices (i.e. Ocean

Sentinel, WET-NZ) are not deployed but anchors and mooring lines remain in place during the April/May grey whale migration, NNMREC will perform visual observations at least bi-weekly during that period. NNMREC will record all opportunistic observations of marine mammals, seabirds, listed species, and/or derelict gear and include them in the Annual Report provided to the Adaptive Management Committee, NMFS and ODFW. Additionally, NNMREC will coordinate with NMFS and ODFW, either through their participation in the Adaptive Management Committee or otherwise, to develop a standard form to use in recording and reporting these observations.

Adaptive Mitigation Threshold and Measure 1: If marine mammals or sea turtles are observed entangled, injured or impinged at the Project Structure, NNMREC will immediately follow the Reporting Protocol for Injured or Stranded Marine Mammals (listed below) and give NMFS and ODFW all available information on the incident. In addition, NNMREC will contact NMFS and ODFW as soon as practical within 24 hours to consult with them regarding modifying the Project and/or monitoring plans.

Reporting Protocol for Injured or Stranded Marine Mammals: NNMREC proposes to implement the following NMFS protocols in the event an injured or stranded marine mammal is observed:

i. *Live marine mammals or sea turtles observed swimming but appearing debilitated or injured.*

Capability to respond to free swimming animals is very limited and relocation is a major issue. In addition, medical treatment facilities for marine mammals and sea turtles are for the most part non-existent in Oregon. Therefore, we recommend that monitors record the sighting as part of the monitoring report and provide the information to the Stranding Network. The data should include: 1) any photos or videos, if possible 2) species or common name of the animal involved; 3) date of observation; 4) location (lat/long in decimal degrees); 5) description of injuries or unusual behavior observed.

ii. *Live marine mammals or sea turtles observed entangled in fishing gear or marine debris.*

The marine mammal disentanglement network in Oregon is based at Hatfield Marine Science Center - contact Jim Rice at 541-867-0446 or Barb Lagerquist at 541-867-0128. The national network is available at 877-SOS-WHALE (877-767-9425). Contact should be made immediately if an entanglement is observed and, if possible the reporting vessel should remain on scene while contact is made. Report should include the following information: 1) species or common name of animal involved; 2) location (lat/long in decimal degrees); 3) whether the animal is anchored by the gear or swimming with the gear in tow; 4) a description of the entangling gear (line size, line color, size number and color of floats if attached, presence or absence of pots or webbing; 5) if animal is towing gear, give direction of travel and current speed; 6) local weather conditions (sea state, wind speed and direction) 7) whether the vessel can stand by until someone is able to get there. The disentanglement network will determine whether or not a response can be mounted immediately and will advise the reporting vessel on next steps.

iii. *Dead marine mammals or sea turtles observed floating at sea.*

Dead floating marine mammals fall within the definition of "stranded" under the MMPA. To report strandings off central Oregon coast contact the Oregon Marine Mammal Stranding Network (Jim Rice) 541-867-0446.

iv. *Dead protected species found entangled or otherwise impinged at the project.*

These should be reported as part of the monitoring report to NMFS and ODFW, giving all available information on the case. The report should include the following information; 1) species or common name of animal involved; 2) location (lat/long in decimal degrees); 3) whether the animal was found on a project device or anchoring system; 4) a description of injuries or entanglement observed; if derelict fishing gear or other debris was involved, give a description of the gear (line size, line color, size number and color of floats if attached, presence or absence of pots or webbing; photographs if possible. In the event derelict gear is involved, the presence of protected species entangled in the gear should be included in the report initiating gear removal planning and coordination.

Adaptive Mitigation Threshold 2: If pinnipeds are identified on one or more of the project structures, NNMREC will implement the NMFS haulout protocols listed below. In addition, NNMREC will notify NMFS and ODFW within two weeks of the haul-out incident.

Pinniped Haulout Protocols

i. If pinnipeds are present on one of the project structures, monitoring or maintenance activities will occur at minimum of 100 yards from the structure (in accordance with the current NMFS guideline of 100 yards for vessel approach of hauled out pinnipeds).

ii. If the pinnipeds do not leave the structure upon approach up to 100 yards and the pinnipeds are non-ESA listed species (e.g., California sea lions), NNMREC may proceed to deter the pinniped from project structures so long as such measures do not result in the death or serious injury of the animal (pursuant to Section 101.(a)(4)(A) of the Marine Mammal Protection Act). NNMREC will follow NOAA guidance on deterring pinnipeds: http://www.nwr.noaa.gov/marine-mammals/seals-and-sea-lions/deterring-pinnipeds.cfm

iii. If pinnipeds present on project structures are an ESA-listed species (e.g., Steller sea lions), NNMREC will not pursue any directed take or intentional harassment, and will remain at least 100 yards from the structure so long as the ESA-listed species is present.

iv. If NNMREC needs to perform emergency maintenance that requires immediate attention (e.g. closing an opened hatch, repairing a failed mooring or electrical fault) and deterrence of a listed species is necessary, NNMREC staff will request assistance from a government official.[1] The NNMREC Response Coordinator will provide an account of the incident to the appropriate staff at NMFS and ODFW as soon as possible.

[1] Section 109(h) of the Marine Mammal Protection Act provides exceptions for take of listed and non-listed marine mammals by Federal, state or local government officials if such taking is for the protection or welfare of the

iv. ACOUSTICS

The objective of the acoustic monitoring is to determine if the WET-NZ and/or Ocean Sentinel devices increase the ambient noise at the project site beyond mammal harassment thresholds, as described in the Acoustic Monitoring Plan. This will be accomplished by measuring time-dependent acoustic background levels and frequency distributions of environmental, biological and anthropogenic sound sources that contribute to the noise budget during the test. NNMREC has collected continuous passive acoustic data to characterize the baseline acoustic conditions at the test site. During the WET-NZ/Ocean Sentinel test, amplitude and frequency distribution through time of the ambient noise field will be characterized and sound sources will be identified.

- Initial monitoring will occur within two weeks following deployment of the WET-NZ/Ocean Sentinel test. (This window may be modified if the health and safety of personnel is at risk due to unforeseen conditions such as weather or operational complications where approaching the device is not safe.)

- Results will be made available to NMFS and ODFW within seven days of the completion of monitoring. If results cannot be transmitted to NMFS and ODFW within seven days, NNMREC will contact NMFS and ODFW with an updated delivery schedule and the reason for delay.

- The following contacts will be notified regarding monitoring results and proposed mitigation, if applicable:

    - NMFS: Keith Kirkendall, Chief of FERC and Water Diversion Branch, 503-230-5431 or keith.kirkendall@noaa.gov

    - ODFW: Delia Kelly, Ocean Energy Coordinator, 541-867-0300 or delia.r.kelly@state.or.us

Adaptive Mitigation Threshold and Measure 1: If acoustic monitoring indicates that sound pressure levels attributable to the WET-NZ and/or Ocean Sentinel device at a distance[2] of 100m are above Level A

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mammal, the protection of the public health and welfare, or the nonlethal removal of nuisance animals [50 CFR 223.202].

[2] It may be ineffective to use an acoustic threshold 10 meters from the Ocean Sentinel as it not likely to result in measurements of the actual noise levels generated solely by the device. A 10-meter distance would be inside the larger project installation and the signals received may be inaccurate due to reflections (and other interactions) with other physical structures nearby. Therefore a greater threshold distance of 100 meters is proposed. Marine mammal detections in surveys covering the Oregon-Washington coast (*citation pending*) indicate a mean incidence of 0.5 animals per square kilometer. A 100-meter radius around the device corresponds to an area of 0.03 square kilometer so the risk of marine mammal exposure within that area is 0.03/0.5 = 0.06 animals, or about a 6% risk in association with a day or an incident of elevated underwater sound generation. Since the test device would be deployed for limited periods of time, there is lower potential for such incidents to occur frequently or for a sustained long period of time. As such the risk of exposure for any marine mammal is very low, even within the 100-meter radius.

injury threshold criteria (either continuous or impulse of 180dB RMS for cetaceans and 190dB RMS for pinnipeds) or Level B harassment threshold criteria (120dB RMS continuous and 160dB RMS impulse),, NNMREC scientists and Ocean Test Facility Manager, in coordination with and after approval from NMFS and ODFW pursuant to their respective statutory authority, will develop and implement a response plan that outlines the appropriate mitigation action within 14 days of acquiring monitoring results. Actions may include, but are not limited to:

- Performing additional or alternative monitoring;
- Modifying the operation of the WET-NZ and/or Ocean Sentinel (e.g., locking down the device during high surf, increasing controls to slow the motion of the device, or conducting on-site repairs if noise is due to the device malfunction);
- Ceasing operations and performing necessary modifications to minimize noise levels. Subsequent monitoring would be conducted to verify that the noise associated with the test has been abated;
- Decommissioning of the test/installation; and/or
- Applying for an Incidental Harassment Authorization.

v. ELECTROMAGNETIC FIELDS

As described in the in Biological Assessment, monitoring of Electromagnetic fields (EMFs) will be conducted during deployment of the Ocean Sentinel and the WET-NZ when the devices are energized. Following device removal and before any subsequent deployments, NNMREC will return to project site and repeat the survey to characterize baseline levels of EMF at the project site. The monitoring results will be summarized and provided to the Adaptive Management Committee as outlined in Section 2 of the NNMREC Test Facility Adaptive Management Framework.

Adaptive Mitigation Threshold and Measure 1: If monitoring results indicate that EMF attributable to the project components is in excess of levels known to have an adverse impact on marine life, NNMREC will, in consultation with and after approval by NMFS and ODFW pursuant to their respective statutory authority, develop and implement a response plan that outlines the appropriate mitigation action any 2013 Ocean Sentinel/WET-NZ test. Actions may include, but are not limited to:

- Additional shielding of cables or other project components;
- Delaying subsequent deployment of tests until resolution of the issue is achieved;
- Adoption of new timeframe restrictions designed to address specific resource conflicts (e.g., green sturgeon); or
- Decommissioning the site and terminating the test.