SETTLEMENT AGREEMENT

AMONG

REEDSPORT OPT WAVE PARK, LLC
UNITED STATES FISH AND WILDLIFE SERVICE
NATIONAL MARINE FISHERIES SERVICE
UNITED STATES FOREST SERVICE
OREGON DEPARTMENT OF STATE LANDS
OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY
OREGON DEPARTMENT OF LAND CONSERVATION AND DEVELOPMENT
OREGON WATER RESOURCES DEPARTMENT
OREGON DEPARTMENT OF FISH AND WILDLIFE
OREGON PARKS AND RECREATION DEPARTMENT
OREGON DEPARTMENT OF ENERGY
OREGON STATE MARINE BOARD
OREGON SHORES CONSERVATION COALITION
SURFRIDER FOUNDATION
SOUTHERN OREGON OCEAN RESOURCE COALITION

DATED JULY 28, 2010

REGARDING CONSTRUCTION AND OPERATION OF
THE REEDSPORT OPT WAVE PARK,
FERC NO. 12713,
DOUGLAS COUNTY, OREGON

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PARTIES

This Settlement Agreement (with attached Appendices and Exhibits, referred to collectively as the "Agreement") is made as of July 28, 2010 (the "Effective Date") by and among Reedsport OPT Wave Park, LLC, a New Jersey corporation (the "Company"); United States Fish and Wildlife Service ("USFWS"); National Marine Fisheries Service ("NOAA Fisheries Service"); United States Forest Service ("USDA-FS"); Oregon Department of State Lands ("DSL"); Oregon Department of Environmental Quality ("ODEQ"); Oregon Department of Land Conservation and Development ("DLCD"); Oregon Water Resources Department ("WRD"); Oregon Department of Fish and Wildlife ("ODFW"); Oregon Parks and Recreation Department ("OPRD"); Oregon Department of Energy ("ODOE"); Oregon State Marine Board; Oregon Shores Conservation Coalition; Surfrider Foundation; and Southern Oregon Ocean Resource Coalition ("SOORC"), each referred to individually as a "Party" and collectively as the "Parties." USFWS, NOAA Fisheries Service, USDA-FS, DSL, ODEQ, DLCD, WRD, ODFW, OPRD, ODOE, and Oregon State Marine Board are referred to individually as a "Governmental Party" and to collectively as the "Governmental Parties."

RECITALS

A. The Company is proposing to install and operate the Reedsport OPT Wave Park, Federal Energy Regulatory Commission ("FERC") No. 12713 (the "Project"), off the coast of Gardiner in Douglas County, Oregon. The Project will involve the deployment and operation of up to 10 PowerBuoy® wave energy converters connected electrically to an underwater power cable. The term "Project" does not refer to a single buoy the Company plans to install prior to installing and operating additional, electric grid-connected buoys pursuant to the FERC License; however, upon connection of the single buoy to the electric grid pursuant to a License, the buoy will become subject to the Agreement's terms as part of the Project. The cable will transport energy to shore at the Oregon Dunes National Recreation Area and ultimately to the Bonneville Power Administration's Gardiner Substation. The PowerBuoys will have a maximum sustained individual capacity of up to 150 kW, and a combined rating of up to 1.5 MW. The Company anticipates the Project to occupy a maximum ocean surface area of 35 acres. For purposes of the Agreement, the term "Project" includes all components of the 10-PowerBuoy Project, including facilities within the marine and terrestrial Project boundary.

B. The Company filed a Preliminary Permit Application to FERC on July 14, 2006 and received a Preliminary Permit from FERC on February 15, 2007. On July 2, 2007, the Company notified FERC of its intent to seek an original license ("License") for the Project. *See Reedsport OPT Wave Park LLC Notice of Intent and Preliminary Application Document* (July 2, 2007). In July 2008, the Company distributed a Draft License Application for stakeholder review and comment. *See Reedsport OPT Wave Park FERC Project No. 12713 Draft Application for a Major License* (July 2008). The Company's primary purpose in seeking a License for the Project, in addition to generating electricity, is to collect sufficient data after the 10 PowerBuoys are deployed for FERC and others (including the Parties) to evaluate the potential future expansion of the Project to up to 50 MWs ("Expanded Project"). Any Expanded Project would require additional authorizations from FERC and other regulatory agencies.

C. The Company has been actively engaged in discussions with key regulatory agencies, the Confederated Tribes of the Coos, Lower Umpqua and Siuslaw Indians, and stakeholders since August 2006. The Project was designated an Oregon Solutions project by Oregon Governor Kulongoski in October 2006. The purpose of the Oregon Solutions process was to define and ensure broad stakeholder involvement in the regulatory process for approving the Project, as well as to provide valuable information for other wave energy projects along the Oregon Coast. On May 15, 2007, this process culminated in the execution of a Declaration of Cooperation by many of the Parties to this Agreement. The Declaration of Cooperation outlined the signatories' commitments to participate in settlement discussions, which resulted in the execution of this Agreement.

NOW, THEREFORE, in consideration of their mutual covenants in this Agreement, the Parties agree as follows:

DEFINITIONS

"401 Certification" is defined in Section 5.2.

"Agreement" is defined in the first paragraph of this Agreement, entitled "Parties."

"AMP" is the adaptive management process defined in Section 3.3.

"Annual Report" is defined in Section 3.3.8.

"Approvals" is defined in Section 2.4.

"Company Obligations" is defined in Section 3.2.

"Company" is Reedsport OPT Wave Park, LLC, which is listed as a Party in the first paragraph of this Agreement, entitled "Parties."

"Complete dispute resolution" is defined in Section 7.5.2.

"Coordination Committee" is defined in Section 4.2.

"DLCD" is the Oregon Department of Land Conservation and Development, which is listed as a Party in the first paragraph of this Agreement, entitled "Parties."

"DSL" is the Oregon Department of State Lands, which is listed as a Party in the first paragraph of this Agreement, entitled "Parties."

"Effective Date" is defined in the first paragraph of this Agreement, entitled "Parties."

"Expanded Project" is defined in Recital B.

"FERC" is the Federal Energy Regulatory Commission, as defined in Recital A.

"First Level Meeting" is defined in Section 7.5.2.

"Force majeure" is defined in Section 8.5.1.

"FPA" means "Federal Power Act," as defined in Section 1.1, and is the federal statute set forth at 16 U.S.C. §§ 791a-828c.

"Governmental Party" and "Governmental Parties" are defined in the first paragraph of this Agreement, entitled "Parties."

"Implementation Committees" is defined in Section 4.2.

"License Application" is defined in Section 2.1.

"License" is defined in Recital B.

"NOAA Fisheries Service" is the National Oceanic and Atmospheric Administration's National Marine Fisheries Service, which is listed as a Party in the first paragraph of this Agreement, entitled "Parties."

"ODEQ" is the Oregon Department of Environmental Quality, which is listed as a Party in the first paragraph of this Agreement, entitled "Parties."

"ODFW" is the Oregon Department of Fish and Wildlife, which is listed as a Party in the first paragraph of this Agreement, entitled "Parties."

"ODOE" is the Oregon Department of Energy, which is listed as a Party in the first paragraph of this Agreement, entitled "Parties."

"OPRD" is the Oregon Parks and Recreation Department, which is listed as a Party in the first paragraph of this Agreement, entitled "Parties."

"ORS" means Oregon Revised Statutes.

"Party" and "Parties" are defined in the first paragraph of this Agreement, entitled "Parties."

"Pre-License Measures" is defined in Section 3.5.

"Proceeding" is defined in Section 2.4.

"Project" is defined in Recital A.

"Quarterly Update" is defined in Section 3.3.8.

"Response Plan" is defined in Section 3.3.5.

"Second Level Meeting" is defined in Section 7.5.2.

"SOORC" is the Southern Oregon Ocean Resource Coalition, which is listed as a Party in the first paragraph of this Agreement, entitled "Parties."

"USDA-FS" is the United States Forest Service, which is listed as a Party in the first paragraph of this Agreement, entitled "Parties."

"USFWS" is the United States Fish and Wildlife Service, which is listed as a Party in the first paragraph of this Agreement, entitled "Parties."

"WRD" is the Oregon Water Resources Department, which is listed as a Party in the first paragraph of this Agreement, entitled "Parties."

1. PURPOSE AND EFFECT OF AGREEMENT

1.1. Purpose of Agreement

The Parties have entered into this Agreement for the purposes of (1) resolving all issues that have or could have been raised by the Parties in connection with a FERC order issuing a License for construction and operation of the Project, including in part through agreement on an adaptive management process that the Parties will use to address uncertainties, and (2) agreeing to use an adaptive management process to identify and implement additional studies that may be required pursuant to the Federal Power Act ("FPA") to evaluate a potential future application for an Expanded Project. Therefore, pursuant to the Parties' various authorities under the FPA as well as other statutory and regulatory authorities, this Agreement establishes the Company's obligations for the protection, mitigation, and enhancement of resources that may be affected by the Project under the License or procedures for determining those obligations, and it establishes the Parties' agreement on a process for identifying and implementing studies to be conducted or funded by the Company in relation to a future application for an Expanded Project. It also specifies procedures to be used among the Parties to ensure the implementation of the License is consistent with this Agreement and with other legal and regulatory mandates. For these purposes, the Parties agree that this Agreement is fair and reasonable and in the public interest. Except as specifically provided below, each Governmental Party agrees that the Company's satisfaction of its obligations under this Agreement, including measures required pursuant to adaptive management (Section 3.3), will be consistent with and is intended to fulfill the Company's existing statutory and regulatory obligations as to that Governmental Party relating to licensing the Project and a process for identifying and implementing the studies necessary to evaluate a potential future application for an Expanded Project. This Agreement is not intended to resolve local governmental permitting issues, should such permits be required or obtained.

The Parties expect that the Company may pursue an Expanded Project once there is sufficient data to obtain necessary approvals. This Agreement does not limit the Company from making any such request, and any such request, as well as any responsive comments by any Party, will not be considered a breach of or otherwise "inconsistent" with this Agreement. The Parties intend to use the adaptive management process to manage an Expanded Project, recognizing, however, that (a) except as to a process for identifying additional studies, this Agreement does not resolve issues related to an Expanded Project or otherwise limit the Parties' ability to recommend, require or oppose additional protection, mitigation and enhancement measures, adaptive management procedures, or other measures necessary under federal or state statutory or regulatory requirements with regard to an Expanded Project; (b) the Parties may collectively choose to modify the adaptive management process for an Expanded Project, in particular to provide better function or more certainty to the Company based on knowledge gained through preceding studies and monitoring, pursuant to Section 8.2; and (c) any Party, including the Company, may choose not to participate in an adaptive management process for an Expanded Project by withdrawing from this Agreement upon FERC's issuance of an order approving an Expanded Project.

1.2. Limitations

This Agreement establishes no principle or precedent with regard to any issue addressed in this Agreement or with regard to any Party's participation in any other pending or future licensing proceeding. Further, no Party to this Agreement shall be deemed to have approved, accepted, agreed to, or otherwise consented to any operation, management, valuation, or other principle underlying any of the matters covered by this Agreement, except as expressly provided in this Agreement. By entering into this Agreement, no Party shall be deemed to have made any admission of fact or law that it did make or could have made in any FERC proceeding relating to the issuance of the License. The Parties intend that this Agreement shall not be offered in evidence or cited as precedent by any Party to this Agreement in any judicial litigation, administrative proceeding, arbitration, or other adjudicative proceeding, except in a proceeding to establish the existence of or to enforce or implement this Agreement. This Section 1.2 shall survive any termination of this Agreement and shall apply to any Party that withdraws from this Agreement.

1.3. Representations Regarding Consistency and Compliance with Statutory Obligations

Except as specifically provided by this Agreement, by entering into this Agreement, the Governmental Parties represent that they believe (i) the measures set forth in Appendices A through D, as implemented and adaptively managed pursuant to this Agreement, satisfy the federal and state requirements of the Parties within the jurisdiction of FERC for the licensing and operation of the Project with respect to the protection, mitigation, and enhancement of aquatic resources, water quality, recreation, public safety, crabbing and fishing, terrestrial resources, and cultural and historic resources affected by the Project, and (ii) their statutory and other legal obligations are, or can be, met through implementation of this Agreement, including any recommendations, conditions and prescriptions consistent with this Agreement that are submitted to FERC for inclusion in the License. Nothing in this Agreement is intended or shall be construed to affect or limit any Governmental Party from complying with its obligations under applicable laws and regulations or from considering and responding to comments received in any environmental review or regulatory process related to the Project. This Agreement shall not predetermine the outcome of any environmental or administrative review or appeal process related to the Project.

1.4. Extent of Agency Authority

Nothing in this Agreement expands or diminishes any existing authority or regulatory jurisdiction under applicable federal or state law. The Parties recognize that each Governmental Party has separate and distinct statutory authorities and that no agency is deemed, by virtue of concurrent approvals, to be sharing its statutory authority with any other agency or to be conceding that the approval of any other agency is required for exercise of the first agency's authority.

2. ACTIONS UPON EXECUTION OF AGREEMENT

2.1. FERC Filings by the Company

Concurrent with filing its license application for the Project ("License Application"), or as soon as practicable thereafter, the Company shall file with FERC an offer of settlement pursuant to Rule 602 (18 C.F.R. § 385.602) consisting of an executed copy of this Agreement, including all Appendices and Exhibits to the Agreement, and a Joint Explanatory Statement. The Company shall request that FERC approve this Agreement in its entirety and without modification and require the Company's implementation of the Agreement and its Appendices as a condition of its License. The Company shall use reasonable efforts to obtain a FERC order approving this Agreement and issuing the License for the Project consistent with this Agreement in a timely manner.

2.2. FERC and Other Filings by Governmental Parties

Except as to the receipt of new information received as a result of the adaptive management process (Section 3.3) or that was otherwise not known to them on the Effective Date, the Governmental Parties agree: (i) that an individual agency's recommendations, conditions, and/or prescriptions filed with FERC pursuant to the FPA regarding the Project shall be consistent with this Agreement; (ii) that any comments or responses to comments filed by them with FERC in the context of this licensing process will be consistent with this Agreement; (iii) to use reasonable efforts to obtain a FERC order approving this Agreement and issuing the License for the Project consistent with this Agreement in a timely manner; and (iv) to use reasonable efforts to support, in all relevant regulatory proceedings in which they participate regarding this Project, regulatory actions consistent with this Agreement.

2.3. FERC and Other Filings by All Other Parties.

Except as to the receipt of new information not known to them on the Effective Date, all Parties other than the Company and the Governmental Parties (which are addressed in Sections 2.1 and 2.2 respectively) agree: (a) that any recommendations or comments filed by them with FERC regarding the Project pursuant to section 10(a) of the FPA will be consistent with this Agreement; (b) that any comments or responses to comments filed by them with FERC in the context of this licensing process will be consistent with this Agreement; and (c) to use reasonable efforts to support, in all relevant regulatory proceedings in which they participate associated with licensing of the Project, regulatory actions consistent with this Agreement.

2.4. Approvals

The Company shall apply for and use reasonable efforts to obtain in a timely manner and in final form all necessary federal, state, regional, and local permits, licenses, authorizations, certifications, leases, determinations, and other governmental approvals for purposes of implementing this Agreement and the License ("Approvals"). The applications for such

Approvals shall be consistent with the terms of this Agreement and its Appendices. Pursuant to Sections 2.2 and 2.3 of this Agreement, each Party, upon the Company's request, shall use reasonable efforts to support the Company's applications for Approvals and shall not file comments or recommend Approval conditions that are inconsistent with this Agreement, provided that this sentence shall not apply to a Party that is the agency issuing the requested Approval. The Company shall pay all fees required by law related to such Approvals. The Parties shall work together as appropriate during the permitting, environmental review, and implementation of this Agreement. Except as expressly provided in this Agreement, the Company shall not be required to implement an action required under this Agreement or the License until all applicable Approvals required for that action are obtained. The Company may, but shall be under no obligation to, apply for an Approval to implement any provision of the License that has been stayed by FERC or court order. Except as otherwise required by the License, if a proceeding challenging any Approval required for the action ("Proceeding") has been commenced, the Company shall be under no obligation to implement the action or any directly related action under this Agreement until any such Proceeding is terminated, and the Parties will not oppose a request to FERC by the Company requesting a reasonable extension of any deadline imposed by the License to implement such action. In the event any Proceeding is commenced, the Parties shall confer to evaluate the effect of such Proceeding on implementation of this Agreement. Nothing contained in this Section 2.4 shall be construed to limit the Company's right to apply for an Approval before issuance of the License, provided that any such applications shall be consistent with this Agreement.

2.5. Communications with FERC and Other Governmental Agencies

Subject to Sections 2.1 to 2.4, 6.1, and 7.2, as applicable, the Parties may make such comments and responses to comments as the Parties deem necessary to be filed with FERC, ODEQ, WRD, or any other federal, state or local agency in the context of the licensing or Approval processes.

3. IMPLEMENTATION OF PM&E MEASURES

3.1. Duration of Agreement

This Agreement shall take effect on the Effective Date and shall remain in effect for the term of the License, unless this Agreement is sooner terminated as provided in Section 7.2(i) or (ii), 8.16 or 8.17.

3.2. The Company's Enforceable Duties Under the License

The Parties agree to request that FERC incorporate as enforceable conditions of the license the Company's obligations contained in the four resource plans set forth as Appendices A through D, in the adaptive management requirements of Section 3.3, in the committee requirements of Section 4.2, in the License Application (including the Project Description, Operations and Maintenance Plan, Spill Prevention Control and Countermeasure Plan, and Emergency Response/Recovery Plan), and in Sections 3.6 and 4.3 ("Company Obligations"). Appendices A through D are attached to and made a part of this Agreement. If issuance of the License is delayed or if the License is stayed, the Parties agree that the Company may delay implementation of Company Obligations or may implement one or more of those activities at its discretion if FERC approval is not first required, except that the Company shall continue to implement Pre-License Measures pursuant to Section 3.5. If an Approval necessary to carry out a Company Obligation is delayed, the Parties agree that the Company Obligations requiring the Approval and any subsequent actions dependent on the Approval that is delayed, will be delayed accordingly, and the Parties will not oppose a request to FERC by the Company for a reasonable extension of the time in which to carry out such Company Obligations. If issuance of an Approval required for a Company Obligation is or is anticipated to be delayed, the Company shall confer with the other Parties to evaluate the effect of such delay on implementation of this Agreement.

3.3. Adaptive Management

Exhibit B provides an overview of the adaptive management process described in this Agreement, including the provisions of this Section 3.3, committee memberships described in Section 4.2, and dispute resolution described in Section 7.5. Exhibit B may be used as a reference tool in implementing the adaptive management process ("AMP"); however, in the event of a conflict between the language in Exhibit B and this Agreement, this Agreement's language shall control. Similarly, in the event of a conflict between the language of Exhibit B and plans attached in Appendices A through D, the language in the plans shall control.

3.3.1. Purpose

The primary purpose of adaptive management under this Agreement is to manage development and operation of the Project in an adaptive manner to avoid or minimize adverse effects to aquatic resources, water quality, recreation, public safety, crabbing and fishing, terrestrial resources, and cultural resources. The underlying reason for this AMP is to provide the ability to adjust management and monitoring of the Project in light of new relevant data. In addition, the Parties will use the AMP to identify and implement additional studies that may be required to evaluate a potential future Expanded Project. Implementation of the AMP will begin on the Effective Date.

Notwithstanding the process set forth in this Section 3.3 and elsewhere in this Agreement for implementing adaptive management, nothing in this Agreement shall delay immediate response mechanisms in the event of an emergency. For purposes of the Agreement, the term "emergency" is not limited to emergencies addressed in Section 3.6 or Appendix B.

3.3.2. Generally

The Company will implement the agreed on actions, including monitoring and studies, described in Appendices A through D; provided, however, that the Parties agree to use the AMP to modify the location of acoustic monitoring or similar monitoring devices or performance of the studies as necessary to address any change in PowerBuoy orientation from the July 2008 Draft License Application to the final License Application. Upon conclusion of a study or monitoring, the Company will provide results to the Parties consistent with the requirements set forth in the applicable Appendix. As of the Effective Date, the Agreement includes detailed studies and monitoring related to aquatic and water quality issues only (Appendix A). The AMP allows Implementation Committees to address issues outside of those initially studied, including issues related to recreation, public safety, crabbing and fishing, terrestrial resources, and cultural resources, as well as aquatic and water quality resource issues not addressed in initial studies. To preserve the Parties' ability to address all of these issues through the AMP, the Agreement refers to Appendices A through D, not just Appendix A, when discussing the AMP process.

3.3.3. Implementation Committee Meetings

The applicable Implementation Committee will meet between 30 and 60 days after the Company's release of any study or monitoring results, or sooner than 30 days with agreement of the Implementation Committee members. In the case of critical adverse effects on a resource, any Implementation Committee member may direct the Licensing Compliance Coordinator to schedule a meeting as soon as practicable. Meetings will be in person or by conference call as determined by those Implementation Committee members who express an interest in the issue. Any Implementation Committee member can elect to participate in any meeting by phone.

The Implementation Committee will analyze monitoring and study results to determine whether results are properly characterized and whether any screening criteria described in Appendices A through D have been met. Any disagreements over the characterization of study results or a determination regarding whether screening criteria are met will be addressed in accordance with the dispute resolution process in Section 7.5.

In addition to meeting between 30 and 60 days after the Company's release of study or monitoring results, any member may call an Implementation Committee meeting with 30 days' notice to discuss information contained in a Quarterly Update or an Annual Report (Section 3.3.8) or new information obtained from other sources that is relevant to the Project's potential effects on aquatic resources, water quality, recreation, public safety, crabbing and fishing, terrestrial resources, and cultural resources. For purposes of this Agreement, the term "new information" includes but is not limited to a new scientific understanding of existing information or changes in the Project design or implementation.

The Company shall provide a facilitator at the first of each Implementation Committee meetings, and thereafter upon request of an Implementation Committee for the first year after the Effective Date.

3.3.4. Formulating Screening Criteria

When screening criteria are not articulated in Appendices A through D because the Parties lacked a reasonable basis for describing such criteria as of the Effective Date, the applicable Implementation Committee has an ongoing obligation to determine whether the monitoring and study results provide a sufficient information base from which to formulate screening criteria. In addition, the Implementation Committee will consider whether changes to initial screening criteria are required based on monitoring and study results. When new or modified screening criteria are warranted, the Implementation Committee will take the steps necessary to formulate such screening criteria, and may retain a technical expert to assist the Implementation Committee pursuant to Section 4.2.1. The Implementation Committee will schedule additional meetings as necessary to determine, within three months, whether screening criteria have been met or to formulate new or modified screening criteria. Screening criteria need not be numerical, but should be based on the best professional judgment of applicable Implementation Committee members and the best available science.

3.3.5. Response to Study or Monitoring Results

If at any time the applicable Implementation Committee determines that (1) no screening criteria have been met, or (2) a screening criterion has been met but continuation of current practices is appropriate; then no new action is required. The Company will either continue or conclude the relevant activity, including monitoring and studies, in accordance with the requirements of Appendices A through D.

If at any time the Implementation Committee determines that (a) a screening criterion has been met and requires a change in current management practices, (b) new information (including a new scientific understanding of existing information) obtained from another source that is relevant to the Project's potential effects on aquatic resources, water quality, recreation, public safety, crabbing and fishing, terrestrial resources, or cultural resources requires a change in current management practices, or (c) a new study is needed; then the Company will prepare for the Implementation Committee's consideration within 60 days of that decision a proposed avoidance, minimization or mitigation plan ("Response Plan"). The Response Plan may include design changes, operational changes, structural changes, changes in maintenance or other management, changes in monitoring or studies (including changes in design, method or duration), new monitoring or studies, temporary suspension of construction or operations, or removal of any or all structures. The Response Plan should include any additional monitoring necessary to judge the success of the Response Plan at addressing the issues raised, the results of which will be provided to the Implementation Committee. The Company will invite input from appropriate members of the Implementation Committee during this time and, while the Company will not be obligated to include specific recommendations in its proposed Response Plan, it will respond to any input received.

The Implementation Committee will meet within 30 days of the Company's release of the proposed Response Plan to determine whether to adopt the Response Plan, modify the Response Plan, or choose an alternative Response Plan for avoiding, minimizing or mitigating to meet the applicable statutory or regulatory authorities. The Implementation Committee will make best efforts to reach consensus. The Implementation Committee will schedule additional meetings as necessary to make these decisions. However, if consensus is not reached within 60 days, any Party may submit the disagreement to dispute resolution (Section 7.5). Notwithstanding the 30-day notice provision of Section 7.5.2, the ability to submit a disagreement regarding the Response Plan to dispute resolution after the initial 60 days continues for as long as the Parties are attempting to reach consensus; any Party claiming a dispute must give notice of the dispute within 20 days after the Parties' last meeting to attempt to reach consensus. If any member of the Implementation Committee, after making best efforts to reach consensus, believes that additional discussion would not be fruitful, the member need not wait for the expiration of the 60-day period, but may trigger dispute resolution at that time.

In some cases, immediate action may be required to address critical adverse effects to affected resources. In such cases, the Implementation Committee will make best efforts to agree on actions that the Company can take immediately to address the effect or will direct the Company to develop a proposed Response Plan within a specified period of time shorter than 60 days.

At any time, the Company may propose Project changes in the form of a Response Plan by email or similar communication to the Implementation Committee members. Upon written approval (by email or other form) from Implementation Committee members, the Company will implement the Response Plan subject to any required FERC or other agency approvals. If any Implementation Committee member objects, the Company will convene the Implementation Committee to initiate the AMP.

3.3.6. Implementation of Response Plan

Upon agreement of the applicable Implementation Committee on a Response Plan, or upon successful conclusion of dispute resolution resulting in a Response Plan to which the Parties agree, the Company will submit the Response Plan to FERC along with the appropriate request for approval or license amendment depending on the type of changes or additional license requirements included in the Response Plan.

3.3.7. Continued Disagreement After Dispute Resolution

In the event of disagreement among the Parties with regard to the content of a Response Plan, when that disagreement is not resolved by dispute resolution, the Company will submit its proposed Response Plan to FERC, with copies to the Parties' authorized representatives (Exhibit A), along with documentation of consultation with the appropriate Implementation Committee members and any consultation with the Coordinating Committee, copies of any comments and recommendations on the Response Plan, and specific descriptions of how those comments were accommodated by the Response Plan or why they were not adopted. In that event, any Party may seek different or additional measures pursuant to state or federal statute or regulation. Such action will not constitute a breach of this Agreement, nor shall it be considered an "inconsistent" action triggering dispute resolution or withdrawal under Section 7. The Company or any other Party may bring an administrative or judicial challenge to such action.

3.3.8. Updates and Reports

Each quarter, the Company shall distribute to the Parties by email or other appropriate method a brief update on the status of any ongoing monitoring and studies and plans for the next quarter ("Quarterly Update"). Quarterly Updates shall be distributed to the Parties as soon as practicable, but not to exceed 30 days, following completion of the previous quarter. Notwithstanding the language of Section 3.3.9, the Company will provide the Quarterly Updates to the appropriate Implementation Committees' representatives.

In addition, the Company, in consultation with the Coordinating Committee and appropriate Implementation Committees, will submit annual reports to FERC summarizing any monitoring and study results from the past calendar year, describing plans and schedules for the coming calendar year, and describing the decisions of the Implementation Committees ("Annual Report") from the past calendar year. The first Annual Report will be due to FERC on April 1 after License issuance, except that if the License is issued between October 1 and April 1, the first Annual Report will be due to FERC on the second April 1 following issuance of the License. For the first five years after license issuance and thereafter on request of the Coordinating Committee, the Company will convene a meeting to present the Annual Report to the Coordinating Committee after submission to FERC.

3.3.9. Communications Regarding Adaptive Management

All communications related to adaptive management by any Party, including monitoring and study results, Annual Reports, notices and other communications, will be sent to each Party's authorized representative (Exhibit A), and to each Party's representative to the Coordinating Committee and applicable Implementation Committee.

3.3.10. Five-Year Evaluations

The Company will convene a meeting of the Parties every five years, at a minimum, following issuance of the License to discuss whether changes to the AMP are appropriate and to provide an additional forum to discuss new or modified studies that may be warranted. If a new or modified study is identified for consideration, the appropriate Implementation Committee will evaluate the study through the AMP. Changes to the AMP will require amendment of the Agreement under Section 8.2.

3.4. License Term

The Parties request that FERC issue the License for a term of 35 years.

3.5. Pre-License Measures

Appendices A through D include measures that the Company will implement prior to FERC issuing the License ("Pre-License Measures"). The Parties do not expect implementation of these measures to become requirements of the License, to the extent the Company has completed them prior to issuance of the License. In anticipation of and consistent with the issuance of a License consistent with this Agreement, including Appendices A through D and Section 3.3, the Company agrees to implement Pre-License Measures after the Effective Date of this Agreement and to continue to implement them regardless of any delay in issuance of the License. If implementation of a Pre-License Measure is delayed or is anticipated to be delayed, the Company shall confer with the other Parties to evaluate the effect of such delay on implementation of this Agreement. The Company will submit results of any studies completed prior to license issuance to FERC.

3.6. Fish or Wildlife Emergency Circumstances

If at any time circumstances arise during construction or operation of the Project in which fish or wildlife are being killed or injured in a manner not anticipated or previously authorized, the Company shall immediately take appropriate action to prevent further loss in a manner that does not pose a risk to human life, limb or property. The Company shall, within six hours of becoming aware of an emergency circumstance, call the emergency contacts listed in Exhibit C and shall cooperate with the relevant agency or agencies to allow them to perform life-saving measures or collect dead animals. As soon as practicable but no later than 10 days after any such occurrence, the Company shall notify the appropriate Implementation Committee members to allow members to initiate the AMP if appropriate. The Company shall provide a copy of this notification to FERC and the Parties. Notification shall include a description of the nature, time, date, location and any action by the Company to prevent further loss. Nothing in this paragraph authorizes or requires the Company to perform life-saving measures or collect dead animals. Each Party shall be responsible for notifying the Company pursuant to Section 8.11 of changes in its emergency contact information. The Company is responsible for making one phone call to each of the emergency contacts. The Company may leave a message or, in the event a message cannot be left, will make reasonable efforts to continue attempting to contact the emergency contact; however, the Company will not be considered in violation of this Section 3.6 for failure to contact an entity that does not answer the phone number provided.

4. COORDINATION AND DECISION-MAKING

4.1. Purpose and Function

The Parties agree to cooperate in implementing this Agreement and in the Company's implementation of the License. In addition to any periodic reporting obligations included in or imposed by FERC in the License, the Company shall provide the Parties with copies of all public filings made with FERC by the Company in connection with implementation of the License.

4.2. Committees

Within 120 days of the issuance of the License, the Company, through its Licensing Compliance Coordinator, shall convene a Coordinating Committee that will address issues related to the implementation of this Agreement, including but not limited to resolving disputes pursuant to Section 7.5 of this Agreement, setting direction for the Implementation Committees (below) on their operation and focus, changing Implementation Committee membership, considering additional signatories or amendments to this Agreement, and consulting with the Company on the content of Annual Reports (Section 3.3.8).

In addition, within 120 days of the issuance of the License, the Company, through its Licensing Compliance Coordinator, shall convene an Aquatic Resources and Water Quality Committee, Recreation and Public Safety Committee, Crabbing and Fishing Committee, and Terrestrial and Cultural Resources Committee (each also referred to as an "Implementation Committee" and collectively as the "Implementation Committees"). The Implementation Committees are charged with overseeing the Company's implementation of Appendices A through D, respectively, and participating in associated adaptive management under Section 3.3. The Parties may designate a representative to these Implementation Committees as indicated in Table 1. The Coordinating Committee and Implementation Committees may be referred to individually as a "Committee" or collectively as the "Committees."

Parties will make best efforts to actively participate in the Committees to which they are assigned. Representatives should have sufficient familiarity with the issues addressed by a Committee to be able to actively participate in Committee discussions. A Party may designate a different representative to each Committee. If any Party fails to designate a representative to a Committee to which it is a member, that Party's authorized representative, as designated in Exhibit A to this Agreement, shall be deemed that Party's representative to that Committee. A Party may at any time designate a different representative to one or more of the Committees by providing notice as provided in Section 8.11 of this Agreement. In addition, without changing its designated representative, a Party may have person(s) other than, or in addition to, its designated representative attend and participate in Committee meetings or discussions.

Table 1: Implementation Committee Memberships

Coordinating Committee	Aquatic Resources and Water Quality Committee	Recreation and Public Safety Committee	Crabbing and Fishing Committee	Terrestrial and Cultural Resources Committee
All Parties	-The Company -NOAA Fisheries Service -USFWS -USDA-FS -ODFW -OPRD -WRD -ODEQ -DLCD -Oregon Shores Conservation Coalition -Surfrider Foundation -SOORC	-The Company -USDA-FS -OPRD -WRD -DLCD -Surfrider Foundation -SOORC -Oregon State Marine Board	-The Company -ODFW -SOORC	-The Company -USFWS -USDA-FS -OPRD -ODFW -Oregon Shores Conservation Coalition

4.2.1. Decision-Making Process

Each of the Committees shall strive to conduct its business by consensus. For purposes of this Agreement, "consensus" shall mean that any decision must be acceptable to all designated representatives of the Parties participating in the Committee who have expressed an interest in the issue. Decisions of the Committees shall not abrogate or limit any Party's statutory or regulatory authority; however, any inconsistencies will be addressed pursuant to Section 7.5. At the request of a Committee, the Company shall fund and make available a mutually agreed-on third-party technical expert to assist the Committee in reaching its decisions. The decisions and operations of the Committees shall be subject to the dispute resolution provisions of Section 7.5 of this Agreement.

4.2.2. Meeting Notice

Unless otherwise specified in this Agreement, the Company shall provide members of the Committees a minimum of 30 days' notice prior to any meeting, provided that meetings may be called on shorter notice if the circumstances require.

4.2.3. Licensing Compliance Coordinator

The Company shall designate a Licensing Compliance Coordinator to oversee the implementation of the License and this Agreement within 120 days of issuance of the License, including helping schedule Coordinating Committee and Implementation Committee meetings, assisting in preparation and completion of timely reports, and maintaining important documents, meeting minutes, and data to be made available to the Parties. If the Licensing Compliance Coordinator is not the Company's representative to a Committee, the Licensing Compliance Coordinator shall work closely with the Company's representative to facilitate communication between the Licensing Compliance Coordinator and that Committee. The Company will provide reasonable administrative and clerical support for the Committees. At the Coordinating Committee or an Implementation Committee's direction, the Licensing Compliance Coordinator will also share appropriate information with the public on a Web site or by other method.

4.2.4. Meetings

The Licensing Compliance Coordinator shall arrange any meetings of the Committees deemed necessary by the Parties to coordinate activities and inform the Parties concerning the status or implementation of this Agreement and the License. Representatives may attend meetings in person or by phone.

4.3. Inspection, Notice and Site Visit

To the extent access is restricted, the Company shall permit the Parties, at any reasonable time, access to, through, and across the Project boundary and works for the purpose of inspecting Project facilities and Project records pertaining to the operation of the Project and implementation of this Agreement and the License. The Company shall allow such inspections only after the Party requesting the inspection provides the Company reasonable notice of such inspections and agrees to follow the Company's standard safety and security procedures when engaged in such inspections including, but not limited to, taking safety training and executing a waiver of liability.

As soon as practicable after completion of construction and initiation of PowerBuoy operations, and considering the season and weather conditions, the Company will host one site visit to the PowerBuoy array to view the PowerBuoys and their environment from the boat deck. The Company will provide at least 30 days' notice regarding the site visit date, but is not responsible for ensuring that all Parties are available on the site visit date. The Company may limit the number of representatives that each Party sends to the site visit based on boat capacity and safety issues and may require representatives to sign liability waivers.

5. COVENANTS

5.1. Public Benefit from Licensing of the Project

As further described in the Joint Explanatory Statement, the Parties agree that licensing of the 10-buoy Project in accordance with this Agreement serves the public interest and achieves a reasonable resolution of issues posed by licensing the Project. The Parties also agree that the time frames described in Appendices A through D for implementation of protection, mitigation and enhancement measures, monitoring and studies are reasonable time frames necessary to serve the public interest in a safe, appropriate, and effective manner. The Parties make no determination regarding the public benefit of an Expanded Project.

5.2. Coordination of Information

The Parties agree to use reasonable efforts to coordinate information provided to public agencies and to the public regarding this Agreement, the Company's filing of this Agreement and associated documents with FERC, the License, Approvals, and a Clean Water Act section 401 certification ("401 Certification"). The Parties acknowledge that Governmental Parties must comply with laws governing public access to public records.

5.3. Federal Governmental Party Processes

Regarding any mandatory conditions filed with FERC prior to issuance of the License, pursuant to Sections 4(e) and 18 of the FPA, that are consistent with this Agreement, each Party waives any right it may have to an agency trial-type hearing on issues of material fact under Sections 4(e) and 18 of the FPA and to propose alternatives under Section 33 of the FPA. The Parties will not support any trial-type hearing requested by any non-Party and will make reasonable efforts to support the federal Governmental Parties, as appropriate, if a trial-type hearing is requested by any non-Party.

5.4. Settlement Negotiations

Pursuant to FERC regulations governing settlement negotiations, the Parties agree that positions advanced or discussed by the Parties during negotiation of this Agreement shall not be used by any Party in any manner, including admission into evidence, in connection with this Agreement or in any other proceedings related to the subject matter of this Agreement, except to the extent required by law. This Section 5.4 shall survive any termination of this Agreement and shall apply to any Party that withdraws from this Agreement.

6. COMMITMENTS OF THE PARTIES

6.1. Resolving Authorities

The Parties have worked collaboratively to develop measures in this Agreement, including but not limited to the AMP in Section 3.3 and plans in Appendices A through D. Based on the information available to the Parties as of the Effective Date, and subject to considering any public comments pursuant to Section 1.3 and performing all other analyses required by law, the Parties anticipate that the Company's implementation of this Agreement will satisfy its obligations under state and federal law and policy with regard to construction and operation of the Project, including but not limited to the following authorities and any associated rules or implementing regulations:

Federal Power Act
Clean Water Act
Endangered Species Act
Magnuson-Stevens Fishery Conservation and Management Act
Marine Mammal Protection Act
Coastal Zone Management Act
National Historic Preservation Act
Migratory Bird Treaty Act
Ports and Waterways Safety Act
Fish and Wildlife Coordination Act
33 C.F.R. Parts 62 and 66 (Aid to Navigation Permit)
36 C.F.R. section 251 (Special Use Authorization)
State Endangered Species Act
ORS chapters 537 and 543 (water right)
ORS 196.805 (Removal-Fill Permit)
ORS 468B (401 Certification)
ORS 274.040 (Ocean Energy Facility Lease)
ORS 390 (Ocean Shores Alteration Permit)
ORS 274.867 (Wave Energy Facilities or Devices)
Oregon Coastal Management Plan
Oregon Territorial Sea Plan
Oregon Statewide Planning Goal 19
Oregon Ocean Resources Management Plan
Siuslaw National Forest Land and Resource Management Plan

The Parties intend that any comments, recommendations, conditions or prescriptions submitted to FERC by them in connection with the Project will be consistent with this Agreement. In addition, the Governmental Parties intend that any Approvals issued by them will be consistent with this Agreement, subject to the need to fully comply with all statutory and regulatory requirements as described in Section 1.3 of this Agreement. If a Governmental Party issues an Approval that is materially inconsistent with this Agreement, or fails to issue a necessary

Approval, the Parties shall address any such inconsistency in accordance with Section 7 of this Agreement.

6.2. Reservations of Authority

Each Party reserves its authority pursuant to state and federal law in the event (i) this Agreement is not filed with FERC, (ii) the Party withdraws from this Agreement, (iii) the Company fails to implement any material provision of this Agreement, or (iv) this Agreement is terminated for any reason whatsoever, provided in each instance that the remaining Parties' rights shall be governed by the applicable provision of Section 7 of this Agreement.

In the event that any Governmental Party includes a reservation of authority under any statute in its modified or final conditions, recommendations or prescriptions that it submits to FERC, and the reservation of authority is included as a condition of the License, the inclusion of such reservation shall not be considered to be inconsistent with this Agreement, provided that in exercising such reserved authority, any Governmental Party shall comply with applicable requirements of section 33 of the FPA; and provided further, that each Party shall be deemed to have reserved the right, to the extent applicable, pursuant to sections 4(e), 18, and 33 of the FPA to (i) propose alternatives to the exercise of such reserved authority; (ii) obtain an agency trial-type hearing on any disputed issue of material fact with respect to such exercise of reserved authority; and (iii) otherwise contest the exercise of such reserved authority at any time in the future.

7. INCONSISTENCIES AND DISPUTE RESOLUTION

7.1. Consistent License

The Parties will not seek rehearing or otherwise appeal components of the License that are consistent with the Agreement; however, while supporting the Agreement, the Parties specifically may take any action should FERC issue the License before the Company has submitted complete applications to DSL for an ocean energy facility lease, OPRD for an ocean shores alteration permit and WRD for a water right, as required by law; received authorizations required from other entities under federal laws including the Clean Water Act and the Coastal Zone Management Act; and completed consultation under the Endangered Species Act.

7.2. Materially Inconsistent Actions by Parties

If any Party (1) takes an action that is materially inconsistent with this Agreement, including but not limited to issuing a materially inconsistent Approval or submitting materially inconsistent comments, recommendations, conditions or prescriptions in any forum; or (2) fails to timely implement an action (hereafter “inaction”) required by this Agreement including failing to issue a necessary Approval in a timely manner, and the inaction results in a material inconsistency that is not excused due to force majeure; *then* any other Party may (a) oppose the action or inaction; (b) seek enforcement by FERC; (c) exercise any rights available to it under applicable law including seeking judicial or administrative review or specific performance; and/or (d) withdraw from the Agreement; *and in addition*, the Company may (i) decline to file the Agreement with FERC if it has not yet done so, in which case the Agreement terminates; or (ii) withdraw the Agreement from FERC’s consideration if it has already filed it but FERC has not yet issued a Project license, in which case the Agreement terminates. If the Company’s materially inconsistent action or inaction is excused due to force majeure, and such action or inaction is reasonably anticipated to continue for more than 180 days, then any other Party may take an action under (a), (b), (c), or (d) of this Section 7.2. Prior to undertaking an option under (b), (c), (d), (i) or (ii) of this Section 7.2, a Party must complete dispute resolution toward resolving the material inconsistency.

Reservations of authority asserted by Parties and/or included in the Project license shall not be considered “materially inconsistent.” Similarly, FERC’s reservation of authority to modify plans or reopen the license shall not be considered “materially inconsistent.” The exercise of such reservations may be considered materially inconsistent.

7.3. Materially Inconsistent Actions by FERC and Other Non-Parties

If (1) FERC issues or modifies the Project license, or approves or modifies Response Plan, other plan, report or design filed by the Company, in a manner materially inconsistent with the Agreement; or (2) any entity that is not a Party to this Agreement succeeds in imposing a requirement on the Project that is materially inconsistent with the Agreement; *then* any Party may (a) exercise any rights available to it under applicable law including seeking judicial or administrative review; or (b) withdraw from the Agreement. Prior to undertaking either (a) or

(b) of this Section 7.3, a Party must complete dispute resolution toward conforming the Agreement to, or otherwise resolving, the material inconsistency. If no Party takes an action pursuant to (a) or (b) of this Section 7.3 within 30 days after FERC issues a materially inconsistent license, Response Plan, other plan, report or design, then the Company may act consistent with the License and such action is not a violation of the Agreement or material inconsistency for purposes of Section 7.2.

The Company shall implement each of the Agreement's terms regardless of whether a term is not included in the Project license, unless implementation would directly conflict with a license term, in which case the inconsistency shall be considered material and addressed pursuant to this Section 7.3.

7.4. Judicial or Administrative Review or Other Remedy

If a Party seeks judicial or administrative review or other remedy under Section 7.2(c) or 7.3(a), any Party may request that FERC delay issuance of the license or stay the license's effectiveness pending completion of that review or resolution among the Parties, and any other Party may oppose such a request.

If waiting for completion of dispute resolution would foreclose a Party from seeking rehearing, or seeking judicial or other administrative review, or preclude a remedy sought pursuant to Section 7.2(c) or 7.3(a), the Party may take actions necessary to preserve the viability of the action or remedy prior to completion of the dispute resolution process, and shall provide notice to the Parties concurrent with taking such actions. In such case, all Parties will continue to follow the dispute resolution process of Section 7.5 to the extent reasonably practicable while any such review is pursued. If the Parties resolve a dispute while a request for review is pending, the Party that sought the review shall withdraw its request.

7.5. Dispute Resolution

7.5.1. Commitment to Dispute Resolution

All disputes among the Parties regarding the obligations of the Parties under this Agreement shall, at the request of any Party, be subject to dispute resolution pursuant to this Section 7.5. The Parties agree to devote such time, resources, and attention to dispute resolution as are needed and as can be reasonably provided to attempt to resolve the dispute at the earliest time possible, and each Party shall cooperate in good faith to promptly schedule, attend, and participate in the dispute resolution. Parties shall promptly implement any final agreements that they reach, consistent with their applicable statutory and regulatory responsibilities. In the event of an emergency, nothing in this Section 7.5 prevents Parties from taking necessary steps to address such emergency consistent with their statutory and regulatory obligations.

7.5.2. First and Second Level Meetings

A Party claiming a dispute shall give notice to the Parties of the dispute within 30 days of such Party's actual knowledge of the act, event, or omission that gives rise to the dispute, or other period of time specifically provided by the Agreement. Within 20 days after receiving such notice, the Company shall convene a meeting of the Implementation Committee if the dispute arose at the Implementation Committee level, or a meeting of the Coordinating Committee if the dispute arose outside of an Implementation Committee, to attempt to resolve the dispute ("First Level Meeting"). If the First Level Meeting is of an Implementation Committee and the dispute is not resolved within 15 days of the First Level Meeting, any Party may refer the dispute to the Coordinating Committee by providing notice to the Parties. Within 20 days after receiving such notice, the Company shall convene a meeting of the Coordinating Committee ("Second Level Meeting").

The term "complete dispute resolution," as used in Sections 7.2 and 7.3, means that 60 days has passed since the Coordinating Committee's First Level Meeting or Second Level Meeting, or that the dispute has been resolved among all Parties, whichever occurs first.

7.5.3. Mediation

If the Coordinating Committee is unable to resolve a dispute within 60 days of its First Level Meeting or Second Level Meeting, the Parties may attempt to resolve the dispute using a neutral mediator unanimously selected by the disputing Parties. The mediator shall mediate the dispute in accordance with the instructions and schedule provided to it by the Coordinating Committee. If the Company agrees to mediation, the Company will pay the mediator's fees. However, unless otherwise agreed among the Parties, each Party shall bear its costs for its own participation in the dispute resolution.

7.5.4. Timing

Any of these time periods provided in this Section 7.5 may be reasonably extended or shortened by agreement of the Parties, or as necessary to conform to the procedure of an agency or court with jurisdiction over the dispute.

8. GENERAL PROVISIONS

8.1. Entire Agreement

This Agreement, together with the Appendices attached to and made a part of this Agreement, sets forth the entire agreement of the Parties with regard to licensing and operation of the Project. This Agreement is made on the understanding that each term is in consideration and support of every other term, and that each term is a necessary part of the entire Agreement.

8.2. Amendments

This Agreement, including the AMP, may be amended by unanimous written consent of the Parties. Any Party may request all other Parties to commence negotiations for a period of up to 90 days to amend this Agreement in whole or in part. Any such amendment that renders the Agreement inconsistent with terms and conditions of the License or other regulatory approvals then in effect shall be subject to approval by FERC or other permitting agency, except that the Parties may agree to implement on an interim basis any amendment not requiring prior regulatory approval. As appropriate, the Parties will submit a statement to FERC in support of any amendment. This Agreement anticipates that the Project will be managed adaptively; changes to the Project through Response Plans (Section 3.3) do not require amendment of this Agreement.

8.3. No Third-Party Beneficiaries

Without limiting the applicability of rights granted to the public pursuant to applicable law, this Agreement shall not create any right or interest in the public, or any member of the public, as a third-party beneficiary of this Agreement, and shall not authorize any non-Party to maintain a suit at law or in equity pursuant to this Agreement. The duties, obligations, and responsibilities of the Parties with respect to third parties shall remain as imposed under applicable law.

8.4. Successors, Transferees and Assigns

This Agreement shall apply to and be binding on the Parties and their successors, transferees, and assigns, to the extent allowed by law. Upon completion of a succession, transfer, or assignment, the initial Party shall no longer be a Party to this Agreement. No change in ownership of the Project or transfer of the License by the Company shall in any way modify or otherwise affect any other Party’s interests, rights, responsibilities, or obligations under this Agreement.

8.5. Failure to Perform Due to Force Majeure

8.5.1. Declaration of Force Majeure

No Party shall be liable to any other Party as a result of a failure to perform or for delay in performance of any provision of this Agreement if such performance is delayed or prevented by force majeure. The term "force majeure" means any cause reasonably beyond the performing Party's control that could not be avoided with the exercise of due care, whether unforeseen, foreseen, foreseeable, or unforeseeable, and that occurs without the fault or negligence of the Party whose performance is affected by force majeure. Cost for the performance of any action required by this Agreement shall not be deemed to constitute force majeure. The Party whose performance is affected by force majeure shall notify the other Parties in writing within 24 hours, or otherwise as soon as reasonably practicable, after becoming aware of any event that such performing Party contends constitutes force majeure. Such notice will identify the event causing the delay or anticipated delay, estimate the anticipated length of delay, state the measures taken or to be taken to minimize the delay, and estimate the timetable for implementation of the measures. The performing Party shall make all reasonable efforts to promptly resume performance of this Agreement and, when able, to resume performance of its obligations and give the other Parties written notice to that effect.

8.5.2. Consultation with Parties

If the Company is unable to perform any obligation pursuant to any provision of this Agreement as a result of force majeure, then the Company shall, (1) as soon as practicable but within three days after notifying the Parties of the existence of an event constituting force majeure, confer with NOAA Fisheries Service and USFWS regarding whether reinitiation of formal Endangered Species Act consultation is required and to minimize any take of species listed as endangered or threatened; and (2) as soon as practicable but within 10 days after notifying the Parties of the existence of an event constituting force majeure, confer with the Coordinating Committee regarding the force majeure event, the anticipated length of delay, and the measures taken or to be taken to minimize delay.

8.6. Section References

Any reference to another section of this Agreement shall include all subsections of the section referred to.

8.7. No Consent to Jurisdiction

By executing this Agreement, no Party is consenting to the jurisdiction of any state, federal, or tribal court.

8.8. Elected Officials Not to Benefit

No member of or delegate to Congress shall be entitled to any share or part of this Agreement or to any benefit that may arise from it.

8.9. No Partnership

Nothing in this Agreement shall be construed to constitute the Parties as principal and agent, employer and employee, partners, joint venturers, co-owners, or otherwise as participants in a joint undertaking. No Party shall have the right or authority to assume or create any obligation or responsibility for or on behalf of another Party except as specifically provided in this Agreement.

8.10. Reference to Statutes or Regulations

Any reference in this Agreement to any federal or state statute or regulation shall be deemed to be a reference to such statute or regulation or any successor statute or regulation in existence as of the date of action taken pursuant to this Agreement.

8.11. Notice

Except as otherwise provided in this Section, any notice required by this Agreement shall be written and shall be sent by first-class mail or comparable method of distribution (including electronic mail) to all Parties still in existence or their successors and shall be filed with FERC. For the purpose of this Agreement, a notice shall be effective seven days after the date on which it is first mailed or otherwise distributed. When this Agreement requires notice in less than seven days, notice shall be provided by telephone, facsimile, or electronic mail and shall be effective when provided. For the purpose of notice, the list of authorized representatives of the Parties as of the Effective Date is attached as Exhibit A. The Parties shall provide notice as provided in this Section 8.11 of any change in the authorized representatives designated in Exhibit A, and the Licensing Compliance Coordinator shall maintain the current distribution list of such representatives.

8.12. Section Titles for Convenience Only

The titles for the paragraphs of this Agreement are used only for convenience of reference and organization, and shall not be used to modify, explain, or interpret any of the provisions of this Agreement or the intentions of the Parties.

8.13. Waiver

Waiver by any Party of the strict performance of any term or covenant of this Agreement, or of any right under this Agreement, shall not be a continuing waiver, and must be in writing.

8.14. Responsibility for Costs

The Company shall be solely responsible for payment of costs of actions required of the Company by this Agreement. The Company shall have no obligation to reimburse or otherwise pay any other Party for its assistance, participation, or cooperation in any activities pursuant to this Agreement, the License, Approvals, or 401 Certification, except as specified in this Agreement, or in cost reimbursement agreements among the Company and Governmental Parties, or as otherwise required by law.

8.15. Availability of Funds

Implementation of this Agreement for a federal Governmental Party is subject to the requirements of the Anti-Deficiency Act, 31 U.S.C. §§ 1341, 1519, and the availability of appropriated funds. Nothing in this Agreement is intended or shall be construed to require the obligation, appropriation, or expenditure of any money from the U.S. Treasury. The Parties acknowledge that the federal Governmental Parties shall not be required under this Agreement to expend any federal agency's appropriated funds unless and until an authorized official of each such agency affirmatively acts to commit such expenditures, as evidenced in writing. Any obligation of any state Governmental Party to make any payment or expend any funds under this Agreement attributable to obligations performed under this Agreement after the last day of the current biennium is contingent upon the state Governmental Parties receiving from the Oregon Legislative Assembly (including but not limited to its Emergency Board) appropriations, limitations, or other expenditure authority sufficient to allow the state Governmental Parties, in the exercise of their reasonable administrative discretion, to continue the obligations contemplated by this Agreement.

8.16. Rejection of License

Nothing in the Agreement limits the Company's right to reject a license issued by FERC, in which case the Agreement terminates.

8.17. Effect of Withdrawal

Within 30 days of a Governmental Party's withdrawal pursuant to Section 7.2(d) or 7.3(b), the Company may also withdraw. Withdrawal of a Party under the previous sentence, Section 1.1, Section 7.2(d), or Section 7.3(b) does not terminate the Agreement for the remaining Parties, except that if the Company withdraws from the Agreement, the Agreement terminates. A Party that withdraws is not bound by and has no rights under the Agreement, except that the limitations of Sections 1.2 and 5.4 shall continue to apply.

8.18. Effect of Termination

If the Agreement terminates pursuant to Section 7.2(i) or (ii), 8.16 or 8.17, the Parties shall not be bound by and shall have no rights under the Agreement, except that the limitations of Sections 1.2 and 5.4 shall continue to apply.

9. EXECUTION

9.1. Signatory Authority

Each signatory to this Agreement certifies that he or she is authorized to execute this Agreement and to legally bind the Party he or she represents, and each Party represents that such Party shall be fully bound by the terms hereof upon such signature without any further act, approval, or authorization by such Party.

9.2. Signing in Counterparts

This Agreement may be executed in any number of counterparts, and each executed counterpart shall have the same force and effect as an original instrument as if all the signatory Parties to all of the counterparts had signed the same instrument. Any signature page of this Agreement may be detached from any counterpart of this Agreement without impairing the legal effect of any signatures, and may be attached to another counterpart of this Agreement identical in form having attached to it one or more signature pages.

9.3. Additional Signatories

Upon agreement of all Parties, additional entities may sign this Agreement, and thus become Parties with representation on the Coordinating Committee and, as agreed upon by the Parties, on particular Implementation Committees.

IN WITNESS WHEREOF the Parties have entered into this Agreement as of the Effective Date first above written.

Reedsport OPT Wave Park, LLC

____

By: George Taylor
Executive Director of Member Ocean Power Technologies, Inc.

United States Fish and Wildlife Service

____

By: Paul Henson
State Supervisor, Oregon Fish and Wildlife Office

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Executive Director of Member Ocean Power Technologies, Inc.

United States Fish and Wildlife Service

[signature]
By: Paul Henson
State Supervisor, Oregon Fish and Wildlife Office

National Marine Fisheries Service

By: Will Stelle
Northwest Regional Administrator

United States Forest Service

By: Mary Wagner
Regional Forester, Pacific Northwest Region

Oregon Department of State Lands

By: Louise Solliday
Director

Oregon Department of Environmental Quality

By: Dick Pedersen
Director

Oregon Department of Land Conservation and Development

By: Richard Whitman
Director

National Marine Fisheries Service

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By: Dick Pedersen
Director

Oregon Department of Land Conservation and Development

By: Richard Whitman
Director

Oregon Water Resources Department

By: Phil Ward
Director

Oregon Department of Fish And Wildlife

By: Roy Elicker
Director

Oregon Parks and Recreation Department

By: Tim Wood
Director

Oregon Department of Energy

By: Bob Repine
Director

Oregon State Marine Board

By: Scott Brewen
Director

Oregon Shores Conservation Coalition

By: Allison Asbjörnsen
President

Surfrider Foundation

By: Pete Stauffer
Ocean Ecosystem Program Manager

Southern Oregon Ocean Resource Coalition

By: Nick Furman
Executive Director

Oregon Shores Conservation Coalition

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By: Nick Furman
~~Executive Director~~ CHAIR

Appendix A – Aquatic Resources and Water Quality Plan

TABLE OF CONTENTS

Reedsport OPT Wave Park, LLC.
Reedsport OPT Wave Park
FERC No. 12713

Issue Assessment
Cetaceans
May 6, 2010

The Company has filed with FERC a License Application for a 35-year license to develop and operate the Project.[1] The Project would consist of deployment and operation of 10 PowerBuoy® wave energy converters (WEC) having a total capacity of 1.5 megawatts (MW), to be located approximately 2.5 miles (4 kilometers) off the coast of Gardiner in Douglas County, Oregon (Figure 1). The ½-mile-by-½-mile (0.25 square miles) Project area represents the area within which the 10-PowerBuoy array would be deployed. The actual footprint of the constructed array is expected to be only about 1,000 feet by 1,300 feet (300 meters by 400 meters) or approximately 30 acres (0.05 square miles), excluding the navigation safety zone. The PowerBuoys will be deployed in an array of three rows, approximately in a northeast-southwest orientation and in an oblique orientation to the beach. Two rows will consist of three PowerBuoys, and one row will consist of four PowerBuoys (Figures 2 and 3). The Company plans to deploy the 10-PowerBuoy array during the summer of 2011. Prior to that, the Company also plans to install a single PowerBuoy in 2010, which will not be grid connected.

1.0 Description of Issue

Gray whales (*Eschrichtius robustus*) and harbor porpoise (*Phocoena phocoena*) are the two cetacean species most commonly found in the Project area. The proposed Project is in the migratory path of gray whales, which migrate between the Bearing Sea and Baja California, and harbor porpoise are regularly seen in the area. In addition, humpback whales (*Megaptera novaeangliae*) are known to periodically swim off the mouth of the Umpqua River. While most sightings of the endangered Southern Resident Killer Whale (*Orcinus orca*) (SRKW) have occurred in inland waters of Washington and British Columbia (Carretta et al. 2005), the population has been documented to range off the coasts of central California and Oregon. Agency staff have indicated that over the License term, other large whales, which all typically occur further offshore than where the Project is located, may occasionally swim through the Project area.

The Aquatic Species Subgroup has identified the potential that cetaceans may not be able to detect the PowerBuoy array mooring system and may subsequently collide or become entangled with mooring lines. Some whale species may swim with their mouth open, and there is a specific concern that a mooring line may become lodged in the mouth of a feeding whale. In addition, members of the Aquatic Species Subgroup (a subgroup which developed this study as part of settlement discussions) indicated concern that derelict fishing gear (abandoned/stray fishing gear) may snag on PowerBuoy array moorings and in turn pose and entanglement risk to cetaceans. If gray whales, which regularly migrate through the Project area, are successful in detecting the PowerBuoy array infrastructure, the Aquatic Species Subgroup also expressed concern over the potential effects from altering their migration route to avoid the PowerBuoy array. The effect of Project noise on whales is also of concern.

[1] Throughout this and other Appendices, terms are as defined in the Agreement.

FIGURE 1
PROJECT LOCATION MAP

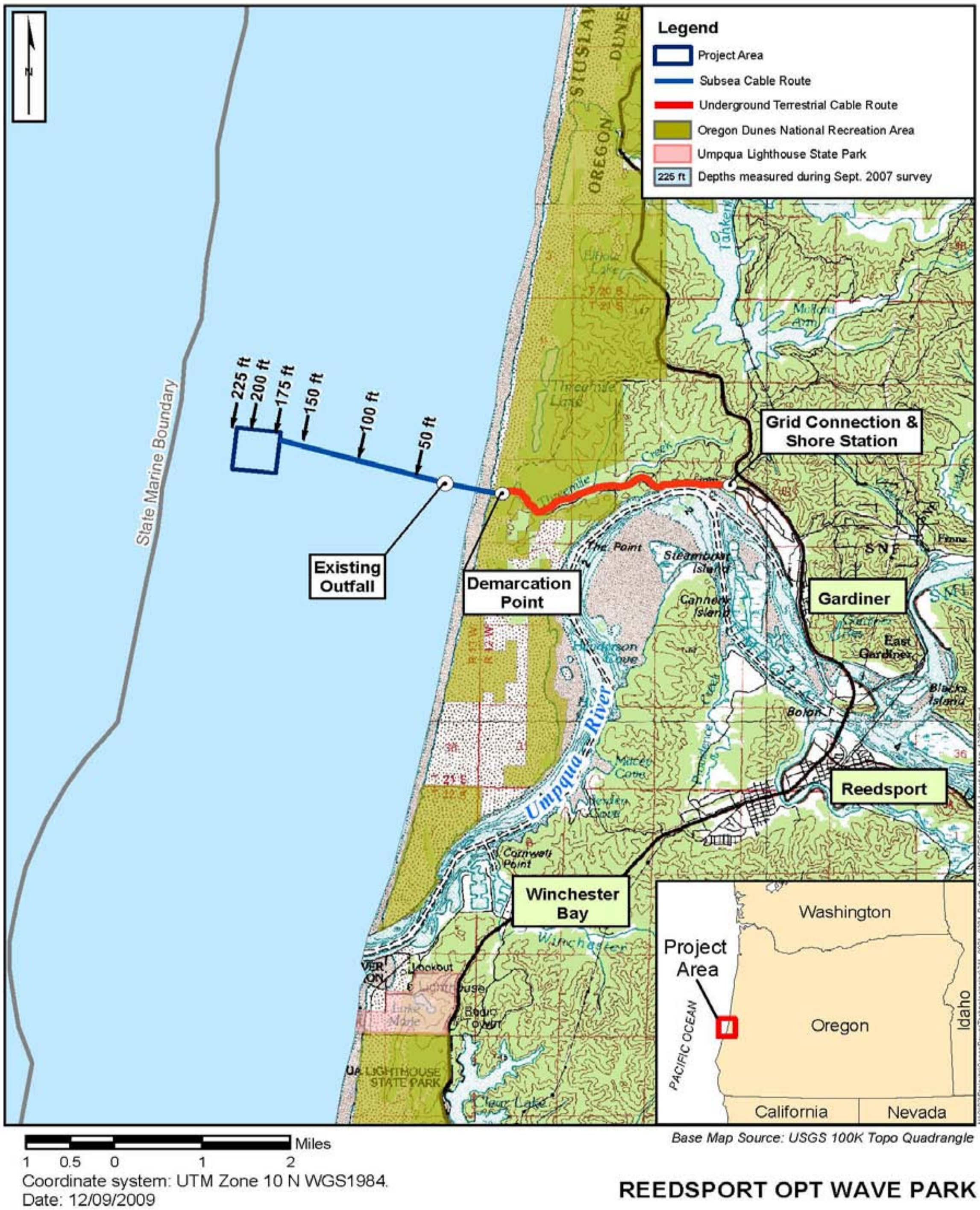
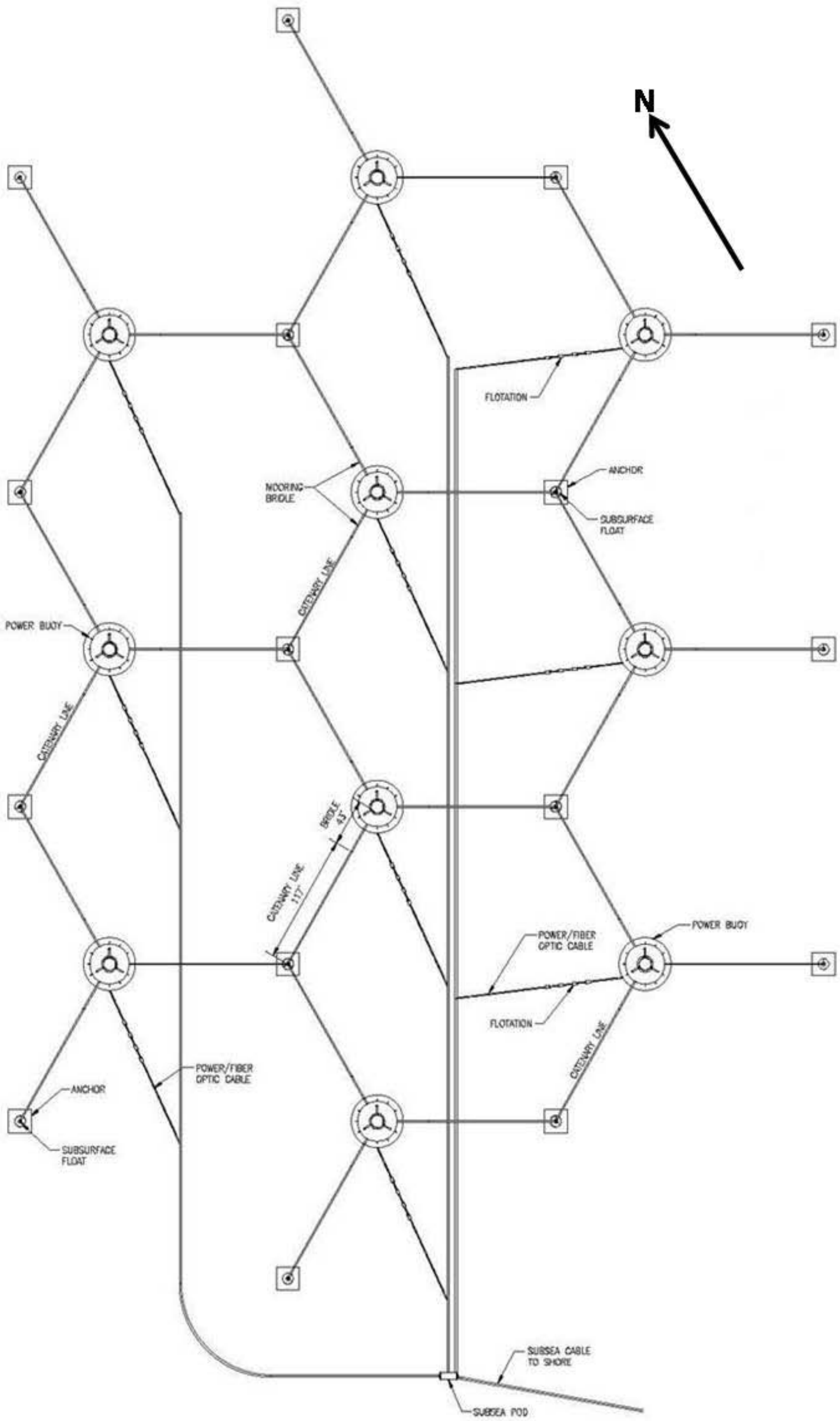
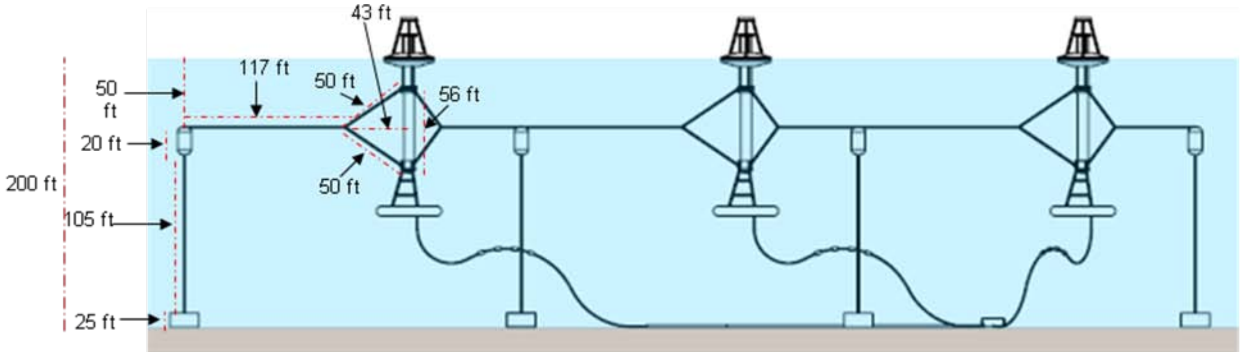


FIGURE 2
PLAN VIEW OF POWERBUOY ARRAY



Note: Dimensions are subject to change with design loads (will vary depending on depth and position within array) and final Project design.

FIGURE 3
PROFILE VIEW OF POWERBUOY ARRAY



Note: Middle PowerBuoy is located forward of left and right PowerBuoys. Underwater Substation Pod shown below PowerBuoy on right. Dimensions are in feet. Assumed depth is 200 feet (61 meters). Dimensions are subject to change with design loads (will vary depending on depth and position within array) and final Project design.

2.0 Relevant Existing Information

2.1 Cetaceans - Non-ESA Listed

Oregon marine waters support a variety of cetacean species that are not ESA listed (National Oceanic and Atmospheric Administration [NOAA] 2007*a*). Population trends for the non-ESA cetacean species appear relatively stable (NOAA 2007*a*). A summary was generated of information compiled by NOAA (2007*a*) for each of these species regarding distribution, habitat use, and population status (Table 1). In addition, maps were generated of whale, dolphin, and porpoise sightings from aerial surveys conducted in 1989 to 1990 and 1996 (Figures 4 and 5).

Based upon both literature review and sea-based surveys plotted in Figures 4 and 5, gray whales and harbor porpoise are the two cetacean species most commonly found in the Project area.

Harbor Porpoise

Harbor porpoises are small marine mammals that generally remain near estuaries and rivers. They feed on small fish such as herring and can venture into freshwater rivers for extended periods of time. Populations are in a stable condition with projections estimating approximately 37,745 total individuals in Oregon and Washington (NOAA 2007*a*). Research has shown that harbor porpoise do not generally migrate and have a limited local range that does not intermix with other proximal stocks (NOAA 2007*a*). They can be found over 100 miles offshore, but generally remain inland. Distribution is based upon food resources.

Gray Whale

The gray whale is a large baleen whale that is composed of an eastern and western stock (Figure 6). The eastern stock inhabits the Pacific Coast and was de-listed from federal protection in 1994. The western stock is found along the Korean coastline and remains classified as endangered.

TABLE 1
SUMMARY OF POTENTIAL NON-ESA LISTED CETACEANS WITHIN THE PROJECT AREA FROM NOAA STOCK ASSESSMENT REPORTS

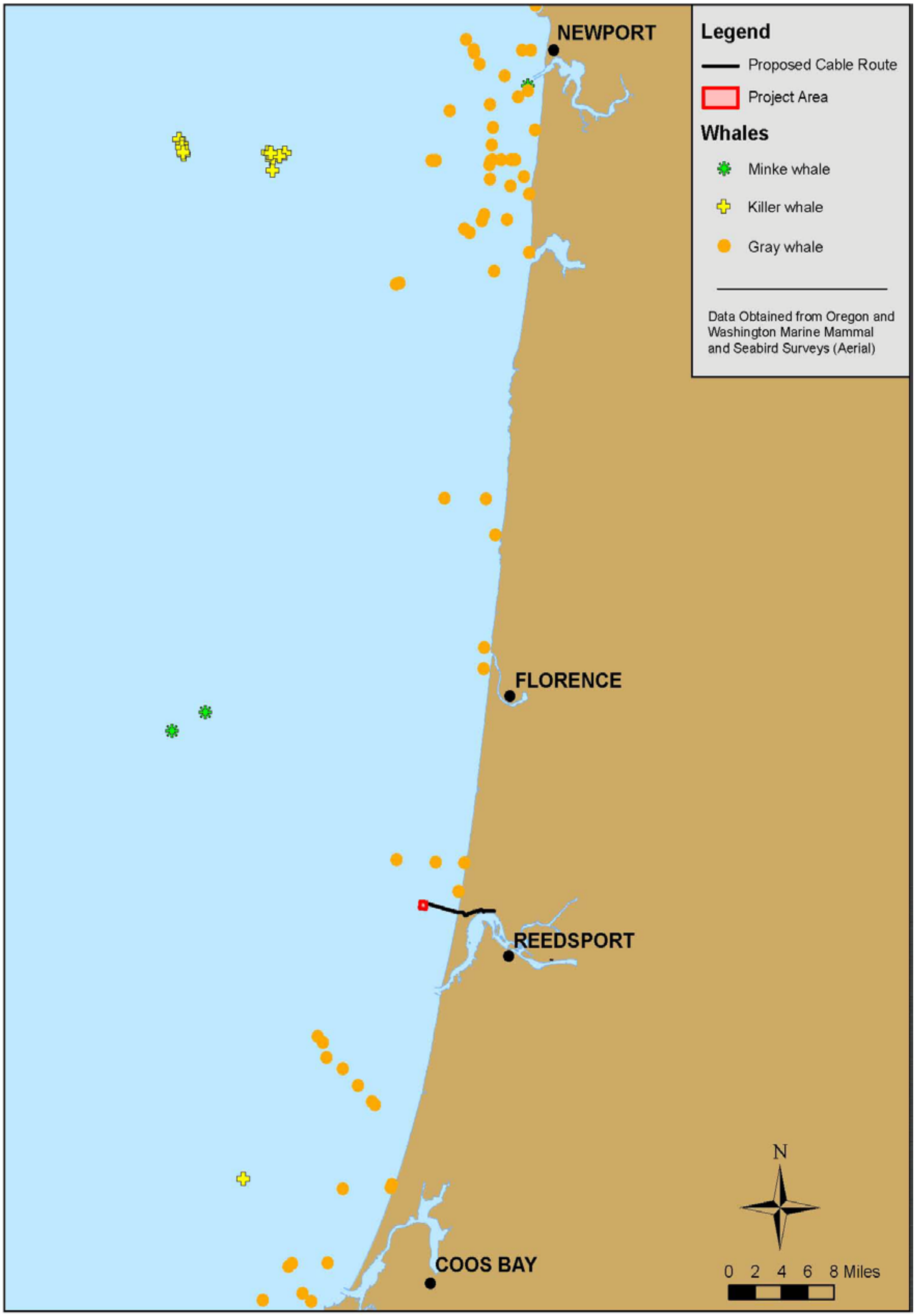
Common Name	Scientific Name	Sightings Proximal to Project Area	Distribution and Habitat	Population Status
Minke Whale	*Balaenoptera acutorostrata*	Few sightings located over continental shelf.	Migratory movement along Oregon's continental shelf.	No direct population estimates are available. Population not considered threatened and is not a strategic stock.
Gray Whale	*Eschrichtius robustus*	Predictable seasonal migration occurs along the West Coast in relatively nearshore habitat	Eastern population migrates seasonally along the West Coast. Northbound migration generally in nearshore habitat, while southern migration further offshore.	Species was delisted in 1994 and is making a marked recovery. Population is currently over 20,000 individuals.
Gray Whale (Pacific Coast Feeding Aggregation)	*Eschrichtius robustus*	Seasonally found in southern and central Oregon in late spring and fall (NMFS 2008*b*).	Spend summer and fall feeding along the Pacific coast south of Alaska instead of migrating north to the Bering Sea (NMFS 2008*b*).	Includes approximately 200 to 250 whales from the Eastern North Pacific stock. There is no evidence of genetic or demographic distinction from the eastern population (NMFS 2008*b*).
Bottlenose dolphin	*Tursiops truncatus*	Prefer warm water and distant offshore locations.	Located primarily in warm waters of southern California. Rarely venture into Oregon and found in distant offshore areas.	No direct population estimates are available, but population considered in good health.
Common dolphin (short beaked)	*Delphinus delphis*	Few sightings in southern Oregon.	Primarily found in California coast. Few sightings in southern Oregon. Can be found from nearshore up to 300 nm (nautical miles) offshore.	The common dolphin represents the most abundant cetacean off California and its population status is in excellent condition.
Northern right whale dolphin	*Lissodelphis borealis*	Seasonally migrate through Oregon in late spring and summer.	Found in shelf and slope waters in California Oregon and Washington. Undergoes seasonal migrations along the coastline.	While moderate risk of unnatural mortality exists, insufficient data is available to indicate low abundance or negative population trends.
Pacific white sided dolphin	*Lagenorhynchus obliquidens*	Seasonally migrate through Oregon in late spring and summer.	Found in shelf and slope waters in California Oregon and Washington. Concentrated in California. Undergoes seasonal migrations along the coastline.	Population trend appears stable and unchanged. Population not considered threatened and is not a strategic stock.
Risso dolphin	*Grampus griseus*	Seasonally migrate through Oregon in late spring and summer.	Found in shelf and slope waters in California Oregon and Washington. Undergoes seasonal migrations along the coastline.	Population trend appears stable and unchanged. Population not considered threatened and is not a strategic stock.

Common Name	Scientific Name	Sightings Proximal to Project Area	Distribution and Habitat	Population Status
Dall's porpoise	*Phocoenoides dalli*	Commonly seen and make interannual north and south movements.	Located in near and offshore waters within shelf and slope habitat. Movement along coastline determined by seasonality and interannual time scales.	Assessment of population trends are not available, but no direct threat to the population was identified and is considered a non-critical stock.
Harbor porpoise	*Phocoena phocoena*	Sighted year-around in nearshore transboundary waters.	Located in nearshore habitat during most of year, but can shift to deeper offshore waters during winter months. Population concentrations driven by primarily by prey availability.	Population is not considered "strategic" due to low annual unnatural mortality. Numbers are not listed as depleted. Overall population trends are not known.
Baird's beaked whale	*Berardius bairdii*	Few sightings in deep waters along continental slope.	Found primarily near Japan with only a few offshore deepwater sightings occurring in Oregon. Most sightings occur from late spring and early fall. Offshore movements occur from November to late April.	Due to rarity, population trend assessment is not available. Population not considered threatened and is not a strategic stock.
Mesoplodont beaked whale	*Mesoplodon spp.*	Only five sightings along entire U.S. west coast.	Found in deepwater habitats near the continental shelf.	Due to rarity, population trend assessment is not available. Population not considered threatened and is not a strategic stock.
Stejneger's beaked whale	*Mesoplodon stejnegeri*	Few sightings, mostly by catch in California/Oregon thresher shark and swordfish drift gillnet fishery.	Endemic to cold-temperature waters of the North Pacific, Sea of Japan, and deep waters of the southwest Bearing Sea.	Reliable estimates of abundance for this stock are currently unavailable.
Cuviers beaked whale	*Ziphius cavirostris*	Few sightings in deep waters along continental slope.	Found in deepwater habitats near the continental shelf.	Due to rarity, population trend assessment is not available. Population not considered threatened and is not a strategic stock.
Transient killer whale	*Orcinus orca*	Sighted year-round along outer coasts of Oregon.	Along the west coast of North America, killer whales occur along the entire Alaskan coast (Braham and Dahlheim 1982), in British Columbia and Washington inland waterways (Bigg et al. 1990), and along the outer coasts of Washington, Oregon, and California (Green et al. 1992; Barlow 1995, 1997; and Forney et al. 1995).	The minimum population estimate for the Eastern North Pacific Transient stock of killer whales is 346.
Pygmy sperm whale	*Kogia breviceps*	Few sightings in distant offshore pelagic waters.	Species remains submerged in distant offshore pelagic waters for long periods of time. Small size make species cryptic and poorly understood.	Due to rarity, population trend assessment is not available. Population not considered threatened and is not a strategic stock.

Common Name	Scientific Name	Sightings Proximal to Project Area	Distribution and Habitat	Population Status
Pilot whale (short finned)	*Globicephala macrorhynchus*	Few sightings in offshore waters	Primarily found in southern California coast. Possible migrants sighted in Oregon were in offshore waters.	Population appears healthy, although no trend analyses are available.

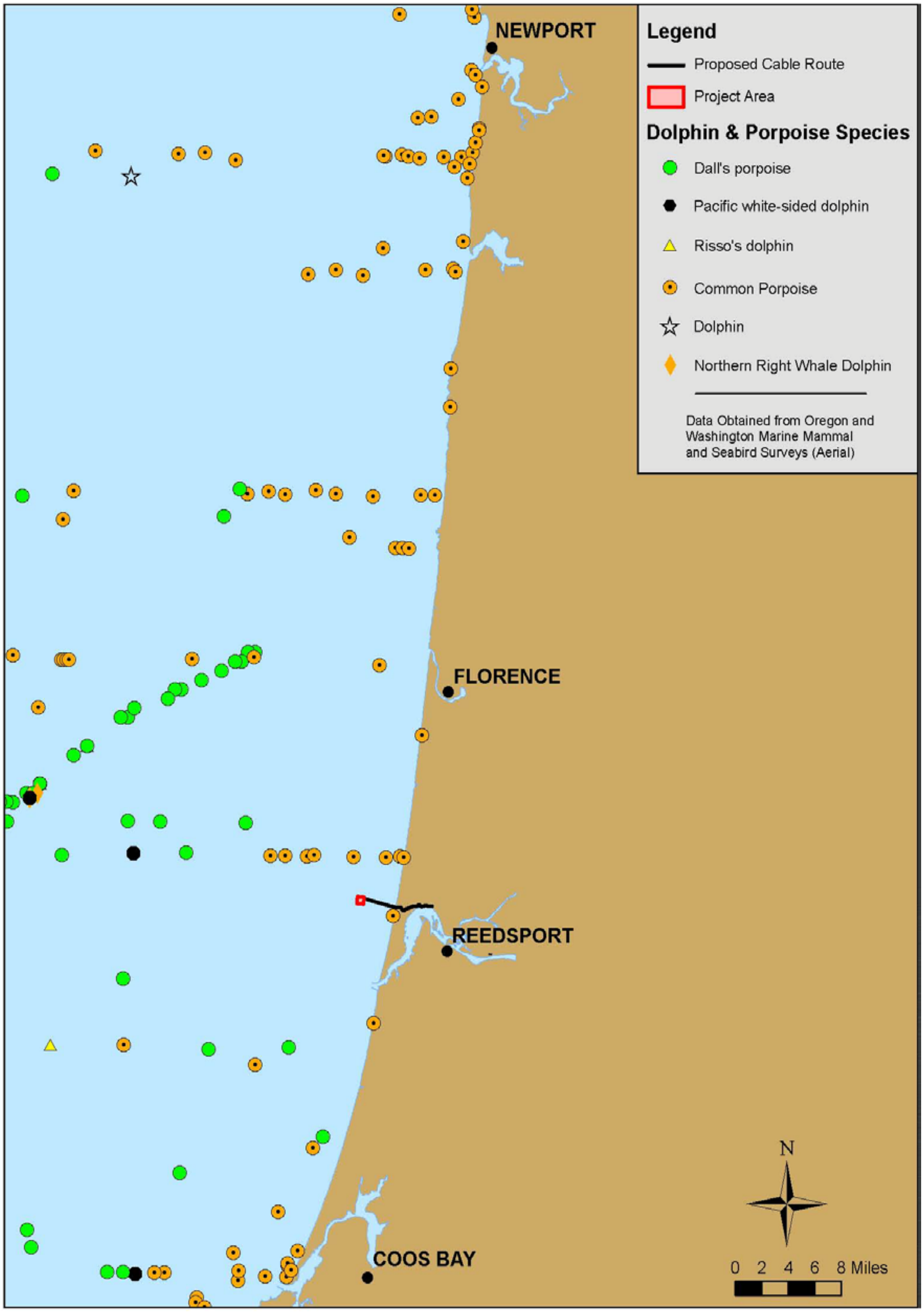
Source: NOAA 2007*a*; Norman et al. 2004

FIGURE 4
NON-ESA PROTECTED WHALE SIGHTINGS DOCUMENTED IN AERIAL SURVEYS FROM 1989-1990 AND 1996



Source: Reed et al. 2007.

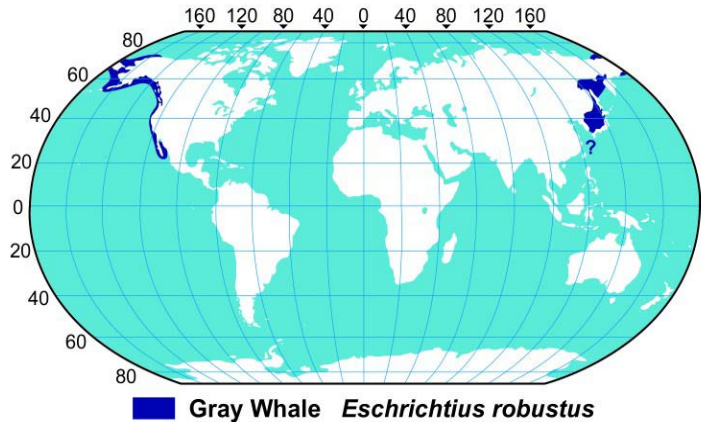
FIGURE 5
DOLPHIN AND PORPOISE SIGHTINGS DOCUMENTED IN AERIAL SURVEYS FROM 1989-1990 AND 1996*



*Surveys occurred along transects.
Source: Reed et al. 2007

FIGURE 6

DISTRIBUTION OF BOTH EAST AND WEST POPULATIONS OF GRAY WHALES



Source: NMFS 2002

Gray whales migrate up and down the Pacific Coast between their Alaskan feeding waters (summer) and Mexican breeding grounds (winter). This migration covers 10,000 to 14,000 miles for a round trip (U.S. Department of the Interior [USDOI] 1989), and it represents the longest migration of any mammal. During migration, whales pass along the Oregon and Washington coasts (National Marine Fisheries Service [NMFS] 2002) and are the focus of nearshore whale watching programs.

Approximately 200 to 250 whales from the Eastern North Pacific stock do not migrate north to the Bering Sea, but instead spend summer and fall feeding along the Pacific coast south of Alaska. These gray whales are referred to as the Pacific Coast Feeding Aggregation, and there is no evidence of genetic or demographic distinction from the eastern population (NMFS 2008*b*).

Gray whales feed on benthic invertebrates (Rice and Wolman 1971), though they have been documented to feed on kelp-dwelling crustaceans (Pers. comm. Oregon Department of Fish and Wildlife [ODFW], September 4, 2008). Generally, gray whales remain within a few miles of the shoreline (Rice and Wolman 1971). They can intermittently be found near the mouths of estuaries as they are searching for food. Collection of prey is done by suction sieving of the ocean floor benthos. Sieving is completed by first rolling on its side just above the seabed, pressing down the tongue, drawing benthic material in the mouth, and then straining the material through keratinous baleen plates to remove undesired fine particulate matter (Weitkamp et al. 1992; Newell 2005). The result of filtering benthic material is the creation of pits along the seafloor, which is a characteristic sign of feeding.

Gray whales are opportunistic feeders and their prey can vary from an array of invertebrate organisms. Along the Oregon coast—specifically Depoe Bay—whales feed on mysid shrimp that live on the edge of bullwhip kelp (Newell 2005). In May, whales can feed on crab larvae. Further, in September 2004, it appeared that whales were feeding on anchovy along the Newport coast (Newell 2005). In Arctic waters, primary prey sources are amphipods residing along and within the substrate (Moore et al. 2003). Other noted prey items have included krill, ghost shrimp, pelagic red crabs, skeleton shrimp, plankton and polychaete worms (Darling et al. 1998; Newell 2005; Weitkamp et al. 1992).

Gray whales are a success story for recovery of endangered species with current populations estimated to be over 20,000 whales (Rugh et al. 1999; NOAA 2007*a*). The population is thought to be near pre-exploitation population levels (NMFS 2002). However, even though gray whales are not federally listed as endangered, they are listed as endangered on the Oregon Threatened and Endangered Species List.

2.2 Cetaceans - ESA Listed

The Company contacted NMFS and requested information on species in the Project vicinity that are protected under the ESA, most recently in a letter dated October 11, 2007 and during various phone conversations and meetings. Federally listed threatened or endangered cetacean species that may occur in the Project area are listed in Table 2.

TABLE 2
LIST OF FEDERALLY-PROTECTED THREATENED AND ENDANGERED CETACEAN SPECIES THAT MAY OCCUR IN THE PROJECT AREA*

Common	Scientific Name	Federal Status
Humpback whale	*Megaptera novaeangliae*	E
Sperm whale	*Physeter macrocephalus*	E
Sei whale	*Balaenoptera borealis*	E
Blue whale	*Balaenoptera musculus*	E
Fin whale	*Balaenoptera physalus*	E
Southern resident killer whale	*Orcinus orca*	E

* In comments on the Preliminary Application Document, NMFS stated that North Pacific right whales (*Eubalaena japonica*) would not be expected in the Project area and should not be included (pers. comm. Bridgette Lohrman, October 10, 2007).

Humpback Whale

The humpback whale, listed as federally endangered, is a highly migratory marine mammal that ranges along the west coast and worldwide (NMFS 2005). Populations of the humpback whale are classified as endangered; however, numbers are improving. Population estimates suggest an annual 6 to 7 percent increase in population over the last 20 years (NMFS 2005). Humpback whales can grow to a length of 15 meters and weigh 23,000 to 36,000 kilograms and reach sexual maturity at around 12 meters in length or 6 to 10 years of age (American Cetacean Society [ACS] 2004*a*). Females of reproductive age generally bear a calf every 2 to 3 years. Humpback whales belong to the sub-order mysticetes (baleen whales), which feed on small crustaceans (known as krill), and various species of small fish. Each whale may consume nearly a ton of food per day by filtering huge volumes of seawater. Feeding behavior can vary from deep diving in pursuit of prey, cooperative feeding such as herding and formation feeding (echelon feeding), and the use of “bubble clouds” produced by lobbing their tail at the surface which forms a cloud of bubbles, followed by a lunge in the middle (NMFS 1991; Weinrich et al. 1992).

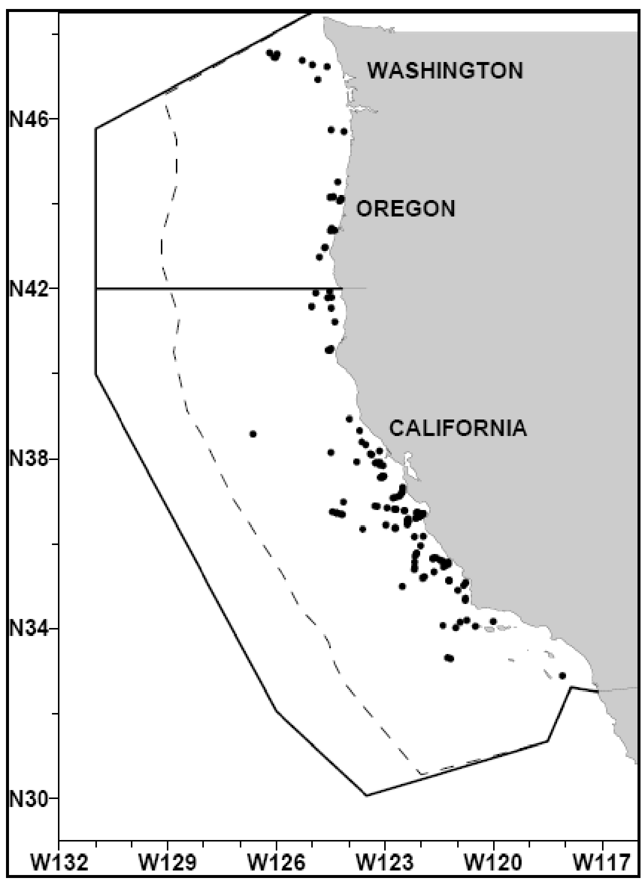
The humpback whale migrates seasonally for feeding and mating. While the International Whaling Commission (IWC) recognizes only one Pacific stock of humpbacks, research suggests at least three populations (NMFS 2005):

1. **Eastern North Pacific Stock** - a stock residing in Central America and Mexico in winter/spring that moves to British Columbia in summer/fall.

2. **Central North Pacific Stock** - a winter/spring population residing in the Hawaiian Islands that migrate to northern British Columbia or southern Alaska through Prince Williams Sound west to Kodiak.
3. **Western North Pacific Stock** - a winter/spring population in Japan that migrates to the Bering Sea and Aleutian Islands in summer/fall.

The Eastern North Pacific stock migrates through Oregon's coastal waters annually. While the known route of humpbacks is not precise, the three identified stocks do follow general migrational trends. Movement along the coastline primarily occurs during summer and fall; however, historical whale observations have been made in every month except February, March, and April (NMFS 1991). Generally, humpback sightings in northwest coastal waters are uncommon (Figure 7). However, humpback whales have been reported occasionally off the mouth of the Umpqua River (Aquatic Species Subgroup meetings, various dates), which is approximately 6 miles south of the Project area. Recent efforts to tag humpback whales by Oregon State University (OSU) led to 10 observations in July and August of 2002 between Coos Bay and Newport (Lagerquist and Mate 2002). These observations occurred over 5 miles offshore in highly productive optimal foraging areas.

FIGURE 7
HUMPBACK WHALE SIGHTINGS BASED ON SHIPBOARD SURVEYS OFF CALIFORNIA, OREGON, AND WASHINGTON, 1991 TO 2001



Note: Dashed line represents the U.S. Exclusive Economic Zone (EEZ). Thick line indicates the outer boundary of all surveys combined.
Source: NMFS 2005

Sperm Whale

The sperm whale (*Physeter macrocephalus*) is federally listed as endangered. It is a deep-diving odontocete or toothed whale (NOAA 2007*b*). This species is unique in many ways, having a disproportionately large head, the largest brain of any animal and strong sexual dimorphisms. Adult males can reach lengths of 15 to 18 meters and weigh 31,750 to 40,800 kilograms while the smaller females rarely exceed 11 meters and 12,000 to 12,700 kilograms (ACS 2004*b*). Males reach sexual maturity at 10 to 12 meters, or about 10 years of age but are not thought to be active breeders until much later, possibly at greater than 25 years of age (NOAA 2007*b*; ACS 2004*b*). Females reach sexual maturity at 8 to 9 meters, or 7 to 13 years of age, and are believed to produce a calf about every five years (NOAA 2007*b*). This species often forms family groups of females and their young. Young males between the ages of 4 and 21 years may be found in "bachelor schools" whereas fully mature adult males often travel alone, though they can sometimes be found with female groups temporarily.

There are several sperm whale stocks found throughout the world, including a West Coast stock (i.e., California, Oregon, and Washington; NOAA 2007*b*). This population resides primarily in California and has been historically observed in every season except winter (December through February) in Oregon and Washington (Figure 8). Prior to commercial whaling, the worldwide population of sperm whales was estimated at 1,100,000 individuals (ACS 2004*b*). More recent estimates put the population at about 360,000 animals. Regarding the California-Oregon-Washington stock, NMFS estimates that there are 1,233 whales based on survey data collected from 1996 to 2001 (NOAA 2007*b*). Population estimates have varied dramatically at times and have shown no apparent trend.

Sperm whales spend their life in waters averaging over 1,300 feet in depth (NOAA 2007*b*). In these waters, they prey upon native deepwater species including squid, shark, skates, and other fishes (NOAA 2007*b*).

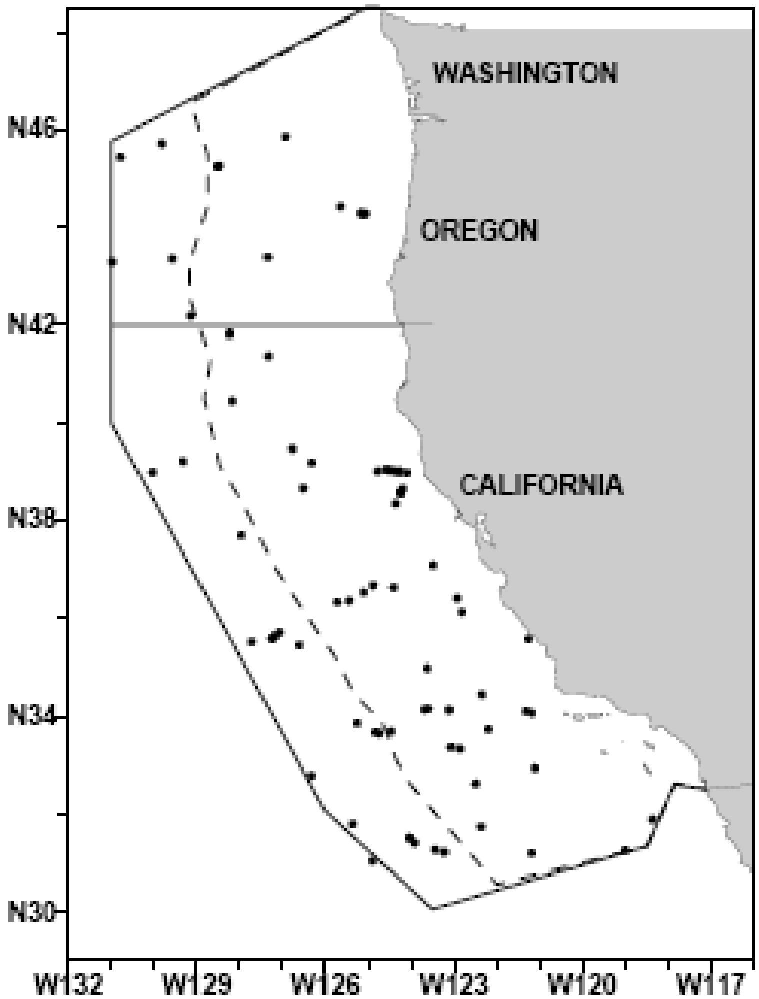
Sei Whale

Sei whales (*Balaenoptera borealis*); federally listed as endangered, occur in subtropical and tropical waters and into the higher latitudes. Sei whales in the eastern North Pacific (east of 180° W longitude) are considered a separate stock (Carretta et al. 2005). They are rarely found off the Washington, Oregon, and California coasts (NMFS 2003) (Figure 9). When observed, individuals are typically in oceanic waters, miles offshore (NMFS 2003).

A very slim whale, the typical adult male sei whale can range from 13.7 to 16.8 meters and weigh 12,700 to 15,400 kilograms with females being slightly larger (ACS 2004*c*). They reach sexual maturity at about 10 years of age or about 12.2 meters (males) and 13.1 meters (females). Very little is known regarding mating activities but it likely can happen year round (ACS 2004*c*). Once of reproductive age, females may calve every 2 to 3 years and calves typically stay with the mother about 6 to 10 months (Whale Center of New England [WCNE] 2007).

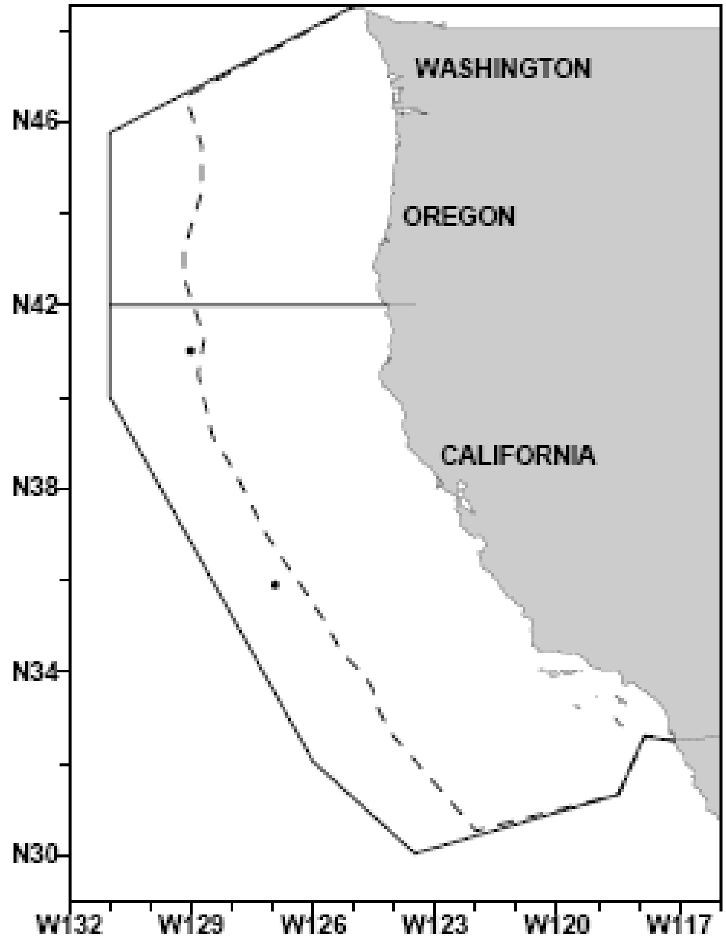
Sei whales usually travel alone or in small groups though they are known to aggregate in areas of dense prey (WCNE 2007). Little is known of their behavior. As with other baleen whales, sei whales forage on small fish, squid, krill, and copepods. The sei whale often feeds on plankton near the surface by skimming the surface with mouth open (ACS 2004*c*).

FIGURE 8
SPERM WHALE SIGHTINGS BASED ON SHIPBOARD SURVEYS OFF CALIFORNIA, OREGON, AND WASHINGTON, 1991 TO 2001



Note: Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys combined.
Source: NOAA 2007*a*

FIGURE 9
SEI WHALE SIGHTING LOCATIONS BASED ON SURVEYS FROM 1991 TO 2001



Note: Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys combined.
Source: Carretta et al. 2005

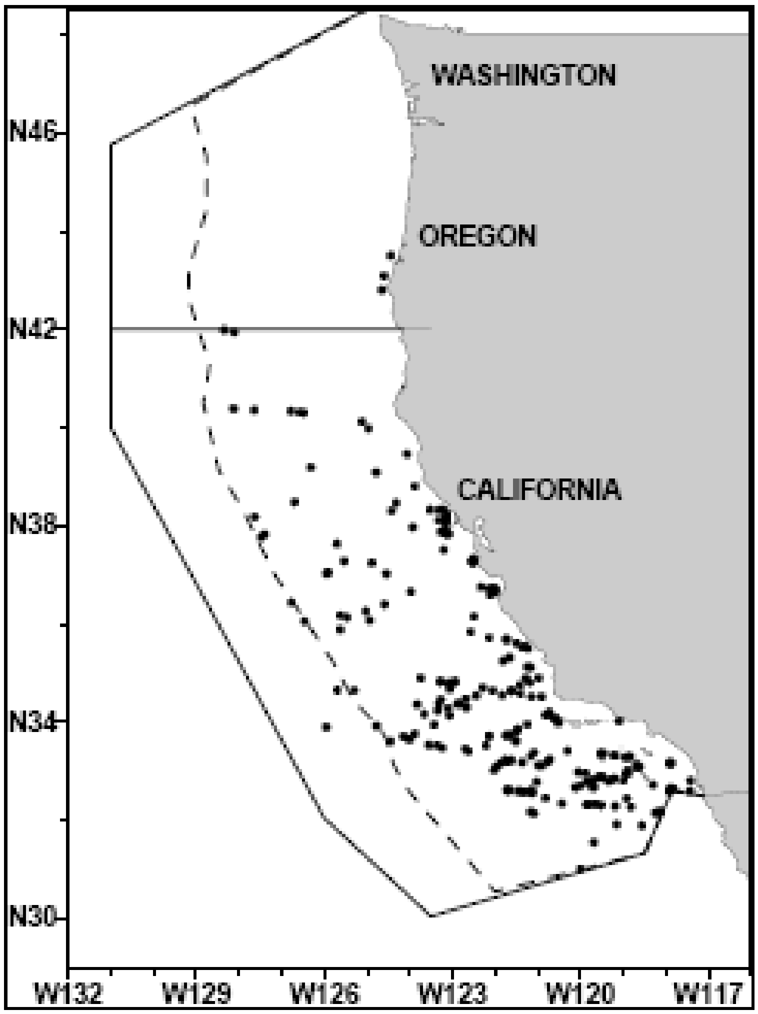
The sei whale was not identified as a separate species from Bryde's whale (*Balaenoptera brydei*) until the early 1900s (ACS 2004*c*). Total numbers of sei whales in the north Pacific pre-whaling times have been variously estimated at 42,000 and as high as 62,000 (NOAA 2007*a*). There are no current estimates for abundance in the eastern North Pacific based on sighting surveys and thus no data on population trends. An abundance estimate of 56 sei whales has been made based on surveys conducted in 1996 and 2001 conducted off the Washington, Oregon, and California coast out to 300 nautical miles (NOAA 2007*a*).

Blue Whale

The federally endangered blue whale (*Balaenoptera musculus*) is the largest known animal ever to exist on this planet. They inhabit most oceans and seas of the world. The eastern north Pacific stock summers off California to feed and migrates as far south as the Costa Rica Dome. It has been estimated that there are about 2,000 whales in this stock (Carretta et al. 2005). They feed on krill and possibly pelagic crabs (Reeves et al. 2002).

As with most species of whales, the blue whale population was devastated by commercial whaling in the late 1800 and 1900s until the IWC prohibited taking of this species in 1966. The population size was estimated at greater than 350,000 whales prior to the commercial whaling industry. The species has been slow to recover, however, and current worldwide population estimates range from 8,000 to 14,000 blue whales (ACS 2004*d*). The most recent estimate for the blue whale population off the Washington, Oregon, and California waters is at 1,744 whales (NOAA 2007*a*; Figure 10).

FIGURE 10
BLUE WHALE SIGHTINGS BASED ON SHIPBOARD SURVEYS OFF CALIFORNIA, OREGON, AND WASHINGTON, 1991 TO 2001



Note: Dashed line represents the U.S. EEZ; thick line indicates the outer boundary of all surveys combined.
Source: NOAA Fisheries 2007*a*

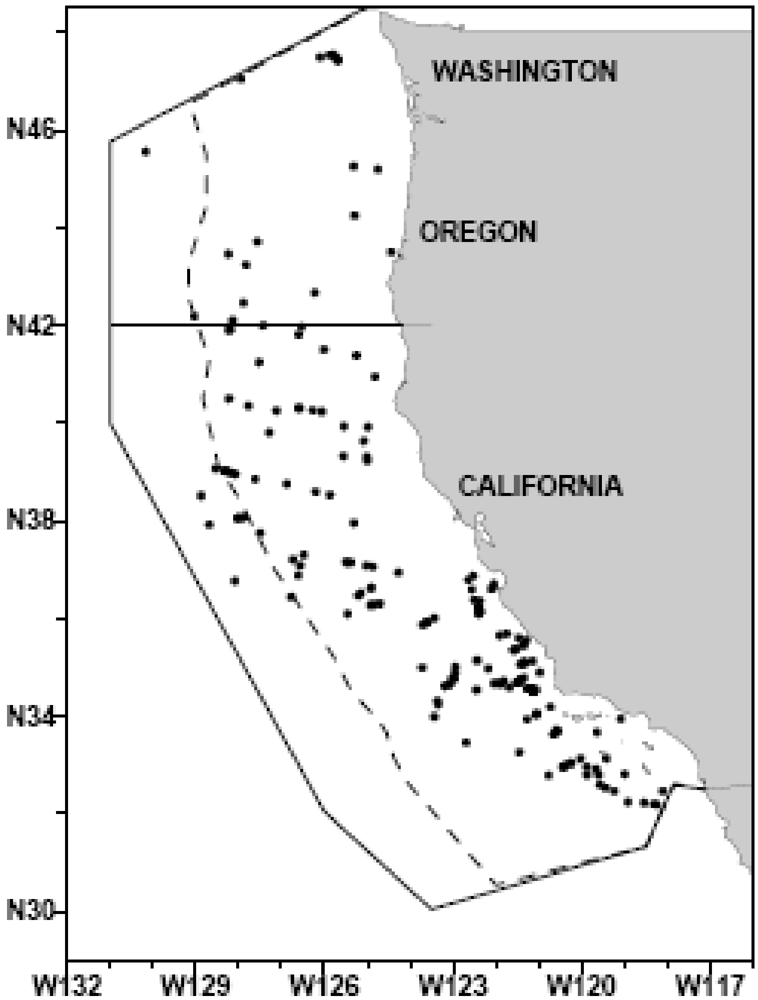
Fin Whale

Federally endangered fin whales (*Balaenoptera physalus*) occur in the major oceans of the world and tend to be more prominent in temperate and polar waters. For stock assessment purposes, NMFS recognizes three populations in the U.S. Pacific waters: Alaska (Northeast Pacific), California/Oregon/Washington, and Hawaii (NMFS 2006*a*). In general, fin whales are more numerous in the coastal waters of California, Oregon, and Washington during summer and fall, with the greatest concentrations in southern California (Figure 11). Though it is not clear where they move to during winter/spring, it is unlikely they make large-scale migrations (NOAA

2007*d*). They generally travel alone or in small groups but aggregations can occur in areas (ACS 2004*e*). They are able to communicate over vast distances due to their powerful song.

FIGURE 11

FIN WHALE SIGHTINGS BASED ON SHIPBOARD SURVEYS OFF CALIFORNIA, OREGON, AND WASHINGTON, 1991 TO 2001



Note: Dashed line represents the U.S. EEZ; thick line indicates the outer boundary of all surveys combined.
Source: NOAA Fisheries 2007*a*

Second only to the blue whale, the fin whale can reach lengths of 24 meters in the northern hemisphere and 26.8 meters in the southern hemisphere and a weight of 45,360 to 63,500 kilograms (ACS 2004*e*). Females are slightly larger than males. Little is known of their reproductive behavior, breeding, or calving areas. Sexual maturity is thought to occur between 6 and 10 years of age and the female calving cycle is two to four years (ACS 2004*e*).

They feed on krill and small pelagic schooling fish and have been known to consume up to 1,800 kilograms of food per day (ACS 2004*e*; NMFS 2006*a*). They have been observed circling schools of fish at high speed and then turning on their right side to consume the fish (ACS 2004*e*).

Based on ship surveys conducted between 1991 and 2001, estimates of 280 to 380 fin whales were made off the Oregon and Washington coasts while the majority (1,600 to 3,200 fin whales) was observed offshore of California (NMFS 2006*a*). The minimum population estimate for the California/Oregon/Washington stock is 2,541 fin whales based on the 1996 and 2001 data (NOAA 2007*a*).

Southern Resident Killer Whale

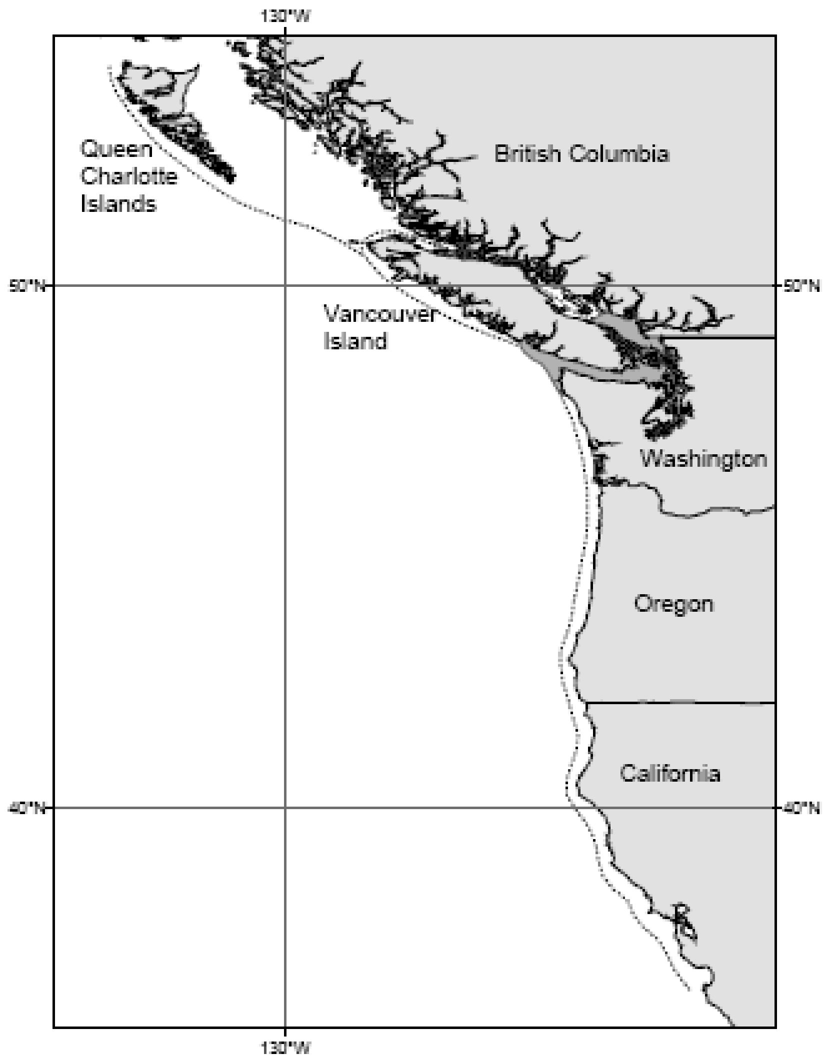
Although not officially recognized as separate subspecies, there are three ecotypes of killer whales in the northeastern Pacific Ocean: resident, transient, and offshore (NOAA 2007*c*). While their ranges overlap, these forms represent significant morphology, ecology, behavior, and genetic differences resulting from a lack of interchange between the groups. In the U.S., resident killer whales occur from California to Alaska and can be further subdivided into four communities: Southern, Northern, Southern Alaska, and Western Alaska North Pacific Residents (NOAA 2007*c*). The Southern Resident Killer Whale (SRKW) population, currently listed as endangered, consists of three family groups or pods, have been documented to range off the coasts of central California, Oregon, Washington, Vancouver Island, and as far north as the Queen Charlotte Islands. Most sightings have occurred in the summer in inland waters of Washington and British Columbia (Carretta et al. 2005). However, the whales can occur anywhere across their range.

The killer whale is the largest member of the dolphin family, with males reaching up to 9.8 meters in length and nearly 10,000 kilograms in weight while females may reach 8.5 meters in length and 7,500 kilograms weight (NOAA 2007*c*). Males are thought to reach sexual maturity at 5.2 to 6.4 meters, have an average life span of 30 years and maximum longevity of 50 to 60 years. Females generally reach sexual maturity at 4.6 to 5.4 meters; have an average life span of 50 years, and maximum longevity of 80 to 90 years (NOAA 2007*c*, NMFS 2008*a*). Female residents are thought to give birth every five years for about 25 years, and then enter into a post-reproductive period. The birthing rate is highly variable and may be affected by a recent loss of a previous calf.

The foraging behavior and prey species is known to vary between killer whale populations. In contrast to other populations, the SRKW prey mainly on salmon and other fishes from late spring through fall (NMFS 2008*a*). Chinook salmon appeared to be the preferred prey, even when other salmon species were more abundant. Little is known of their winter and early spring foraging patterns. Resident killer whales may spend 50 to 67 percent of their time foraging, using echolocation, passive listening, and well-developed vision to locate and capture prey (NMFS 2008*a*).

From late spring through fall, the primary residence for the SRKW is in the inland waterways of Washington State and British Columbia (Strait of Georgia, Strait of Juan de Fuca, and Puget Sound). Winter and early spring movements and distribution are generally unknown (NMFS 2008*a*; NOAA 2007*c*). Pods have on occasion been observed off Washington and Vancouver Island, as far south as southern California, and as far north as the Queen Charlotte Islands (NWFSC 2007) (Figure 12). Offshore movements and distribution are largely unknown. To date there have been more than 40 confirmed coastal sightings over the last 25 years off of the outer Pacific Ocean coast (British Columbia and Washington outer coasts, Oregon, and California). Of these, 4 sightings occurred off of Oregon in April 1999, March and April 2000, and March 2006, and 10 sightings occurred off California between 2000 and 2008 in January (four sightings), February (two sightings), March (three sightings), and October (one sighting)(NMFS unpublished data, Pers. comm. NMFS. September 5, 2008). The sightings that occurred off California represent whales, which would have traversed Oregon waters. While SRWKs can occur throughout their range any time of the year, sightings of pods along the outer coast are more likely to occur between January and May (Pers. comm. NMFS. September 5, 2008). Sightings off Oregon and California have occurred between January and March, with one exception (one sighting off California in October 2007) (NMFS unpublished data, Pers. comm. NMFS. September 5, 2008).

FIGURE 12
SOUTHERN RESIDENT KILLER WHALE DISTRIBUTION



Note: Approximate April-October distribution of the SRKW stock (shaded area) and range of sightings (dotted line).
Source: NOAA Fisheries 2007*a*

The number of SRKWs has never been large, perhaps numbering between 100 and 200 before 1960 (NMFS 2008*a*). Olesiuk et al. (1990) modeled the population size of the Southern Resident community between 1960 and 1973 and projected an increase in numbers from about 78 to 96 whales from 1960 to 1967. Capture of Southern Resident whales for the public display industry resulted in numbers dropping to fewer than 70 in 1971-1972. The population has gone through several periods of decline and growth since 1975 (NMFS 2008*a*). Based on the 2005 stock assessment report (Carretta et al. 2005), numbers generally increased until 1995 when 98 animals were counted. Numbers then declined to 83 whales in 2000. The current estimate of SRKWs (2007) is 87 (NMFS 2008*a*).

The Company does not expect Project construction, maintenance, and operation to affect the blue whale, fin whale, sei whale, and sperm whale as these whale species frequent deeper offshore waters (ACS 2004*b*, 2004*c*, 2004*d*, 2004*e*; Carretta et al. 2005) than those found within the Project vicinity. However, NMFS stated that potential effects to blue whales and fin whales should be evaluated because the Project is sufficiently long in duration that there is potential for occurrence in the Project vicinity. While acknowledging that these two species primarily occur offshore, NMFS notes that in Oregon, fin whales have been sighted relatively close to shore and that in a recent study, four blue whales clustered in a five-mile area of water off Coos Bay, Oregon (Pers. comm. NMFS, September 5, 2008). As stated above, humpback whale sightings in northwest coastal waters are uncommon. However, humpback whales have been reported occasionally off the mouth of the Umpqua River, which is approximately 6 miles south of the Project area, and it therefore appears likely that a humpback whale could swim through the Project area. While research indicates that the SRKW have very low population numbers (NMFS 2008*a*) and occur mainly within the inland waters of Washington state and southern British Columbia (Carretta et al. 2005), it is nonetheless possible that this species could pass through the Project area, especially considering they are known to occur off of California.

3.0 Project Effects

There is a potential that mysticetes (baleen whales) may not be able to detect the PowerBuoy array mooring system and subsequently collide or become entangled with mooring lines. Some species of whales may swim with their mouth open, and there is a specific concern that the mooring line may become lodged in the mouth of a feeding whale. Derelict fishing gear may snag on PowerBuoy array moorings, and in turn pose an entanglement risk to cetaceans. The effect of Project noise to whales is also of concern. If gray whales, which regularly migrate through the Project area, are successful in detecting the PowerBuoy array infrastructure, the Aquatic Species Subgroup has also expressed concern over the potential effects from altering their migration route to avoid the PowerBuoy array. At the meeting of marine mammal acoustic experts on October 9 and 10, 2008, there was agreement that concern for cetacean collision was for mysticetes; odontocetes (toothed whales) colliding with the PowerBuoy array mooring system was not a concern, especially if it is documented that sound produced by the Project does not have a high frequency component that might interfere with odontocete sonar (the Project is not expected to create any high frequency sounds and this will be confirmed by the acoustic monitoring).

Below, the following potential effects on cetaceans of deploying and operating the Project are further discussed:

- Collision/entanglement during operation
- Underwater noise/vibration
- Change in migration route within area of the Project

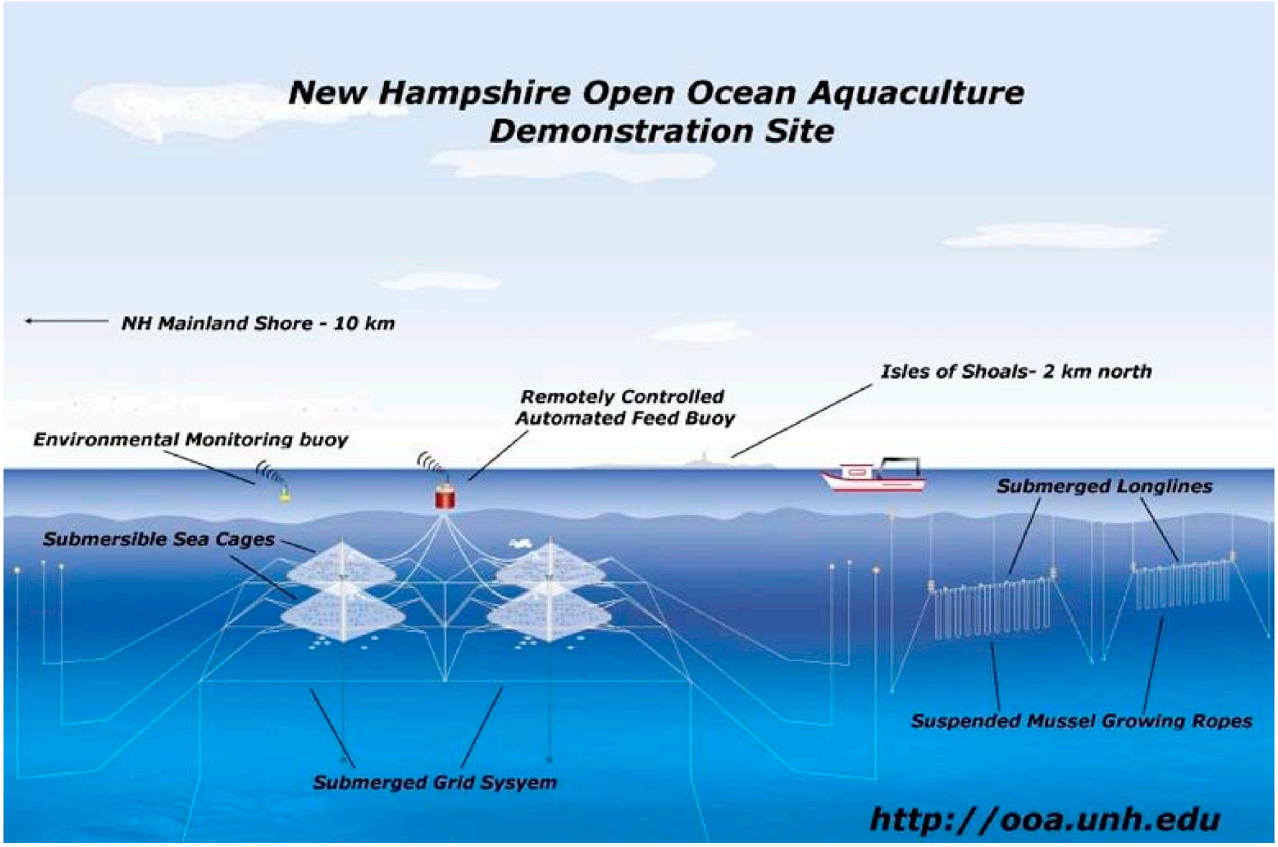
3.1 Collision/Entanglement During Operation

The PowerBuoys, subsurface floats, and gravity-base anchors will be connected with 5 to 6-inch-diameter synthetic mooring lines. In addition, a power/fiber optic cable, having a diameter of 2.8 inches, will exit the bottom of the PowerBuoy, descending to the seabed in a lazy "S" shape with floats attached to the cable and a clump weight at the seabed (Figure 3). The football-shaped floats are two-piece and clamp onto the power cable at prescribed locations to give the necessary buoyancy to the cable to act as both a strain relief (for the heaving motion of the PowerBuoy) and to keep it off the bottom (prevents cable sweep at the seabed). This will provide the installation with power and communications transmission.

NOAA has funded an open ocean aquaculture (OOA) facility located 6 miles off the New Hampshire mainland (Figure 13) (Atlantic Marine Aquaculture Center 2008). The facility was installed in 1997, and has a mooring system similar to the one proposed at the Reedsport Project, has a similar footprint (30-acres), and is in similar depths. For this project, a biological assessment (Celikkol 1999) was requested by NMFS with an emphasis on marine mammal entanglement, and USACE permits were issued (Cicin-Sain et al. 2001). Endangered right, fin, and humpback whales occur in the project area (Atlantic Marine Aquaculture Center 2008). Celikkol (1999) analyzed the risk of entanglement and concluded, "The chance of whale entanglement should be considered unlikely to very unlikely" due to the absence of structures known to cause entanglements such as slack lines and netting. Following deployment of the project in 1997, monitoring of whales and sea turtles in the project vicinity occurred. Fin and humpback whales were observed in the project vicinity, but not in the actual project area. In 2006 researchers reported, "…no incidents related to marine mammals or turtles have occurred at the OOA field site and no impacts have occurred since the beginning of aquaculture activities in 1997" (Atlantic Marine Aquaculture Center 2008).

An examination of the NMFS Stock Assessment for the U.S. west coast (Carretta et al. 2007) shows that since 1999 the known causes of fin and humpback whale mortalities due to entanglement are limited to fishing gear, drift gillnets, crab pot lines, and polypropylene/nylon lines. The mooring lines of the PowerBuoy array and the power/fiber optic cables are more substantial than the fishing or crab pot lines that have been involved in previous entanglement incidents. The mooring system of the Company's PowerBuoys is designed to remain under tension: the mass of the PowerBuoys and the anchors creates enough tension in the mooring lines to preclude the formation of loops or twists around a passing animal. The combination of heavy mooring gear and relatively taut mooring lines has been shown to render the potential for entanglement negligible (Wursig and Gailey 2002). The power/fiber optic cables descending from the PowerBuoys to the seabed have a smaller diameter than the mooring lines (approximately 3 inches verses 5 to 6 inches). However, this is still a substantial cable and considering the relative rigidity of the armored power/fiber optic cable, the Company believes that it is unlikely that these cables will form loops or twist around a passing animal.

FIGURE 13
NOAA-FUNDED NEW HAMPSHIRE OPEN OCEAN AQUACULTURE DEMONSTRATION SITE INSTALLED IN 1997



Source: Atlantic Marine Aquaculture Center 2008

The potential of whales colliding with mooring lines or PowerBuoys is based largely on the fact that nothing is known about the whale's behavior in response to wave energy buoys. Whale impacts with ships, buoys, and other moored objects are considered uncommon. In an analysis of a similar type of wave energy project having four WEC in the state of Washington, FERC (2007) stated:

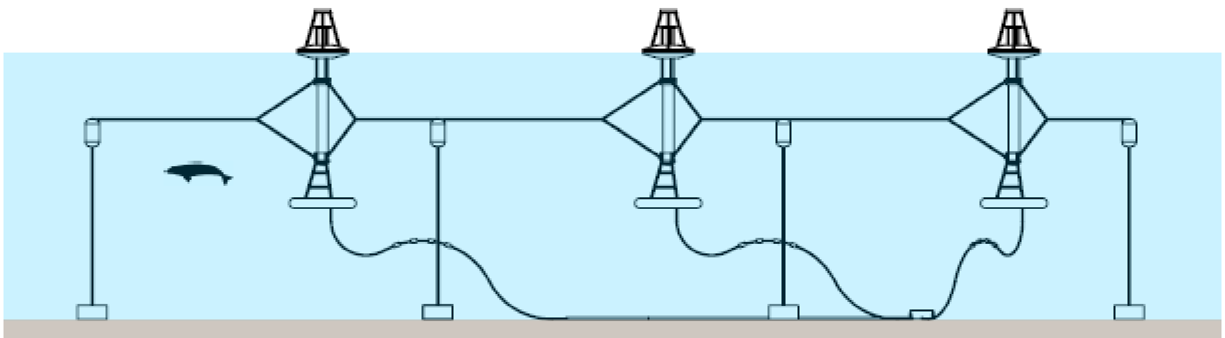
> *We … suspect that because the project's cables would be similar in size and type to anchoring systems associated with navigation buoys, the potential for collisions and injury (of marine mammals) is low. We found no information that would suggest that navigation buoys have resulted in injury to marine mammals. While there would be an array of 10 such cables at the project compared to a single one associated with a navigation buoy, the spacing between the cables (60 feet) should be sufficient for most species to avoid hitting the cables.*

The spacing of the PowerBuoys, 330 feet (100 m) apart from each other, will further decrease the likelihood of collision by providing room for gray whales, harbor porpoises, and other whales to pass between the PowerBuoys. To illustrate this point, Figure 14 depicts, to scale, a gray whale of average length (45 feet [NMFS 2007]) within the PowerBuoy array. It is worth noting that, while the mooring lines are taut, they do allow for some give and the hard, rounded surface of the PowerBuoys are expected to deflect an animal in most cases rather than halt their progress.

Aquatic Species Subgroup members also indicated concern that derelict fishing gear (abandoned/stray fishing gear) may snag on PowerBuoy array moorings, and in turn pose an entanglement risk to cetaceans

Evaluating the effects of a PowerBuoy on whales in any credible way is at present difficult due to the absence of previous experience with such technology and the relatively poor understanding researchers have of cetacean behavior.

FIGURE 14
SCALE ILLUSTRATION OF A GRAY WHALE WITHIN THE POWERBUOY ARRAY



Scaled full size adult gray whale 45 feet (NMFS 2007)

3.2 Underwater Noise/Vibration

Ambient noise, intermittent and continuous, in the marine environment originates from a variety of both natural and anthropogenic sources including commercial and recreational vessel traffic, wave action (wide areas of the ocean surface are excited into noisy waves by the wind), marine life, seismic events, and atmospheric noise. Generally speaking, an equivalent sound in water will travel five times faster and 60 times farther than when generated in air (American Cetacean Society [ACS] 2007). Animals such as fish and marine mammals have biological receptors that are sensitive to sound pressure levels (expressed in dB re 1 μPa), particle velocity (expressed in m/s), and the frequency of sound (expressed in Hz). Ambient continuous noises in the ocean includes those generated by oceanic traffic (10 to 1,000 hertz [Hz], breaking waves, associated spray, and bubbles (100 to 25,000 Hz). Noise pressure spectral densities can range from about 35 to 80 dB (re 1 μPa^2/Hz) for usual marine traffic and 20 to 80 dB (re 1 μPa^2/Hz) for breaking waves and associated spray and bubbles (Richardson et al. 1995).

The installation and maintenance of the PowerBuoys would result in a certain level of noise from service vessels and equipment. Noise associated with the installation activities may temporarily alter migration and feeding patterns. The PowerBuoy will also produce some level of noise during its operation.

In its EA for the Makah Bay Offshore Wave Energy Pilot Project in Washington (FERC No. 12751), FERC (2007) reported, "Sound induced effects on marine mammals are expected when the sound overlaps in frequency and level with the hearing capability of the species under consideration. There is considerable variation among marine mammals in both absolute hearing range and sensitivity. Their composite range is from ultrasonic (frequencies greater than 20 kHz) to infrasonic (frequencies less than 20 Hz). Marine mammals as a functional group have functional hearing ranges of 10 Hz to 200 kHz. Odontocetes and pinnipeds are more sensitive to higher frequencies while mysticetes are more sensitive to lower frequencies (FERC 2007). Direct hearing measurements, for the most part, are not available for large whale species, but it is generally believed that a whale's hearing range is related to the range of sound it produces (LGL Ecological Research Associates [LGL] and JASCO Research 2005). Mysticetes are low-frequency specialists with peak spectra of their vocalizations occurring from 12 Hz to 3 kHz; Odontocetes are high-frequency specialist, with peak spectra of their vocalizations occurring from 10 kHz to 200 kHz (Ketten 2000).

Several baleen whale species, exposed to varying sound sources, impulsive and low frequency sounds, were observed to display avoidance behaviors at received levels of 140 to 160 dB re 1 uPa (Malme et al. 1983, 1984, 1988, Ljungblad et al. 1988, Tyack and Clark 1998). The effect of noise created by human activities has received a mixed reaction by gray whales (Moore and Clarke 2002). Large commercial vessels and oil and gas developments have been shown to create noise that will make whales change path, increase swim speed, and alter breathing patterns (Moore and Clarke 2002). Off California, researchers determined a predicted reaction zone around a semi-submersible drill rig was less than 1 kilometer at a received level of about 120 dB re 1 μPa (Malme et al. 1983, 1984). Other noise associated with whale watching boats has actually attracted whales out of curiosity. It has been shown that slow-moving vessels that produce noise at less than 120 dB re 1μPa and are located over approximately 600 feet from gray whale groups do not provoke a fleeing reaction (Moore and Clarke 2002).

In an evaluation of the effects of underwater noise from the Neptune Project, a proposed Massachusetts LNG facility, on marine mammals, LGL and JASCO Research (2005) reported the following regarding reaction of baleen whales to transient sounds:

> Reactions of baleen whales to boat noises include changes in swimming direction and speed, blow rate, and the frequency and kinds of vocalizations (Richardson et al. 1995). Baleen whales, especially minke whales (*Balaenoptera acutorostrata*), occasionally approach stationary or slow-moving boats, but more commonly avoid boats. Avoidance is strongest when boats approach directly or when vessel noise changes abruptly (Watkins 1986; Beach and Weinrich 1989). Humpback whales responded to boats at distances of at least 0.5 to 1 kilometer (0.3–0.54 nm), and avoidance and other reactions have been noted in several areas at distances of several kilometers (Jurasz and Jurasz 1979; Dean et al. 1985; Bauer 1986; Bauer and Herman 1986). During some activities and at some locations, humpbacks exhibit little or no reaction to boats (Watkins 1986). Some baleen whales seem to show habituation to frequent boat traffic. Over 25 years of observations in Cape Cod waters, minke whales' reactions to boats changed from frequent positive interactions to a general lack of interest, while humpback whales reactions changed from being often negative to being often positive and finback whales (*B. physalus*) reactions changed from being mostly negative to being mostly uninterested (Watkins 1986).

Harbor porpoise were observed to leave the area of an offshore wind farm being constructed in Denmark during periods of piling activities (Tougaard et al. 2003), it should be noted that neither construction nor operation of the Reedsport Project would involve any activities creating a comparable noise level. Recent work in the U.K. suggested that, for harbor porpoise, the zone of audibility ranges from 1 to 3 kilometers depending on the noise emitted by the ship (Thomsen et al. 2006). The Scottish Executive (2007), in its assessment of environmental effects of marine renewable projects, reported that cable trenching activities created noise levels that were below the level at which a behavioral reaction would be expected for harbor porpoise. Harbor porpoises usually avoid boats; during a survey off California, Oregon, and Washington, Barlow (1988) observed harbor porpoises rapidly moving away from the path of a survey vessel within 1 kilometer of the boat.

Much of the study of effects of sound on killer whales has been done within the context of evaluating whale-watching effects in inland waters of Washington and British Columbia (NMFS 2008*a*). Using vessel sound modeling, Erbe (2002) "predicted that the sounds of fast boats are audible to killer whales at distances of up to 16 kilometers, mask their calls up to 14 kilometers away, elicit behavioral responses within 200 m, and cause temporary hearing impairment after 30-50 minutes of exposure within 450 m. For boats moving at slow speeds, the estimated ranges fall to 1 kilometer for audibility and masking, 50 meters for behavioral reactions, and 20 meters for temporary hearing loss." Northern Resident killer whales were reported to sometimes react to the approach of a single boat to within 400 meters (Kruse 1991). It should be noted that, in the Puget Sound area, the mean number of vessels following groups of killer whales during the peak summer months ranged from 18-26 boats from 1996 to 2006 with annual maximum counts of 72 to 120 boats made near whales from 1998 to 2006 (Koski 2004, 2006, 2007). Consequently, killer whale responses could be expected to be different in the Reedsport Project area where they are infrequently seen and where there is not a whale watching industry targeting them. In 2007 Holt (in press) reported that vessel noise can significantly reduce the range at which echolocating killer whales can detect salmon (NMFS 2008*a*).

The predominant source of noise during Project installation and maintenance would originate from the vessels' propellers (Minerals Management Service [MMS] 2007). The Company expects the peak underwater sound intensity, generated by a vessel fully underway, to be no greater than 130 to 160 dB re 1μPa at 1 meter over a frequency range of 20 Hz to 10 kHz (Richardson et al. 1995). The vessel should only be fully underway when traveling to and from the Project site. In addition, these high noise levels may result from cavitations during vessel starts and stops during construction activities. Most of the time during Project installation and maintenance, the sound intensity will be much lower.

It is important to note that during Project construction and maintenance, the Company expects that the above-water sounds from the support vessels and equipment will not be transmitted into the water at a higher level than the natural environmental noise from wind and wave action. FERC (2007), in the Makah Bay Wave Energy Pilot Project Environmental Assessment, concluded that they expected such above-water sounds to be largely damped by ambient ocean noise on all but the calmest of days. Installation of the anchoring and mooring system will not involve percussive pile driving or drilling, the most significant noise source during most marine construction (Halcrow Group 2006). Additionally, vessels involved with laying the transmission cable are expected to be operating at idle speed. Therefore, while the noise associated with the installation and maintenance activities may temporarily cause avoidance and alter feeding patterns for certain marine species, any effects would be short term and are anticipated to be negligible.

During Project operation, the Company expects the underwater noise to primarily originate from waves impacting the float portion of the PowerBuoy and movement of internal mechanical components. However, because the waves impacting the float occur at the surface, coupling into the water would be very poor. According to the MMS, "once installed, wave energy technologies would produce low-intensity, broadband noise of a repetitive continuous nature, similar in character to noise from ship operations. Such noise would be expected to have minimal impacts to human and marine populations" (MMS 2007). Previous research by EPRI reports that "…noise from wave power plant machinery will generally increase in proportion to the ambient background noise associated with surface wave conditions, thus tending to minimize its noticeable effect" (EPRI 2004).

Maintenance divers working underwater around the Company's PowerBuoys deployed in Kaneohe Bay, Hawaii, and in New Jersey have not noticed any audible sounds from the PowerBuoys or mooring system. It should be noted that diver hearing underwater would not likely detect low frequencies. Based on this information and considering that the wave energy generation uses relatively low-intensity wave-to-electrical energy conversion technologies (MMS 2007), the Company expects the source levels generated by the WEC to be much less than 130 to 160 dB re 1μPa at 1 meter and likely closer to ambient ocean sound levels. Consequently, Project operations should not result in noise being produced at levels that would negatively affect fish, marine mammals, or other marine life in the area.

3.3 Change in migration route within area of the Project

If gray whales, which regularly migrate through the Project area, are successful in detecting the PowerBuoy array infrastructure, the Aquatic Species Subgroup has expressed concern over the potential effects from altering their migration route within the area of the Project to avoid the PowerBuoy array. It should be noted, at the meeting of marine mammal acoustic experts on October 9 and 10, 2008, while there was agreement that odontocetes colliding with the PowerBuoy array mooring system was not a concern, there was concern about the potential cumulative effect of displacement, particularly for harbor porpoise, that may result if a number of larger wave energy park areas are eventually constructed (Ortega-Ortiz 2008).

4.0 Need for Additional Information

While there is evidence suggesting that whales can detect and avoid underwater structures (no whales have been entangled at the New Hampshire offshore marine aquaculture facility deployed since 1997 (Atlantic Marine Aquaculture Center 2008) and discussed above), the Company and the Aquatic Species Subgroup believe that it is prudent to develop a better understanding of: 1) gray whale paths in the Project vicinity; and 2) the acoustic emissions generated by the PowerBuoys and any potential for sound disturbance, and 3) how whales behave in the presence of the Project (e.g., do they have the acuity to detect and avoid the systems). If study results indicate that a deterrent system should be employed, the Aquatic Species Subgroup indicated that the type and effectiveness of the acoustic guidance used should be thoroughly evaluated. Lastly, the Aquatic Species Subgroup indicated an interest in evaluating potential Project effects and mitigation within the framework of an adaptive management plan. The Company believes that the proposed phased whale monitoring (Section 5.0), within an adaptive management framework, will provide for a methodical and flexible approach to understand how whales interact with the wave park

5.0 Study Plan

Wave generation units such as PowerBuoys are a new technology, and there is no experience with wave energy projects along the Pacific coast. The Company is advancing the following work plan to evaluate the effects of the proposed action on cetaceans. The elements of this work plan are based on the criteria set forth in the Oregon Territorial Sea Plan, Part Two (Oregon Ocean Policy Advisory Council [OPAC] 1994). The Company submitted an initial and subsequent drafts of the study plan to the Aquatic Species Subgroup for their review in Fall 2007, January 2008, as part of the PDEA in July 2008, and again in Fall 2008. The study plan addresses comments received to date by stakeholders.

5.1 Study Objectives

The goal of this study is to verify the hypothesis that whales have the acuity to detect and avoid the system in all seastates. A three-phase program is proposed:

- **Phase I, Baseline Characterization** - Characterize the behavior of whales in the absence of wave energy systems (Baseline) and develop a strategy and study plan for monitoring the behavior of whales in the presence of wave energy systems.
- **Phase II, Acoustic Emissions Characterization** - Characterize the acoustic emissions of wave energy conversion systems as a function of seastate and evaluate the expected behavioral response of whales.
- **Phase III, Post-Deployment Monitoring** - Monitor the behavior of whales once wave energy systems are deployed. Of particular importance will be whether whales enter wave energy system and, if so, if they become struck or entangled with the mooring lines or PowerBuoys. Monitoring the Project mooring system to determine if derelict fishing gear becomes entangled on array components will be conducted as part of the Company's operations and management plan.

The Baseline Characterization (Phase I) was conducted from December 10, 2007 through May 30, 2008). Migratory behavior by whales has been the subject of numerous studies (Rugh et al. 2001; Mate and Ramirez 2003; Swartz and Jones 1987; Mate and Harvey 1984 Calambokidis et al. 2000; Steiger and Calambokidis 2000; Urban et al. 2000), so the methodology for completing this work has been well established. However, due to the newness of the technology, the Company opted to consult with a panel of marine experts before committing to a specific study methodology for Phases II and III of this work plan. This meeting occurred on October 9 and 10, 2008, and resulting recommendations are incorporated into the methodology for Phases II and III.

5.2 Phase I - Baseline Characterization

The OSU Marine Mammal Institute proposed the following Phase I study of gray whales along the Oregon coast in response to the proposed installation of wave energy projects. This phase consists of two tasks:

- **Task 1, Gray Whale Migration Study** - This task was conducted from December 10, 2007 through May 30, 2008. The results provide baseline data on the route, rate, and timing of migrating gray whales as well as the presence of other large whale species.
- **Task 2, Whale Monitoring Study Plan** - This task will include:

- A small conference with leading marine mammal and acoustic experts to further define and resolve issues (conference was held on October 9 and 10, 2008);
- A recommendation on the possible need for active acoustic deterrence; and
- A written study plan on how to further assess and monitor whales in the presence of a wave energy project.

5.2.1 Task 1 - Gray Whale Migration Study

Observations for the migration study occurred every day (weather permitting) from 8:00 a.m. until 3:00 p.m. from December 2007 to June 2008. The following are the methods for the completed migration study as previously presented.

Shore-based observation using binoculars and theodolite are effective to determine distribution of large whales (blue, humpback, gray, and even killer whales). Tracking the gray whales, as well as observations of other large whales, will be accomplished by a four-person team of observers stationed on the deck adjacent to the lighthouse at Yaquina Head. The deck is located 25 meters above mean sea level and distance to the horizon is approximately 16 kilometers. On a good weather day, the observers may be able to see whales near the horizon. However, due to the accuracy of the method, reliable distribution and movement data are restricted to a smaller radius (about 9 kilometers) around the observation station.

The Yaquina Head location has a number of advantages. First, it has been the site of a multi-year effort in describing the timing of gray whale migrations from 1978 to 1981. Second, it is our hypothesis that whales are migrating along bathymetry lines (a relatively consistent depth). This means that whales are likely passing headland areas closer than they would along uninterrupted sandy beach areas like Gardiner. As a result, this area is more cost effective and accurate in acquiring information about timing, speed, and water depth of whales on migration than would be similar efforts in flat areas where whales are farther offshore.

OSU Marine Mammal Institute will conduct some preliminary assessments of this hypothesis by conducting aerial surveys on four different days during the southbound migration off the Florence coast. Aerial surveys will occur on fair weather days around the Project site from zero to 10 miles offshore over an approximately 50-square-mile area from Florence to Heceta Head. During the surveys, Global Position System (GPS) will be used to determine position of whales and to assess their consistent favor of specific water depths in order to relate those to what is observed off Yaquina Head. This will be done during the southbound migration when the largest number of whales/hour are moving and the survey can expect to be most efficient in a short period of time.

The team at Yaquina Head will use binoculars with reticles and a high-quality theodolite to monitor the position of large whales as the animals travel past their station (all marine mammal sightings made from the Yaquina Head observation station will be recorded and reported). Observers will determine as many positions of the whales as possible (to the north, directly offshore, and to the south) given the sighting characteristics of the theodolite (magnification, elevation) and the weather. The observation team will consist of a theodolite operator, two observers using binoculars (observers), and a data recorder (recorder). At the beginning of each observation period, three people will scan the ocean directly offshore (to the west) and to the north of their station until the first whale is sighted. At this point, the observer will direct the theodolite operator to the whale's position. The recorder will document the number of whales in the group, age classes (probably only feasible for mothers and calves), and their direction of travel. The theodolite operator will get a "fix" on the whales and call out this position to the recorder, who will use improved software (Pythagoras) to link serial sightings into estimates of the underwater route of whale travels. The team will continue to track this whale (and other whales) and record all positions as the animals pass out of sight to the south. Concurrently, as time allows, all three people will be scanning the ocean for new whales. Team members will rotate positions between the functions as spotters and recorder to maintain their attention to details. Weather and visibility conditions will be recorded hourly. Tracking data will be analyzed to determine the whales' distance from shore, speed of travel, and the number of whales passing per hour. The migratory corridor will be determined from these data.

The metrics that will be used to assess potential impacts include movement pattern parameters (speed, directionality, surfacing rate, surface interval, and distance from shore). Consistency of whale distances from shore will be compared by limited aerial surveys along shallow-sloping sandy beaches in the general vicinity of the Reedsport Project. The documented parameters will be compared between the baseline study (2007-2008 migration) at Yaquina Head and the following years at the Reedsport Project area when PowerBuoys will be present and data would be collected by vessel-based observers.

Observations may occasionally be made also from Cape Foulweather (approximately 130 meters above sea level) to determine the practicality of "handing off" observation of specific whales and as a means to determine the consistency of whale travel in relation to bottom depth, distance from shore, and speed. These data may be valuable in planning for future tracking, when positioning a vessel at the same distance (and water depth) offshore of Yaquina Head might be necessary for an acoustic deterrent experiment.

Extension of shore-based observation effort beyond the gray whale migration season is not an effective or cost-efficient method to determine marine mammal distribution in the area of the wave energy park. No other whale is nearly as common within 3 miles of shore as gray whales are. The OSU Marine Mammal Institute gets only 6 to 10 calls per year about killer whales that are visible from shore and several attempts by other investigators to mount studies dependent upon regular observations of killer whales off Oregon have been unsuccessful. Humpbacks, the next most abundant large whale after gray whales, are an order of magnitude less abundant (in good years) and highly variable year to year based on local ocean conditions. They appear more common most years beyond three miles from shore (Pers. Comm. Bruce Mate, Director of the OSU Marine Mammal Institute, December 20, 2007).

The following deliverables will be completed for Task 1:

- A report containing a summary of the results of the migration monitoring, including distance from shore, speed of travel, and the number of whales passing per hour, will be provided to the Aquatic Resource and Water Quality Implementation Committee[2] within

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[2] The Implementation Committees are charged with overseeing the the Company's implementation of resource studies and issues and participating in the associated adaptive management framework. Specifically, the Aquatic Resources and Water Quality Implementation Committee will analyze monitoring and study results on aquatic resources to determine whether results are properly characterized and whether any screening criteria have been met. The Aquatic Resources and Water Quality Implementation Committee may also discuss information contained in a Quarterly Update or Annual Report or new information obtained from other sources that is relevant to the Project's potential effects on aquatic resources. The Aquatic Resources and Water Quality

two months of the filing of the fully signed Settlement Agreement with FERC. In addition to statistical assessment of the timing, speed, distance from shore and water depth of migrant whales, we will provide a simple correlation of counts with wind and swell data collected from local buoy systems, which will provide insight into some whale sightability issues up to B-5 wind levels. It is anticipated that primarily gray whales will be observed though data on all observed whale species will be collected.

- Dissemination of the findings in a peer reviewed journal.
- Presentation of the results at a forum accessible to a broad range of Oregon stakeholders.

Study Results

The Company conducted Phase I, Baseline Characterization of the Cetacean Study Plan from December 10, 2007 through May 30, 2008. The study report (Ortega-Ortiz and Mate 2008) is included in Attachment 1. Observations were possible on 78 days during the study period. A total of 256 scan sampling events were completed during 106.3 hours of scan effort. Focal follows were conducted on 120 individual whales during 103.2 hours of tracking effort. A total of 2,416 gray whale locations were recorded: 460 locations during scan sampling and 1,956 locations during focal follows (Ortega-Ortiz and Mate 2008). Only two observations of cetaceans other than gray whales were made: two minke whales were observed moving south at the end of May (Pers. comm. Joel Ortega-Ortiz, October 9, 2008).

The average distance from shore for sightings recorded during previously conducted aerial surveys off the Oregon coast was 5.7 miles (9.2 kilometers) and the farthest sighting occurred 14 miles (23 kilometers) offshore (Green et al. 1995). During the 2008 Yaquina Head survey, shore-based observations could be made within a range of 11 miles (18 kilometers) from shore (Ortega-Ortiz and Mate 2008). The following provides average distance offshore of observed migrating whales.

Migration Phase	**Average Distance**	**S.D.**	**n**
Southbound	4.09 miles (6.59 km)	0.200	139
Northbound, Phase A (Feb. 26-April 7, 2008)	3.15 miles (5.08 km	0.155	230
Northbound, Phase B (April 7-May 29, 2008)	2.54 miles (4.08 km)	1.529	26

Source: Ortega-Ortiz and Mate 2008

The average speed of tracked whales was 4.19 mph (6.74 km/h) (S.D.= 1.382, n = 37) during the southbound migration, 3.76 mph (6.05 km/h) (S.D.= 1.094, n = 47) during phase A of the northbound migration, and 3.37 mph (5.42 km/h) (S.D.= 1.529, n = 26) during phase B (Ortega-Ortiz and Mate 2008).

Average bottom depth of whale locations during scan sampling was 152 feet (46.3 m) (S.D.=13.70, range=39-246 feet [12-75 m]; Ortega-Ortiz and Mate 2008). Ortega-Ortiz and Mate (2008) noted that the migration paths of tracked whales appeared to follow a constant depth (isobath) rather than the shoreline. For example, some whales that were tracked more than 3 kilometers from the observation point maintained a straight path even as they approached

Implementation Committee is composed of members from the Company, NMFS, USFWS, USDA-FS, ODFW, OPRD, OWRD, ODEQ, DLCD, Oregon Shore Conservation Coalition, Surfrider Foundation, and SOORC

Yaquina Head and linearity of their path continued as they moved away from Yaquina Head. However, variability in the isobaths followed by different whales occurred within the each migration phase. The results indicated that the migratory paths of some, but not all, tracked whales will cross through the proposed Project area (Ortega-Ortiz and Mate 2008). The proposed Reedsport Project PowerBuoy array will be located 2.5 miles offshore. As presented above, the average distance of migrating whales ranged from 4 miles offshore during the southbound migration to 2.5 miles during Phase B of the northbound migration.

5.2.2 Task 2 - Whale Monitoring Study Plan

On October 9 and 10, 2008, the OSU Marine Mammal Institute conducted a two-day meeting at the Hatfield Marine Science Center in Newport, Oregon with a group of marine mammal and acoustic experts[3]. The purpose of the meeting was to further discuss and resolve the following:

- Potential need for and effectiveness of active deterrence, as well as its other potential effects on marine resources.
- Device options for active deterrence.
- Methodology for monitoring whale behavior near wave energy systems.
- Applicability of recommendations from marine mammal group of Ecological Effects Workshop[4].

The following deliverables will be completed for Task 2:

- A report summarizing key findings of the workshop will be provided to the Aquatic Species Subgroup within two months of filing the Settlement Agreement with FERC;
- A recommendation on a strategy to avoid whale entanglements and collisions within three months of deployment of the single PowerBuoy; and
- A draft approach for monitoring the behavior of whales near the proposed PowerBuoy array within three months of deployment of the single PowerBuoy.

Guidance from this meeting was used in developing the Phase II and III components of the study plan, below.

5.3 Phase II - Acoustic Emissions Characterization

It is anticipated that the PowerBuoys will generate steady, continuous noises of considerable variability. Noise will vary between different phases of the Project (e.g., installation and operation) and will also vary depending on environmental conditions (e.g., wind blowing, wave height, and sea state).

The Company has been testing a 40 kW PowerBuoy (PB-40) at its Kaneohe Bay Project in Hawaii. In developing a finding of no significant impact (FONSI) for the deployment of up to six WEC buoys in its Environmental Assessment for the Kaneohe Bay Project Operation, the

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[3] Marine mammal experts that participated in the meeting were: Dr. Dave Mellinger, Oregon State University/NOAA Fisheries, Dr. Charles Greene, Greeneridge Sciences, Inc.; Dr. Brandon Southall, Ocean Acoustics Program, NOAA Fisheries; Dr. Adam Frankel, Marine Acoustics, Inc.; Dr. Bruce Mate, Director, OSU Marine Mammal Institute; and Dr. Joel Ortega, OSU Marine Mammal Institute.

[4] The workshop - *Ecological Effects of Wave Energy Development in the Pacific Northwest* - occurred on October 11 and 12, 2007 at the Hatfield Marine Science Center in Newport, Oregon.

Department of the Navy (2003) concluded, “It is unlikely that noise from system installation or operation would have adverse impacts on humpback whales, dolphins, and green sea turtles. The USFWS and NMFS concur with the Navy that the Proposed Action is not likely to adversely affect threatened or endangered species. The taking of marine mammals protected under the MMPA is unlikely during the installation and operation of the WEC system.”

While these findings strongly suggest that the proposed Project will have no impact on marine resources in terms of acoustic emissions, the Company has conservatively elected to not rely solely on this assessment due to the following differences in the projects:

- **Size difference** - 40 kW versus 150 kW that is planned for Reedsport;
- **Distance from shore** - PB-40 is deployed less than 1 mile from the beach, and as such, background noises are expected to be significantly different for a given seastate; and
- **Benthic conditions** - Much of the area surrounding the PB-40 consists of reefs and rocks, which could lead to very different acoustic background measurements.

Instead, the Company will conduct *in-situ* measurements of the acoustic emissions of the single PowerBuoy as a function of seastate (different representative ocean conditions) at the Reedsport Project. Because of the variability in noise anticipated to be produced by the PowerBuoys, it is agreed that acoustic measurements to characterize sound from the PowerBuoys should be collected over a time period sufficient to account for a wide variety of sea states. The following is the Company’s proposed approach and is based on the results of the recommendations resulting from the October 2008 workshop (Ortega-Ortiz 2008). The Company will deploy autonomous recorders, which were identified as a viable, practical option to monitor the sounds at and from the single buoy installation and operation. Frequency will be monitored in a range of 1 Hz to 10 kHz, because this will include the expected machinery noise (Ortega-Ortiz 2008, Richardson et al. 1995, Foundation for the Sea 2008). Recording will be at a sampling rate of 22 kHz and 5 minutes every hour. Two recorders will be deployed to better understand sound propagation. Recorders will be placed along the same water depth contour (isobath) at approximately 1) 200 meters and 2) 500 meters from the first PowerBuoy. During the October 2008 workshop of marine mammal acoustic experts, it was discussed that three sensors would provide the optimal methodology to determine the attenuation of the sounds being emitted from the PowerBuoys. Upon further analysis and consultation with a marine mammal acoustic expert, the Company has determined that two recorders should provide redundancy for the sound measurement and the basis for estimating sound transmission loss for the installation site, and that three recorders are not essential to the proposed monitoring program. While three transmitters are better at accounting for absorption and scattering losses, this is usually a relatively small number and is unimportant except at long distances. Based on this, the Company believes that two recorders should provide adequate data, but that the Agreement’s Adaptive Management Process can be used if the data are determined to be inadequate.

This testing will be completed on the single PowerBuoy, which is expected to be installed in 2010. These values will be compared against acoustic thresholds documented in scientific literature in order to form an assessment of the potential effects of the Project on marine resources. This data will also provide additional information towards the determination as to whether whales will be likely to detect and avoid the proposed Project in all weather conditions. The Company will deploy the recorders for one month prior to, and a total of at least two months following, the single PowerBuoy deployment. In order to capture a widest range of sea states, the Company anticipates that the post-deployment monitoring will be conducted between

December and March, the period when highest sea states can be expected (winter storms). Consequently, post deployment monitoring will likely not occur immediately after deployment is completed and, in order to capture sea state variability, sampling may not occur during a continuous two month period. This approach differs from that proposed by the October 2008 workshop of marine mammal acoustic experts in that the Company is proposing two months of post deployment monitoring during a period having high sea states instead of a full year. The Company believes that the proposed monitoring is sufficiently robust and will allow for collection 1) of some baseline information, 2) characterization of noise associated with Project deployment, and 3) an initial assessment of temporal variability of operational noise generated over a variety of seastates. A study report will be submitted to the Aquatics Resources and Water Quality Implementation Committee within two months of study completion. Following review of the collected data, if sound levels produced by the PowerBuoy prove to be at levels of concern or if additional monitoring is deemed necessary, the Aquatic Resources and Water Quality Implementation Committee will determine appropriate steps through the Agreement's Adaptive Management Process.

The report shall contain a literature review of whale behavior in the presence of similar noise sources and acoustic pingers. The Aquatic Resources and Water Quality Implementation Committee will review the information provided in the report to determine if sufficient information exists to determine the behavior of whales in the presence of the single PowerBuoy. If additional information is required by the Aquatic Resources and Water Quality Implementation Committee, the Agreement's Adaptive Management Process shall be utilized to determine additional information to be collected. The results of the acoustics study and the literature review are anticipated to inform the consultation process for nine additional PowerBuoys to be deployed.

In the event that acoustic measurements indicate that sound produced by the PowerBuoy has not attenuated to below broadband 120 dB_{rms} re 1 µPa (the threshold for marine mammal disturbance from constant sound, 70 FR 1871) at the boundaries of the physical footprint of the PowerBuoy structure (including moorings), the Aquatic Resources and Water Quality Implementation Committee[5] shall be notified and the new information on potential sound exposure will be assessed through the Agreement's Adaptive Management Process. The Company will have access to data from the acoustic recorders, and shall contact the Aquatic Resources and Water Quality Implementation Committee to report any verified, quality controlled detections that exceed 120 dB as the data are processed and verified in accordance with standard protocols and quality control procedures. Standard protocols and quality control procedures shall be mutually agreed upon by the Aquatic Resources and Water Quality Implementation Committee and shall be in accordance with generally accepted monitoring and quality control procedures for the type(s) of monitoring performed.

Opportunistic observations of whale behavior is planned to be conducted in coordination with other studies on the single PowerBuoy, such as the Pinniped Study.

[5] NMFS shall be notified as soon as practicable upon detection of a exeedance. This notification may precede general notification to other Aquatic Resources and Water Quality Implementation Committee members.

5.4 Phase III - Post-Deployment Monitoring of the Array

At the October 2008 marine mammal acoustic expert workshop, several methods were discussed to monitor whale behavior near a wave energy project and are summarized as follows. Direct monitoring from boats is limited to good weather, it is expensive, and the presence of the boat may have confounding effect on whale behavior – is the whale reacting to sound from the boat or sound from the PowerBuoy. Aerial surveys are not reliable to study behavior because aircraft need to keep moving at relatively high speed for detailed observation. Telemetry can be very accurate – location, speed, dive profiles, pitch and roll – but it is expensive and there is no guarantee that tagged whales will travel through or near the PowerBuoy array. Moreover, sample size (number of tagged individuals) may not be enough to obtain definitive conclusions. Shore-based observations may be a practical and convenient method if there is a high enough (>30 feet) and close enough (<4 miles) observation point. Boat, aerial, and shore-based observations are limited to favorable environmental conditions (wind < 14 mph, Beaufort sea state < 5, no rain, and no fog) (Ortega-Ortiz 2008).

Previous shore-based observations off the California coast indicate that southbound gray whales detected a 21 kHz signal and deflected offshore when sound source was turned on (Frankel 2005). The study by Frankel (2005) had two theodolite stations, 2 kilometers apart, which enabled gathering longer tracks – further north and sound than with just a single station. Tracks had to be at least 1 kilometer long to yield usable data. Handing off a whale from one station to the other was complicated but possible. During the October 2008 workshop of marine mammal acoustic experts, it was agreed that shore-based observations were the best method for evaluating whale interactions with operating PowerBuoys, and that on site observations were preferable to play-back experiments because of differences in environmental conditions, acoustic propagation field, and general context (Ortega-Ortiz 2008).

The Company proposes to observe the presence and behavior of whales in response to the presence of the Project. The Phase III monitoring will begin December 2011. The Company will establish a shore observation station on top of the approximately 80-foot high sand dune, located approximately ¼ mi. inshore from a location adjacent to the proposed PowerBuoy deployment site. Using theodolites, observers will record large whale presence and track movements, noting if there is a deflection around the array of 10 PowerBuoys. Metrics are developed to statistically detect effects of stimulus that observes cannot identify in the field. While observation stations off California were higher and the sound source was closer to shore than at the Reedsport site, observations at Reedsport are expected to be reliable (Ortega-Ortiz 2008). The Company plans to deploy the PowerBuoy array in summer 2011. To maximize opportunities to observe whales, the shore based monitoring program will occur from December 2011 through June 2012, to coincide with the peak migration season. Monitoring shall document observations during south bound migration as well as both phases of north bound migration. The appended report (Attachment 1) found that the migratory path in relation to distance from shore varied by migration direction, as well as phase, for north bound migration. Whales are closest to shore, and therefore most likely to interact with the buoy system during the phase B northbound migration. That being the case, observation should continue through June, when the Ortega-Ortiz and Mate report indicate the north bound phase B is complete.

Because the shore-based observations will be conducted from December through June during the gray whale migration season, the Company also proposes to conduct observations of cetaceans in the Project vicinity during other times of the year in order to maximize opportunities to evaluate presence of other cetacean species in the Project area. Boat-based observations of cetaceans will be conducted concurrently with the Fish and Invertebrates Study, the Offshore Avian Use Study, and operation and maintenance site visits. All designated observers will be appropriately trained. Operations and maintenance site visits to the array area will occur monthly; this is discussed further below. The number and timing of ship visits to the array area for the Fish and Invertebrates Study and the Offshore Avian Use Study are summarized in Table 3.

TABLE 3
ADDITIONAL CETACEANS OBSERVATION OPPORTUNITIES - NUMBER AND TIMING OF SHIP VISITS TO THE REEDSPORT PROJECT ARRAY AREA FOR THE FISH AND INVERTEBRATES STUDY AND THE OFFSHORE AVIAN USE STUDY

Monitoring method	Species addressed	J	F	M	A	M	J	J	A	S	O	N	D	Frequency	Control sites	Years
Fish and Invertebrates Study																
Hook and Line	Salmonids					X	X	X		X				4 sampling efforts each year	2	Before installation and years 1, 2, and 3 after installation
	Rockfish			X		X		X				X		4 sampling efforts each year	2	Before installation and years 1, 2, and 3 after installation
	Pelagic fish and invertebrates			X		X		X				X		See rockfish & biofouling studies	2	Before installation and years 1, 2, and 3 after installation
Multimesh gillnet	Salmonids, rockfish, pelagics					X		X						Late spring & early summer	2	Before installation and years 1, 2, and 3 after installation
Trapping	Dungeness crab							X				X		Trapping for at least 3 days each outing	3	Before installation and years 1, 2, and 3 after installation
Acoustic telemetry	Sturgeon													2 receivers for 3 years	0	Years 1, 2, and 3 after installation
Trawling	Flatfish and epibenthic invertebrates			X		X				X				3 times per year (5 10-minute trawls)	2	Before installation and years 1, 2, and 3 after installation

Monitoring method	Species addressed	J	F	M	A	M	J	J	A	S	O	N	D	Frequency	Control sites	Years
Settlement plates	Biofouling													see right	0	One settlement unit removed during years 1, 2, and 5 after deployment of the array.
Grab samples	Benthic infauna						X			X				3 samples (5 replicates each)	2	Before installation and years 1, 2, and 3 after installation
SCUBA/ ROV	Pelagic Fish and invertebrates								X					See below	0	Years 1, 2, and 5 after installation
	Biofouling								X					Evaluate 3 PowerBuoys to 100 ft	0	Scuba: Years 1, 2, and 5 after installation. ROV: performed every 3 to 4 months, for the first 2 years, then annually.
Water quality	Water quality			X		X	X	X	X	X		X		During fish & invertebrate monitoring	0	During fish and invertebrate monitoring
Offshore Avian Use Study																
Avian presence		X	X	X	X	X	X	X	X	X	X	X	X	2+ days; 2x per month, 2 weeks apart	0	Before installation
Cetacean Study																
Phase II Acoustic Monitoring (Single PowerBuoy)		X	X	X									X	Autonomous	0	Winter After Installation of Single PowerBuoy
Phase III Post-Deployment Monitoring of Array		X	X	X	X	X	X						X	Observations to be determined	0	Winter After Installation of PowerBuoy Array

The Company has developed an operations and maintenance (O&M) activities plan (outlined in more detail in the APEA - Section 3.A.2, Project Operation and Appendix B). The O&M plan includes the following components:

- **Preventative Maintenance/Site Inspection** - Monthly inspection of all aspects of the PowerBuoy array visible from the sea surface to check connections, wear conditions, and any other visual anomalies.
- **Underwater Inspection –** A diver or ROV will be used to view the site underwater and visually inspect PowerBuoy array components, including looking for any accumulation of derelict fishing gear on the PowerBuoy system, with the results being recorded by video camera. This will be carried out every three to four months, weather permitting, for the first two years and in year 5, and underwater visual inspections only annually thereafter.

The Preventative Maintenance/Site Inspection and Underwater Inspection frequency shall commence with the commissioning of the single PowerBuoy.

Company staff will look for derelict fishing gear visible from the surface during the monthly preventative maintenance/site inspection visits and will conduct more comprehensive searches for derelict fishing gear during the underwater inspection visits. As indicated, the Company will conduct the underwater inspections every three to four months, weather permitting, for the first two years following deployment of the 10-PowerBuoy array. This will allow the Company to monitor the degree to which fishing gear gets caught on PowerBuoy array moorings, if at all, and will provide insight to whether changing the frequency of subsequent underwater inspections (Year 3+ post-deployment) is appropriate (to be determined in consultation with the Aquatic Resources and Water Quality Implementation Committee within the framework of the Agreement’s Adaptive Management Plan). Also, as discussed in Section 5.C.6 of the APEA, the Company proposes to work with the crabbing industry (post-license issuance) to identify ways to minimize the potential for loss of gear. Summaries of the Company’s monitoring of derelict fishing gear will be reported to the Aquatic Resources and Water Quality Implementation Committee in quarterly updates. In the event that findings during the O&M inspections indicate derelict fishing gear is found on the PowerBuoy array, the Company will remove the derelict fishing gear as soon as possible and feasible.

The documented parameters will be compared to the baseline study (2007-2008 migration) at Yaquina Head and an analysis will be completed as to the net effect of the Project on whale behavior (e.g., avoidance of array). The Company plans to hire a marine mammal expert to further refine this study plan (develop a more detailed methodology), coordinate with the Aquatic Resources and Water Quality Implementation Committee for finalization of the study plan (to be finalized before the deployment of the array), oversee the study, and work with the Aquatic Resources and Water Quality Implementation Committee to evaluate study results within the Adaptive Management Process. The Company will allow sufficient time for the Aquatic Resources and Water Quality Implementation Committee to review and comment upon the future versions of the study plan. The Aquatic Resources and Water Quality Implementation Committee will be informed of the study progress, including a characterization of how frequently whales are seen within or close to the PowerBuoy array, and whether any injuries to whales are observed, through quarterly updates and a summary of study results will be provided in annual reports.

As mentioned above, at the meeting of marine mammal acoustic experts on October 9 and 10, 2008, while there was agreement that odontocetes colliding with the PowerBuoy array mooring system was not a concern, there was concern about the potential cumulative effect of displacement, particularly for harbor porpoise, that may result if a number of larger wave energy park areas are eventually constructed (Ortega-Ortiz 2008). Sound emitted by the 10-PowerBuoy array is not expected to disturb odontocetes because sound produced will be largely below the higher frequency range of odontocetes. Physical presence of the PowerBuoy array may cause odontocetes to avoid the immediate Project vicinity; however, any potential displacement would be localized. The Company is not proposing to conduct passive acoustic monitoring, a method well suited to detecting small cetacean species, because Project effects on odontocetes are expected to be minimal.

The Company proposes the following approach to responding to potential collision/entanglement scenarios:

- If observation of injury, notification to the Aquatic Resources and Water Quality Implementation Committee within two weeks.
- If there is evidence of a whale collision, notify Aquatic Resources and Water Quality Implementation Committee within two business days.
- If entanglement, immediate notification of Aquatic Resources and Water Quality Implementation Committee and activate NMFS response plan.

If an injured, stranded, entangled, or dead marine mammal is observed during the study, researchers will follow the protocol provided by NMFS. This protocol is included in Attachment 2.

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ATTACHMENTS

ATTACHMENT 1

DISTRIBUTION AND MOVEMENT PATTERNS OF GRAY WHALES MIGRATING BY OREGON: SHORE-BASED OBSERVATIONS OFF YAQUINA HEAD, OREGON, DECEMBER 2007-MAY 2008.

Distribution and movement patterns of gray whales migrating by Oregon: Shore-based observations off Yaquina Head, Oregon, December 2007-May 2008.

Report submitted to the Oregon Wave Energy Trust

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Introduction

The growing demand for energy, the rising oil prices, and the need to curb carbon emissions have stimulated a search for alternative (*i.e.* non-fossil fuel) sources of energy. The quest for "clean" energy has resulted in development of technology to produce electricity from by harnessing wind, wave, and solar radiation. The Oregon coast has been identified as an area with great potential for production of electricity from wave energy. In 2007 the state legislature appropriated funding to create the Oregon Wave Energy Trust (OWET), a non-profit organization composed of stakeholders including representatives from industry, fishing, environmental, government and community groups. OWET has the objective of promoting responsible development of a wave energy industry in the State of Oregon. Within the last couple of years, applications have been filed for permits to develop wave energy parks in several locations along the Oregon coast. Recent plans to develop of wave energy parks on the Oregon coast raise the priority of assessing any potential environmental effects (Boehlert *et al.* 2008). Assessment of ecological risk (as defined in US Environmental Protection Agency 1998) of wave energy parks requires an estimation of the magnitudes of both exposure and effects on species, species assemblages or habitats.

Gray whales are a protected species under the U.S. Marine Mammal Protection Act. Two extant distinct populations are recognized for this species: the Eastern North Pacific stock, which lives along the west coast of North America, and the Western North Pacific stock, which lives along the coast of eastern Asia (Rice *et al.* 1984, Swartz *et al.* 2006, Angliss and Outlaw 2008). The majority of the Eastern North Pacific population spends the summer feeding in the northern Bering and Chukchi Seas, although some gray whales have been observed feeding in the summer in waters off of Southeast Alaska, British Columbia, Washington, Oregon, and California (Rice and Wolman 1971, Darling 1984, Nerini 1984, Rice *et al.* 1984, Newell and Cowles 2006). Whales observed foraging in these more southern locations during several summers are referred as "residents" (*e.g.* Newell and Cowles 2006). Resident whales have been observed off the Oregon coast from May through October and 28 individuals were observed near Depoe Bay for at least three successive summers (Newell and Cowles 2006).

Every year, a significant part of the population of eastern gray whales migrates from their summer feeding grounds towards the calving lagoons in Baja California, Mexico and back (Rice and Wolman 1971). Segregation has been observed in the migration timing of whales of different sex, age and reproductive status. The sequence during the southward migration is: females in late pregnancy, followed by females that recently ovulated, adult males, immature females, and immature males (Rice and Wolman 1971, Rice *et al.* 1984). Although it is difficult to define an exact date for the start of the southbound migration, most whales are migrating out of the northern seas between mid October and November (Rugh *et al.* 2001). A series of observations of gray whale migration collected since 1967 at Granite Canyon, in central California, shows a one-week delay in the southbound migration after 1980 (Rugh *et al.* 2001). Calves are born in the Baja lagoons from early January to mid-February (Rice *et al.* 1981). The northbound migration begins in mid-February. Newly pregnant females are the first to leave Baja, followed by anestrous females, adult males, and immature males and females (Rice *et al.* 1984). This first wave is known as “phase A” of the northbound migration. Cows with calves are the last to leave the lagoons 4-6 weeks later and constitute “phase B” (Poole 1984). Mother/calf pairs have been observed in San Ignacio Lagoon up into April (Rice *et al.* 1981).

Previous observations indicated that southbound whales pass by Yaquina Head between early December and mid February (Herzing and Mate 1984). Peak dates for the southbound migrations along Yaquina Head were 28 December 1978, 6 January 1980, 1 January 1981 (Herzing and Mate 1984) and 7 January 1999 (Mate and Poff 1999). Phase A of the northbound migration starts the last week of February and peaks in mid March while Phase B begins in late April and peaks in mid May (Herzing and Mate 1984).

Gray whale migration along Oregon is primarily coastal. The average distance from shore for sightings recorded during aerial surveys off the Oregon coast was 9.2 km and the farthest sighting occurred 23 km offshore (Green *et al.* 1995). Because of their coastal path, gray whales are well known and appreciated by the public and by visitors to the Oregon coast. Whale-watching is one of the main attractions offered by tour boat operators in Depoe Bay and Newport. Whale-watching is also an important attraction at visitor centers along the Oregon coast (*e.g.* Yaquina Head Outstanding Natural Area, Whale Watching Center in Depoe Bay, etc.). However, the coastal migratory path of gray whales crosses areas where wave energy parks have been proposed.

The objective of this study is to generate accurate, up to date data on distribution (distance to shore, travel path) and behavior (travel speed, migration timing) of gray whales migrating along the central Oregon coast. Results from this study will help estimating potential exposure of migrating gray whales to wave energy parks in the Oregon territorial sea. Moreover, the baseline information reported here, combined with further observations to monitor gray whale behavior after wave energy parks are installed, can be used to determine potential effects and to evaluate the need for and effectiveness of mitigation measures. This study is included in the first phase of an action plan outlined by the OWET. The second phase will include a characterization of acoustic emissions from wave energy conversion systems and evaluate the expected behavioral response of grey whales. A third phase will consist of monitoring gray whale behavior once wave energy systems are deployed.

Methods

From December 10th, 2007 through May 30th 2008 a team of three observers surveyed for marine mammals from an observation station next to Yaquina Head lighthouse, Oregon. The station was located at 44.67675º latitude north and 124.07956º longitude west, 25.395 m above mean sea level. Average eye-height was 1.572 m. Therefore, total height of the theodolite eye-piece was 26.967 m above sea level and distance to the horizon was approximately 10 nautical miles (18.65 km).

Observations took place during daylight hours, whenever environmental conditions were favorable to search for whales: no rain, no fog, wind less than 12 miles per hour and white caps, if present, not numerous (*i.e.,* Beaufort wind force scale < 4).

The observation team consisted of at least three members: one person searching with 70×50 handheld binoculars (Fujinon FMTRC-SX), one person handling a digital theodolite with a 30× scope (Sokkia DT210, 2 seconds of arc resolution), and one person recording data into a portable computer. Observers rotated every 30 minutes between the three positions.

We determined that magnetic declination at the station was 15.199º (east) for the binoculars' compass during our study. A reference point (antenna) coincident with zero in the binoculars' magnetic compass was used as reference azimuth for the theodolite so that horizontal angles were equivalent between the two instruments.

Whenever a whale was sighted, observers recorded azimuth (horizontal) and declination (vertical) angles with the theodolite to estimate distance from the station following the approximation described by Lerczak and Hobbs (1998). The theodolite was connected to a computer running the software package *Pythagoras* (Gailey and Ortega-Ortiz 2002) which recorded angle measurements, estimated distance to the whale and calculated the whale's geographic location. Alternatively, if it was not possible to acquire a theodolite fix, azimuth and declination angles were measured with a compass and reticle etched into the eyepiece of the handheld binoculars, applying the conversion factors described by Kinzey and Gerrodette (2001). Binocular angle measurements were manually entered into *Pythagoras* to estimate whale's location. Magnetic declination was entered into *Pythagoras* station set up and accounted for in all location calculations.

Scan sampling

Observers surveyed the area of the ocean included in the sector from 160º to 360º, clockwise, in the magnetic compass (175.199º to 15.199º degrees true) and from Yaquina

Head to the either the horizon or shore line (Figure 1). As part of the sampling protocol, hereafter referred to as "scan", all three observers focused in a 5º arc segment for 30 seconds, searching for whales or whale cues such as water splash and spouts or blows. To prevent duplicate counts, during the southbound migration the survey was conducted clockwise, starting at the south end of the scan sector (160º magnetic) and ending in the north end (360º magnetic). Conversely, during the northbound migration scan surveys were conducted counterclockwise, from 360º to 160º magnetic.

Behavioral Observations

In addition to scan sampling, the observers conducted focal follow behavioral observations. During focal follow observations, also referred as "tracking", observers followed individual whales and obtained multiple theodolite fixes to determine speed and path of whales as they passed by Yaquina Head. Duration of focal follows was variable but an effort was made to track the whales for as long as possible.

Scans and focal follows were not conducted concurrently. Scan sampling events were conducted every two hours if weather conditions were favorable and no focal follow was being performed. An effort was made to conduct at least one scan sampling event and one focal follow on each observation day.

Whale location data were imported into a geographic information system (GIS) created with the computer software package *ArcMap*. The GIS included a bathymetry raster layer with 500m pixel size and a vector map of Oregon's coastline scale 1:75,000. A vector line map of the Oregon territorial sea, defined as 3 nautical miles (5.556 km) off land and islands, was derived from the coastline map. Bottom depth, distance to shore and occurrence inside/outside Oregon's territorial sea were determined for each whale location.

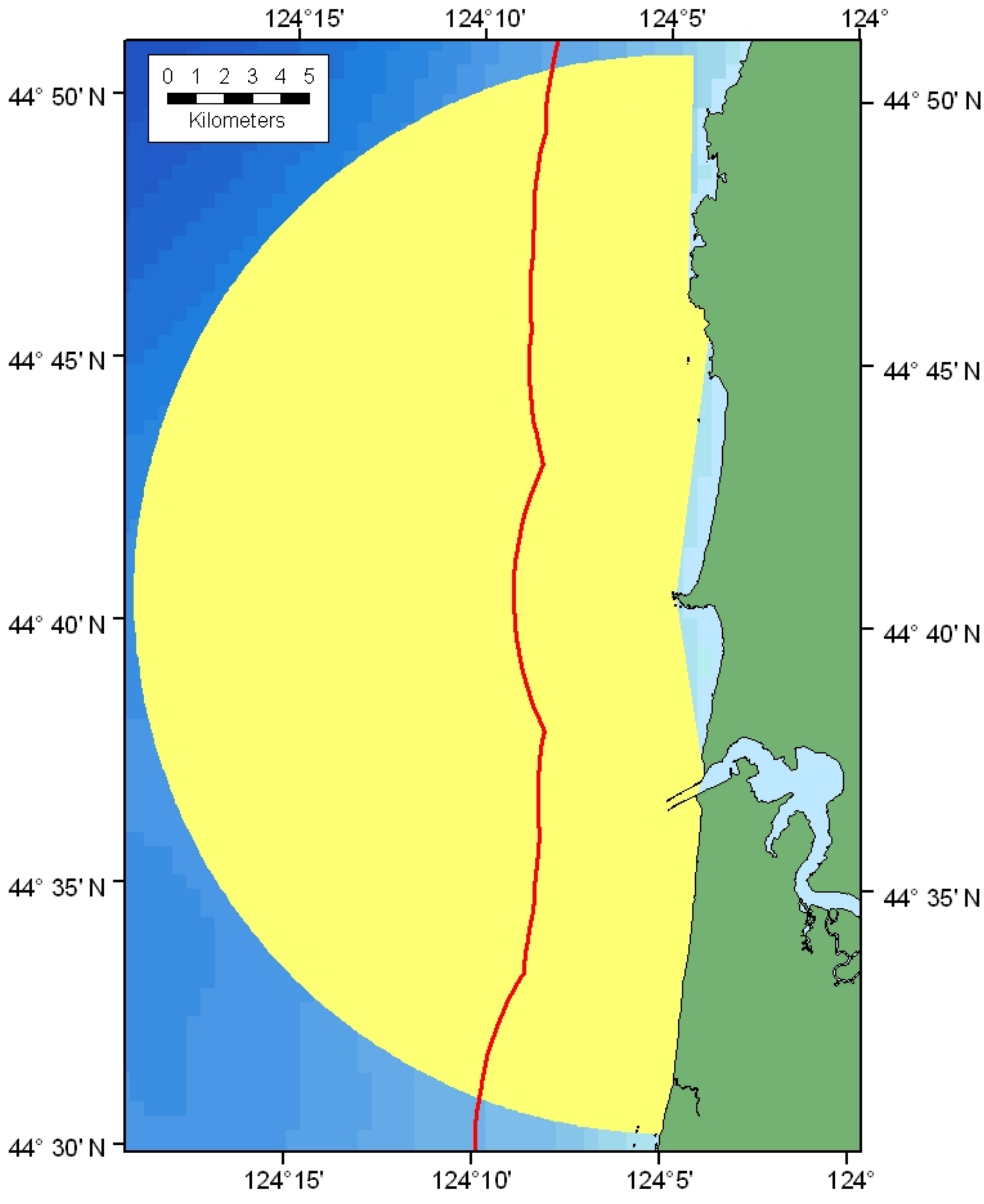

Figure 1. Map of Yaquina Head indicating the area covered during scan surveys (yellow highlight). Distance to the horizon was approximately 10 nautical miles (18.52 km) from the observation station. Red line indicates the State of Oregon territorial waters (3 nautical miles or 5.556 km offshore).

Results

Observations were possible on 78 days during the period of this study. A total of 256 scan sampling events were completed during 106.3 hours of scan effort (Table 1). Focal follows were conducted on 120 individual whales during 103.2 hours of tracking effort (Table 2). A total of 2416 gray whale locations were recorded: 460 locations during scan sampling and 1956 locations during focal follows.

Due to weather conditions and logistical issues, continuous scan sampling started until January 11, 2008. The first whale was observed on January 13. This was also the day with the highest number of whales migrating southbound. The first northbound whale was observed on February 26 and the first cow/calf pair was sighted on April 10. The peak of northbound migration phases A and B was April 7 and April 16, respectively (Fig. 2). The last northbound whale was recorded on May 29. No whales were observed on May 30, the last day of fieldwork.

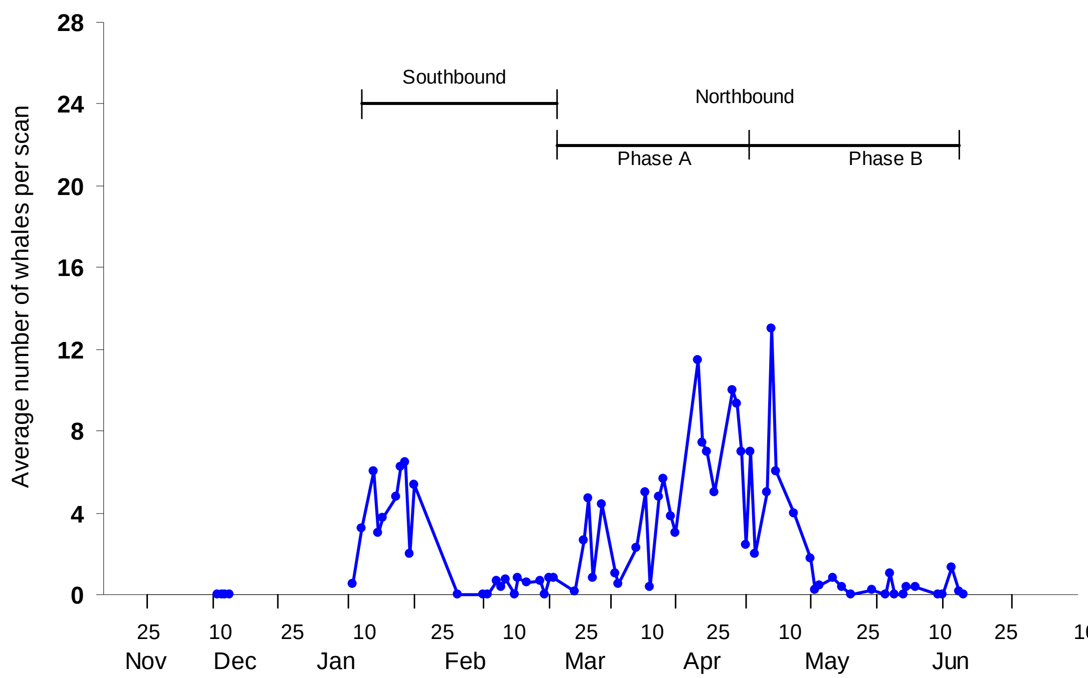

Figure 2. Migration timing, determined from average number of whales per scan surveys conducted at Yaquina Head, Oregon, from December 2007 to May 2008.

Table 1. Scan sampling events, number of whales observed, and wind speed during observations.

Scan	Date	Start time	End time	Duration (hours)	Number of whale groups	Total number of whales	Wind speed (km/h)
1	11-Dec-07	13:57	16:33	2.59	0	0	12.9
2	12-Dec-07	12:00	12:53	0.88	0	0	8.0
4	12-Dec-07	13:57	14:30	0.56	0	0	5.0
5	12-Dec-07	14:41	14:57	0.26	0	0	5.0
7	13-Dec-07	10:46	11:06	0.34	0	0	6.6
8	14-Dec-07	10:51	11:25	0.57	0	0	5.3
9	14-Dec-07	12:30	12:55	0.42	0	0	4.0
10	11-Jan-08	08:59	09:21	0.36	0	0	14.0
11	11-Jan-08	10:55	11:48	0.88	1	1	11.3
12	13-Jan-08	08:48	09:23	0.58	4	4	10.1
13	13-Jan-08	11:01	12:08	1.13	3	3	7.0
14	13-Jan-08	13:05	13:49	0.73	0	0	1.2
15	13-Jan-08	14:54	15:25	0.51	3	4	4.8
16	13-Jan-08	15:52	16:19	0.45	3	5	3.7
17	16-Jan-08	08:56	09:20	0.39	3	4	6.9
18	16-Jan-08	10:42	11:22	0.67	7	12	7.3
19	16-Jan-08	13:21	13:46	0.42	2	2	3.4
20	17-Jan-08	08:43	09:13	0.50	2	2	7.0
21	17-Jan-08	10:24	10:57	0.56	4	4	7.0
22	17-Jan-08	11:56	12:27	0.50	1	3	6.2
23	18-Jan-08	08:53	09:21	0.47	2	2	7.1
24	18-Jan-08	10:06	10:36	0.50	4	4	9.4
25	18-Jan-08	12:51	13:20	0.48	2	5	8.1
26	18-Jan-08	14:15	14:41	0.43	2	4	5.9
27	21-Jan-08	08:54	09:17	0.38	6	6	13.2
28	21-Jan-08	11:01	11:25	0.39	3	3	13.1
29	21-Jan-08	14:21	14:39	0.29	5	5	23.7
30	21-Jan-08	15:18	15:45	0.45	5	5	23.8
31	22-Jan-08	08:38	09:01	0.39	4	4	11.2
32	22-Jan-08	10:02	10:31	0.49	7	7	9.8
33	22-Jan-08	12:56	13:21	0.41	4	5	13.1
34	22-Jan-08	14:43	15:13	0.49	8	9	9.3
35	23-Jan-08	08:42	09:10	0.48	3	6	19.8
36	23-Jan-08	11:41	12:11	0.50	7	9	16.4
37	23-Jan-08	13:26	13:48	0.37	3	3	13.5
38	23-Jan-08	15:07	15:36	0.47	5	8	14.3
39	24-Jan-08	08:33	08:57	0.40	0	0	12.3
40	24-Jan-08	09:08	09:40	0.54	2	3	11.7
41	24-Jan-08	10:18	10:47	0.50	3	3	15.7
42	25-Jan-08	09:57	10:32	0.58	9	10	14.0
43	25-Jan-08	14:22	14:43	0.35	0	0	14.2
44	25-Jan-08	15:56	16:23	0.45	6	6	13.0
45	04-Feb-08	15:06	15:31	0.43	0	0	7.9

Table 1. Continued.

Scan	Date	Start time	End time	Duration (hours)	Number of whale groups	Total number of whales	Wind speed (km/h)
41	10-Feb-08	15:28	15:47	0.33	0	0	6.5
42	11-Feb-08	13:01	13:23	0.36	0	0	8.9
44	11-Feb-08	14:54	15:19	0.41	0	0	8.1
45	11-Feb-08	16:01	16:20	0.32	0	0	10.0
46	13-Feb-08	13:23	13:47	0.39	0	0	8.4
47	13-Feb-08	14:20	14:43	0.37	0	0	9.2
48	13-Feb-08	15:43	16:09	0.43	2	2	11.5
49	14-Feb-08	10:52	11:15	0.38	0	0	6.1
50	14-Feb-08	11:16	11:41	0.42	1	1	6.0
51	14-Feb-08	13:59	14:20	0.35	0	0	8.0
52	15-Feb-08	10:00	10:20	0.34	0	0	9.9
54	15-Feb-08	13:10	13:33	0.39	1	1	6.2
55	15-Feb-08	14:16	14:36	0.34	1	1	8.4
56	15-Feb-08	15:04	15:26	0.37	1	1	11.6
57	17-Feb-08	08:44	09:07	0.38	0	0	8.1
58	17-Feb-08	09:53	10:19	0.44	0	0	7.0
59	17-Feb-08	11:18	11:42	0.40	0	0	6.3
60	17-Feb-08	12:25	12:46	0.35	0	0	8.7
61	17-Feb-08	13:35	13:56	0.35	0	0	8.7
62	17-Feb-08	14:42	15:03	0.35	0	0	10.6
63	17-Feb-08	15:41	16:01	0.33	0	0	11.4
64	18-Feb-08	10:01	10:23	0.37	0	0	7.0
65	18-Feb-08	10:59	11:25	0.43	1	1	6.0
66	18-Feb-08	12:07	12:31	0.39	1	4	7.2
67	18-Feb-08	13:15	13:37	0.36	0	0	9.5
68	18-Feb-08	14:13	14:35	0.37	0	0	10.6
69	18-Feb-08	14:58	15:21	0.39	0	0	9.0
70	20-Feb-08	11:06	11:29	0.37	0	0	5.0
71	20-Feb-08	12:13	12:35	0.37	0	0	4.1
72	20-Feb-08	13:20	13:40	0.33	0	0	4.1
73	20-Feb-08	14:24	14:46	0.37	1	3	3.6
74	20-Feb-08	15:26	15:48	0.35	0	0	4.3
75	23-Feb-08	12:22	12:42	0.33	0	0	13.6
76	23-Feb-08	13:27	13:51	0.40	0	0	10.7
77	23-Feb-08	14:31	14:55	0.41	1	2	8.5
78	24-Feb-08	08:26	08:48	0.36	0	0	11.5
79	24-Feb-08	09:38	10:01	0.39	0	0	10.7
80	24-Feb-08	11:18	11:41	0.39	0	0	8.0
81	24-Feb-08	11:45	12:08	0.39	0	0	8.0
82	25-Feb-08	09:00	09:26	0.43	0	0	7.0
83	25-Feb-08	10:33	10:57	0.40	0	0	8.2
85	25-Feb-08	11:59	12:22	0.38	2	4	5.1

Table 1. Continued.

Scan	Date	Start time	End time	Duration (hours)	Number of whale groups	Total number of whales	Wind speed (km/h)
86	25-Feb-08	14:20	14:43	0.38	0	0	4.4
87	25-Feb-08	15:23	15:46	0.38	0	0	4.7
88	26-Feb-08	08:25	08:50	0.41	0	0	7.2
89	26-Feb-08	09:43	10:09	0.43	2	3	8.2
90	26-Feb-08	10:47	11:11	0.41	0	0	3.2
91	26-Feb-08	13:27	13:50	0.37	0	0	4.6
92	26-Feb-08	14:38	14:56	0.29	2	2	2.9
93	26-Feb-08	16:05	16:31	0.43	0	0	4.8
94	02-Mar-08	09:11	09:29	0.29	1	1	7.4
95	02-Mar-08	09:40	10:03	0.38	0	0	6.4
96	02-Mar-08	11:27	11:48	0.35	0	0	6.0
97	02-Mar-08	12:58	13:23	0.41	0	0	9.4
98	02-Mar-08	14:04	14:26	0.37	0	0	8.9
99	02-Mar-08	15:11	15:32	0.35	0	0	11.8
100	04-Mar-08	09:53	10:18	0.41	1	1	3.9
101	04-Mar-08	11:03	11:28	0.42	2	7	6.0
102	04-Mar-08	14:20	14:42	0.36	0	0	10.6
103	05-Mar-08	09:29	09:54	0.41	0	0	8.9
104	05-Mar-08	10:33	10:56	0.39	0	0	9.5
105	05-Mar-08	11:34	11:59	0.42	2	14	8.8
106	06-Mar-08	09:34	09:58	0.39	0	0	6.0
107	06-Mar-08	10:34	11:00	0.43	1	1	6.6
108	06-Mar-08	12:46	13:08	0.37	0	0	9.6
109	06-Mar-08	14:20	14:43	0.38	0	0	6.0
110	06-Mar-08	16:10	16:33	0.39	3	3	5.7
111	08-Mar-08	08:25	08:48	0.38	2	2	0.0
112	08-Mar-08	10:13	10:38	0.41	4	8	2.4
113	08-Mar-08	11:39	12:04	0.41	2	3	3.3
115	08-Mar-08	14:34	14:57	0.38	3	3	9.1
116	08-Mar-08	15:32	15:58	0.43	4	6	10.6
117	11-Mar-08	14:27	14:46	0.32	1	1	6.0
118	11-Mar-08	15:29	15:50	0.35	1	2	7.9
119	11-Mar-08	16:35	16:55	0.33	0	0	10.6
120	12-Mar-08	09:25	09:48	0.38	1	1	4.2
121	12-Mar-08	10:33	10:56	0.38	0	0	5.8
123	16-Mar-08	09:34	10:00	0.43	1	1	1.0
124	16-Mar-08	13:56	14:21	0.41	1	1	7.1
125	16-Mar-08	15:01	15:24	0.38	2	2	5.1
126	16-Mar-08	16:08	16:35	0.44	3	5	3.9
127	18-Mar-08	15:21	15:45	0.39	3	5	7.0
128	19-Mar-08	10:16	10:40	0.41	1	1	7.5
129	19-Mar-08	11:46	12:09	0.39	0	0	12.1
130	19-Mar-08	12:33	12:55	0.36	0	0	15.9

Table 1. Continued.

Scan	Date	Start time	End time	Duration (hours)	Number of whale groups	Total number of whales	Wind speed (km/h)
131	21-Mar-08	11:11	11:34	0.37	0	0	9.1
132	21-Mar-08	12:05	12:31	0.43	4	5	9.8
133	21-Mar-08	14:41	15:05	0.40	3	4	6.0
134	21-Mar-08	16:30	16:50	0.34	7	10	4.1
135	22-Mar-08	10:19	10:44	0.41	6	7	9.3
136	22-Mar-08	13:10	13:36	0.44	6	7	9.4
137	22-Mar-08	15:31	15:55	0.41	2	3	5.6
138	24-Mar-08	09:25	09:48	0.39	1	2	3.8
139	24-Mar-08	10:44	11:09	0.41	1	1	5.7
140	24-Mar-08	11:38	12:01	0.37	1	1	6.4
141	24-Mar-08	15:08	15:32	0.40	6	9	4.8
142	24-Mar-08	16:46	17:07	0.37	5	6	2.9
143	25-Mar-08	09:05	09:29	0.40	3	3	5.4
144	30-Mar-08	10:28	10:54	0.43	8	13	6.5
145	30-Mar-08	12:31	12:56	0.42	8	10	6.5
146	30-Mar-08	14:41	15:03	0.36	5	5	7.7
147	30-Mar-08	16:08	16:31	0.39	11	18	8.1
148	31-Mar-08	09:33	09:58	0.41	3	6	4.9
149	31-Mar-08	10:39	11:05	0.42	4	5	4.8
150	31-Mar-08	11:36	12:02	0.43	7	10	5.6
151	31-Mar-08	15:22	15:41	0.32	5	7	15.3
152	31-Mar-08	15:46	16:07	0.35	8	9	15.7
153	01-Apr-08	08:26	08:49	0.39	3	5	7.6
154	01-Apr-08	10:44	11:08	0.40	4	9	11.3
155	03-Apr-08	08:27	08:51	0.40	4	6	2.7
156	03-Apr-08	11:28	11:56	0.46	3	4	10.9
157	07-Apr-08	14:06	14:30	0.39	5	8	8.2
158	07-Apr-08	15:21	15:49	0.46	9	9	9.5
159	07-Apr-08	16:34	16:57	0.39	10	13	7.8
160	08-Apr-08	11:10	11:35	0.42	7	9	9.1
161	08-Apr-08	13:48	14:13	0.41	6	8	11.7
162	08-Apr-08	16:27	16:53	0.44	10	11	9.7
163	09-Apr-08	08:30	09:00	0.50	7	10	8.0
164	09-Apr-08	12:16	12:40	0.39	4	6	10.5
165	09-Apr-08	14:19	14:43	0.41	5	5	10.9
166	10-Apr-08	09:36	09:59	0.40	2	2	11.1
167	10-Apr-08	11:35	11:58	0.39	3	3	9.5
168	10-Apr-08	13:14	13:38	0.41	2	2	9.7
169	10-Apr-08	15:22	15:46	0.40	1	2	8.1
170	10-Apr-08	16:21	16:42	0.35	2	3	10.3
171	11-Apr-08	08:31	08:55	0.41	5	6	9.0
172	11-Apr-08	11:24	11:51	0.44	3	8	8.7
173	12-Apr-08	10:23	10:49	0.43	1	1	8.4

Table 1. Continued.

Scan	Date	Start time	End time	Duration (hours)	Number of whale groups	Total number of whales	Wind speed (km/h)
174	12-Apr-08	11:24	11:48	0.41	3	3	10.2
175	12-Apr-08	12:23	12:52	0.48	5	5	10.8
176	12-Apr-08	14:07	14:29	0.37	0	0	13.0
177	12-Apr-08	15:04	15:24	0.33	1	1	12.7
179	15-Apr-08	12:14	12:39	0.41	3	5	11.8
180	16-Apr-08	10:48	11:15	0.45	9	16	3.1
181	16-Apr-08	12:16	12:40	0.41	8	8	5.1
182	16-Apr-08	14:52	15:17	0.41	10	20	13.5
183	16-Apr-08	15:54	16:17	0.39	6	8	14.9
184	17-Apr-08	08:30	08:54	0.39	4	4	9.6
185	17-Apr-08	11:15	11:41	0.43	6	8	15.8
186	21-Apr-08	08:49	09:11	0.38	4	4	8.2
187	25-Apr-08	08:25	08:48	0.39	1	1	6.0
188	25-Apr-08	08:52	09:19	0.44	1	2	6.0
190	25-Apr-08	10:33	10:58	0.42	2	3	6.8
191	25-Apr-08	12:01	12:25	0.40	1	1	8.8
192	26-Apr-08	10:13	10:38	0.40	0	0	6.6
193	26-Apr-08	10:40	11:04	0.41	0	0	5.7
194	26-Apr-08	12:27	12:52	0.41	0	0	4.8
195	26-Apr-08	14:04	14:28	0.40	1	1	4.5
196	26-Apr-08	16:16	16:39	0.39	0	0	4.1
197	27-Apr-08	08:35	08:58	0.38	0	0	4.5
198	27-Apr-08	09:44	10:08	0.39	1	1	5.5
199	27-Apr-08	11:25	11:48	0.39	0	0	6.0
200	27-Apr-08	13:02	13:26	0.41	1	1	6.2
201	27-Apr-08	14:15	14:37	0.37	1	1	6.3
202	27-Apr-08	15:18	15:43	0.40	0	0	6.4
203	27-Apr-08	16:25	16:47	0.37	0	0	6.5
204	30-Apr-08	08:25	08:48	0.39	0	0	5.5
205	30-Apr-08	11:02	11:25	0.37	0	0	2.9
206	30-Apr-08	12:15	12:39	0.40	1	2	2.9
207	30-Apr-08	14:29	14:52	0.39	2	3	2.8
208	30-Apr-08	15:30	15:51	0.36	0	0	2.8
209	30-Apr-08	16:20	16:39	0.33	0	0	2.8
210	02-May-08	08:38	09:02	0.40	0	0	4.0
211	02-May-08	09:40	10:04	0.40	1	1	7.0
212	02-May-08	11:01	11:22	0.35	0	0	5.1
213	02-May-08	12:11	12:38	0.44	1	1	5.4
214	02-May-08	13:44	14:08	0.40	0	0	5.8
215	02-May-08	15:53	16:17	0.40	0	0	6.3
216	04-May-08	08:45	09:07	0.38	0	0	8.0
217	04-May-08	09:43	10:06	0.38	0	0	14.0
218	09-May-08	08:31	08:55	0.39	0	0	5.5

Table 1. Continued.

Scan	Date	Start time	End time	Duration (hours)	Number of whale groups	Total number of whales	Wind speed (km/h)
219	09-May-08	10:01	10:24	0.39	0	0	8.0
220	09-May-08	11:12	11:30	0.30	0	0	8.4
221	09-May-08	12:30	12:53	0.40	1	1	9.9
222	12-May-08	11:08	11:31	0.38	0	0	7.0
223	12-May-08	12:14	12:36	0.37	0	0	7.5
224	12-May-08	13:19	13:43	0.39	0	0	8.9
225	13-May-08	10:57	11:19	0.38	0	0	10.9
226	13-May-08	11:52	12:14	0.38	0	0	9.2
227	13-May-08	12:58	13:20	0.36	1	3	9.9
228	14-May-08	10:50	11:12	0.38	0	0	6.7
229	14-May-08	13:20	13:43	0.38	0	0	11.6
230	14-May-08	14:42	15:05	0.38	0	0	7.3
231	14-May-08	16:03	16:25	0.36	0	0	18.1
232	16-May-08	13:45	14:09	0.39	0	0	3.6
233	16-May-08	14:57	15:19	0.36	0	0	7.8
234	16-May-08	16:05	16:28	0.39	0	0	6.7
235	17-May-08	10:32	10:54	0.38	0	0	8.8
236	17-May-08	12:00	12:23	0.39	1	1	7.0
237	17-May-08	13:11	13:34	0.38	0	0	5.3
238	19-May-08	11:58	12:23	0.42	0	0	4.1
239	19-May-08	13:13	13:37	0.40	0	0	2.7
240	19-May-08	14:34	14:58	0.39	1	1	3.2
241	24-May-08	14:33	14:57	0.40	0	0	4.9
242	24-May-08	15:57	16:19	0.37	0	0	5.9
243	25-May-08	14:48	15:11	0.37	0	0	8.9
244	25-May-08	16:04	16:27	0.38	0	0	12.8
245	27-May-08	11:26	11:48	0.36	0	0	5.9
246	27-May-08	12:30	12:52	0.37	1	1	7.5
247	27-May-08	15:18	15:42	0.39	3	3	11.7
248	29-May-08	09:15	09:39	0.41	1	1	1.9
249	29-May-08	09:41	10:05	0.41	0	0	1.9
250	29-May-08	11:38	12:03	0.42	0	0	7.0
251	29-May-08	12:55	13:18	0.38	0	0	8.0
252	29-May-08	14:02	14:23	0.35	0	0	7.0
253	29-May-08	15:19	15:42	0.38	0	0	7.0
254	29-May-08	16:30	16:54	0.40	0	0	7.0
255	29-May-08	17:28	17:50	0.38	0	0	7.0
256	30-May-08	08:28	08:52	0.39	0	0	4.8
257	30-May-08	09:37	10:01	0.40	0	0	9.2
258	30-May-08	10:48	11:12	0.40	0	0	10.9
259	30-May-08	12:02	12:23	0.35	0	0	11.2
260	30-May-08	12:59	13:21	0.38	0	0	14.0

Table 2. List of focal behavioral observations of migrating whales recorded from Yaquina Head.

Track Num.	Start Date-Time		Group size	Duration (hours)	Track Length (km)	Num. of Fixes	Average Speed (km/h)	Average Distance to shore (km)	Average Depth	Notes	Migration phase
1	2008-01-13	12:29	3	0.42	5.53	10	75.9	9.3	63		Southbound
2	2008-01-16	09:22	1	0.25	6.48	3	30.6	2.3	28		Southbound
3	2008-01-16	09:57	2	0.57	4.75	6	8.5	7.0	57		Southbound
4	2008-01-16	11:30	1	0.68	4.89	3	8.7	7.0	59		Southbound
5	2008-01-16	12:14	3	0.07	0.55	4	8.3	11.1	64		Southbound
6	2008-01-16	12:35	6	0.64	4.77	8	7.8	9.5	67		Southbound
7	2008-01-17	09:48	2	0.41	1.54	4	6.7	4.8	42		Southbound
8	2008-01-17	11:06	2	0.81	13.97	9	53.3	8.2	63		Southbound
9	2008-01-17	14:03	1	0.43	4.04	3	9.7	5.2	47		Southbound
10	2008-01-18	11:07	1	0.89	5.20	9	6.1	3.8	41		Southbound
11	2008-01-18	13:37	5	0.35	1.38	4	5.4	9.8	57		Southbound
12	2008-01-18	13:59	1	0.06	0.87	2	13.5	10.5	59		Southbound
13	2008-01-18	14:45	3	0.43	4.16	10	10.1	9.7	64		Southbound
14	2008-01-18	15:24	5	0.39	2.43	8	6.6	6.7	50		Southbound
15	2008-01-21	09:35	3	0.56	3.35	4	5.5	4.4	42		Southbound
16	2008-01-21	10:13	3	0.43	3.45	8	8.2	5.4	52		Southbound
17	2008-01-21	11:41	2	0.67	3.70	11	7.2	4.1	44		Southbound
18	2008-01-21	14:53	3	0.18	1.31	7	6.9	7.4	50		Southbound
19	2008-01-21	15:04	2	0.21	0.95	3	3.8	5.3	46		Southbound
20	2008-01-21	15:48	4	0.48	3.92	7	8.2	6.2	55		Southbound
21	2008-01-22	10:38	2	0.67	3.66	9	6.1	7.8	62		Southbound
22	2008-01-22	11:28	3	0.50	4.14	6	8.2	8.2	61		Southbound
23	2008-01-22	13:32	2	0.47	3.73	14	8.1	5.9	53		Southbound
24	2008-01-22	14:04	1	0.39	2.62	10	6.5	7.7	52		Southbound
25	2008-01-22	15:25	1	0.09	2.71	2	31.5	9.4	60		Southbound
26	2008-01-22	15:57	1	0.93	6.65	23	7.1	4.9	46		Southbound
27	2008-01-23	09:11	5	0.53	3.29	9	6.5	7.8	52		Southbound

Table 2. Continued

Track Num.	Start Date-Time	Group size	Duration (hours)	Track Length (km)	Num. of Fixes	Average Speed (km/h)	Average Distance to shore (km)	Average Depth	Notes	Migration phase
28	2008-01-23 10:18	3	1.16	7.14	23	6.5	5.2	48		Southbound
29	2008-01-23 13:49	1	0.01	0.46	3	50.8	6.1	60		Southbound
30	2008-01-23 13:55	1	0.00	0.00	1		6.4	60		Southbound
31	2008-01-23 13:57	1	0.39	3.13	4	7.4	7.4	61		Southbound
32	2008-01-23 14:26	2	0.52	3.92	19	7.8	7.8	61		Southbound
33	2008-01-23 15:36	1	0.06	8.57	3	192.3	5.6	49		Southbound
34	2008-01-24 11:34	1	0.65	5.16	4	7.8	6.3	53		Southbound
35	2008-01-25 08:46	4	1.10	6.15	20	5.3	1.9	24		Southbound
36	2008-01-25 10:33	1	0.28	1.55	3	3.2	1.3	20	Resident	
37	2008-01-25 10:57	3	2.26	15.24	32	6.8	7.2	56		Southbound
38	2008-01-25 15:19	3	0.62	2.49	7	5.7	3.2	40		Southbound
39	2008-01-25 16:24	4	0.66	4.76	21	6.9	3.5	34		Southbound
40	2008-02-04 15:31	1	0.15	1.07	5	6.6	1.0	20	Resident	
41	2008-02-23 15:05	2	1.89	12.97	32	6.2	4.9	47		Southbound
42	2008-02-24 10:25	2	0.56	3.17	8	4.6	5.4	45		Southbound
43	2008-02-24 13:00	1	1.14	5.64	15	5.2	3.0	38		Southbound
44	2008-02-24 15:11	3	1.10	7.86	25	7.1	6.4	54		Southbound
45	2008-02-25 12:31	2	1.04	6.95	11	6.9	8.5	63		Southbound
46	2008-02-26 11:51	1	0.99	5.56	9	5.3	6.7	49		Southbound
47	2008-02-26 15:01	2	1.00	5.71	21	6.0	3.2	40		Northbound-A
48	2008-03-04 11:38	4	0.22	1.24	9	5.8	8.1	52		Northbound-A
49	2008-03-04 12:04	1	1.09	7.08	20	5.3	1.9	23		Northbound-A
50	2008-03-04 14:50	1	0.28	1.08	2	3.8	3.0	35		Northbound-A
51	2008-03-05 12:05	3	1.27	6.55	76	5.4	3.7	42		Northbound-A
52	2008-03-06 11:09	3	1.55	10.07	40	6.5	4.0	40		Northbound-A
53	2008-03-06 14:51	2	1.22	7.97	23	6.6	2.5	30		Northbound-A
54	2008-03-06 16:50	1	0.18	1.26	9	6.7	2.6	35		Northbound-A

Table 2. Continued

Track Num.	Start Date-Time	Group size	Duration (hours)	Track Length (km)	Num. of Fixes	Average Speed (km/h)	Average Distance to shore (km)	Average Depth	Notes	Migration phase
55	2008-03-08 08:57	3	1.23	7.79	22	6.5	3.0	33		Northbound-A
56	2008-03-08 10:46	2	0.79	3.84	8	5.6	4.3	47		Northbound-A
57	2008-03-08 13:28	2	0.84	6.13	15	7.0	4.9	48		Northbound-A
58	2008-03-08 15:00	7	0.45	2.99	25	6.9	8.2	63		Northbound-A
59	2008-03-08 16:02	3	0.39	2.36	11	5.9	4.2	37		Northbound-A
60	2008-03-11 15:00	2	0.39	1.84	4	5.4	2.5	30		Northbound-A
61	2008-03-11 15:59	2	0.59	4.05	6	7.9	2.8	28		Northbound-A
62	2008-03-12 12:04	3	0.69	4.34	22	6.2	5.0	44		Northbound-A
63	2008-03-16 10:12	3	1.90	10.27	37	6.1	5.1	48		Northbound-A
64	2008-03-16 16:43	3	1.14	4.83	22	4.6	4.6	41		Northbound-A
65	2008-03-18 16:05	3	0.88	4.70	12	6.1	3.8	43		Northbound-A
66	2008-03-19 10:49	1	0.28	1.34	5	6.5	2.2	29		Northbound-A
67	2008-03-19 11:09	1	0.56	2.75	9	6.7	1.7	24		Northbound-A
68	2008-03-21 12:46	3	0.31	0.92	3	4.7	3.3	40		Northbound-A
69	2008-03-21 13:07	1	0.25	0.38	2	1.5	1.8	31		Northbound-A
70	2008-03-21 13:34	3	0.68	5.29	8	7.3	3.7	37		Northbound-A
71	2008-03-21 15:12	1	0.64	4.66	8	7.1	2.5	34		Northbound-A
72	2008-03-21 15:55	1	0.55	3.59	9	6.9	4.1	46		Northbound-A
73	2008-03-22 10:49	3	2.04	12.67	24	6.8	5.2	49		Northbound-A
74	2008-03-22 13:46	4	1.69	11.29	62	6.3	6.3	51		Northbound-A
75	2008-03-24 10:01	2	0.66	4.26	8	6.9	5.3	52		Northbound-A
76	2008-03-24 12:07	3	1.46	10.44	46	7.6	5.9	51		Northbound-A
77	2008-03-24 15:40	3	1.05	6.54	27	6.1	3.5	37		Northbound-A
78	2008-03-24 17:20	2	0.40	2.38	13	6.1	4.2	41		Northbound-A
79	2008-03-25 09:39	2	0.70	3.80	11	6.3	5.6	51		Northbound-A
80	2008-03-30 13:59	1	0.49	2.65	8	5.2	2.4	34		Northbound-A
81	2008-03-30 15:07	2	0.94	5.24	26	6.1	5.6	51		Northbound-A

Table 2. Continued

Track Num.	Start Date-Time		Group size	Duration (hours)	Track Length (km)	Num. of Fixes	Average Speed (km/h)	Average Distance to shore (km)	Average Depth	Notes	Migration phase
82	2008-03-31	10:01	3	0.55	2.86	7	6.5	7.4	61		Northbound-A
83	2008-03-31	12:12	2	2.07	12.04	24	6.2	5.8	53		Northbound-A
84	2008-04-01	08:55	5	1.61	8.58	72	5.9	7.0	58		Northbound-A
85	2008-04-01	11:19	1	1.01	4.57	11	4.7	1.2	19		Northbound-A
86	2008-04-03	08:55	2	2.17	15.92	19	7.2	3.2	37		Northbound-A
87	2008-04-03	12:06	2	1.42	10.98	19	7.1	4.3	45		Northbound-A
88	2008-04-07	13:31	2	1.78	3.46	4	4.3	5.9	54		Northbound-A
89	2008-04-08	11:46	2	1.95	12.59	34	6.4	5.8	52		Northbound-A
90	2008-04-08	14:24	3	1.96	12.44	47	6.4	6.3	54		Northbound-A
91	2008-04-09	12:49	3	1.46	8.47	37	6.0	3.8	42		Northbound-A
92	2008-04-10	10:15	1	0.94	6.03	13	6.2	2.2	24		Northbound-A
93	2008-04-10	13:44	3	1.57	7.97	47	5.0	3.4	34		Northbound-A
94	2008-04-10	16:59	2	1.11	5.14	26	5.3	1.3	18	Cow/calf	Northbound-B
95	2008-04-11	09:34	3	1.62	8.21	26	5.6	7.2	59		Northbound-B
96	2008-04-11	12:03	1	1.39	5.77	19	4.2	3.0	38		Northbound-B
97	2008-04-12	12:58	1	0.98	4.53	12	5.2	3.6	43		Northbound-B
98	2008-04-15	10:44	3	1.47	7.09	28	5.9	6.8	58		Northbound-B
99	2008-04-15	12:53	1	0.11	1.17	3	10.0	3.2	29		Northbound-B
100	2008-04-16	11:26	1	0.77	4.16	4	5.8	4.5	42		Northbound-B
101	2008-04-16	12:44	3	2.05	14.54	58	6.7	3.3	36		Northbound-B
102	2008-04-17	09:13	2	1.99	9.64	48	4.7	4.0	43		Northbound-B
103	2008-04-25	10:02	3	0.29	1.19	3	4.1	2.0	17		Northbound-B
104	2008-04-25	10:28	1	0.06	1.43	7	28.4	2.0	17		Northbound-B
105	2008-04-26	14:33	2	1.45	8.05	20	5.8	1.4	18	Cow/calf	Northbound-B
106	2008-04-27	10:15	1	0.83	6.60	5	7.4	1.5	14	Resident	
107	2008-04-25	11:02	1	0.97	3.02	19	2.6	0.4	14	Resident	
108	2008-04-30	12:47	2	0.32	2.22	7	6.8	2.7	35	Cow/calf	Northbound-B

Table 2. Continued

Track Num.	Start Date-Time		Group size	Duration (hours)	Track Length (km)	Num. of Fixes	Average Speed (km/h)	Average Distance to shore (km)	Average Depth	Notes	Migration phase
109	2008-04-30	14:44	1	1.55	3.50	9	3.3	0.8	16	Resident	
110	2008-05-02	10:20	2	0.45	1.79	4	5.3	1.9	16		Northbound-B
111	2008-05-02	14:58	1	0.56	2.89	11	5.4	0.7	15		Northbound-B
112	2008-05-09	12:59	1	2.01	9.90	27	4.7	2.4	28		Northbound-B
113	2008-05-12	14:04	1	1.49	6.17	8	4.2	1.3	15		Northbound-B
114	2008-05-13	13:24	2	0.26	1.87	4	7.8	1.4	12		Northbound-B
115	2008-05-14	11:40	2	1.29	5.72	12	5.0	0.8	14	Cow/calf	Northbound-B
116	2008-05-14	15:19	2	0.53	2.14	12	4.9	0.8	16	Cow/calf	Northbound-B
117	2008-05-17	10:56	3	1.03	6.26	19	5.8	0.9	15		Northbound-B
118	2008-05-19	12:27	1	0.46	2.66	13	6.1	0.7	17		Northbound-B
119	2008-05-19	15:08	1	1.65	8.27	13	4.8	2.3	28		Northbound-B
120	2008-05-27	12:58	1	2.10	7.01	111	3.4	1.1	14	Resident	

Distance from the observation station to location of whales sighted during scan surveys ranged from 0.23 to 17.29 km ($\bar{x}$ = 6.80 km, n = 460). Significant differences (F = 33.92, $p < 0.01$) were observed in the average distance to shore of whale locations recorded during the different migration phases (Figures 3-6). Average distance from shore during the southbound migration was 6.59 km (S.D. = 0.200, n = 139). During phase A of the northbound migration, whales were sighted at an average of 5.08 km from shore (S.D. = 0.155, n = 230), while during phase B the average distance from shore was 4.08 km (S.D. = 0.247, n = 91).

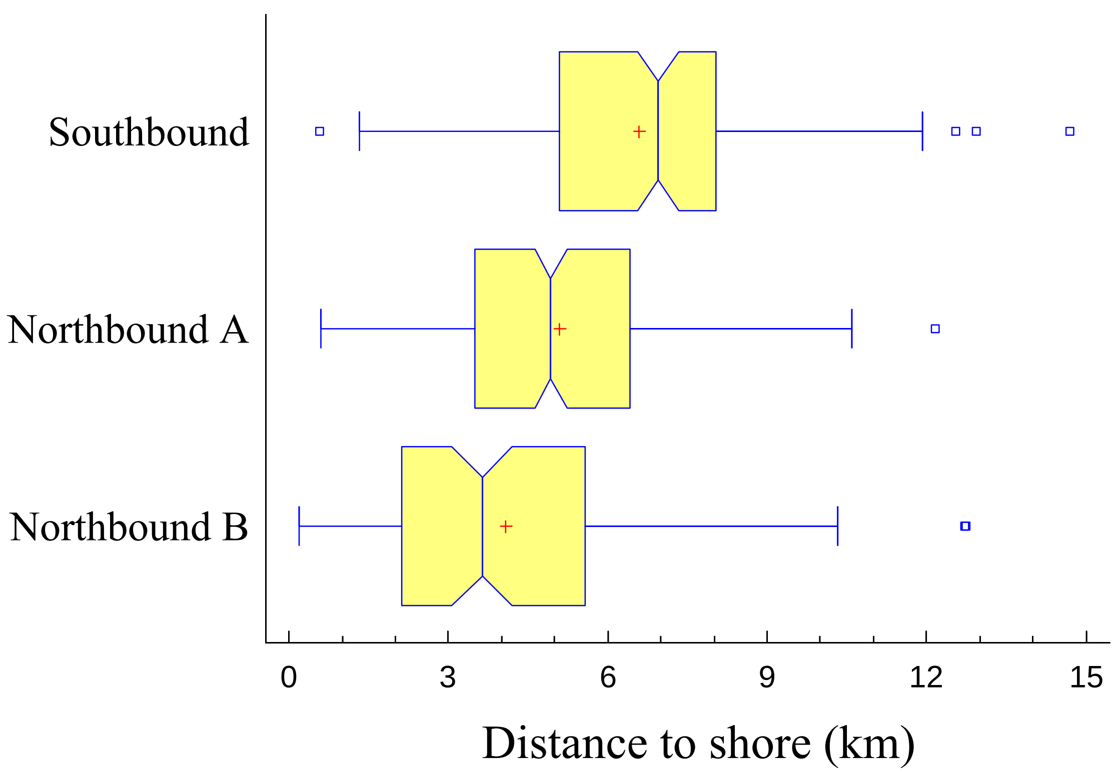

Figure 3. Box plot of distance from shore for gray whale locations recorded during the different migration phases. Average values are indicated by a cross. Boxes represent the interquartile range, the notch indicates the median value. Outlier values are indicated by squares.

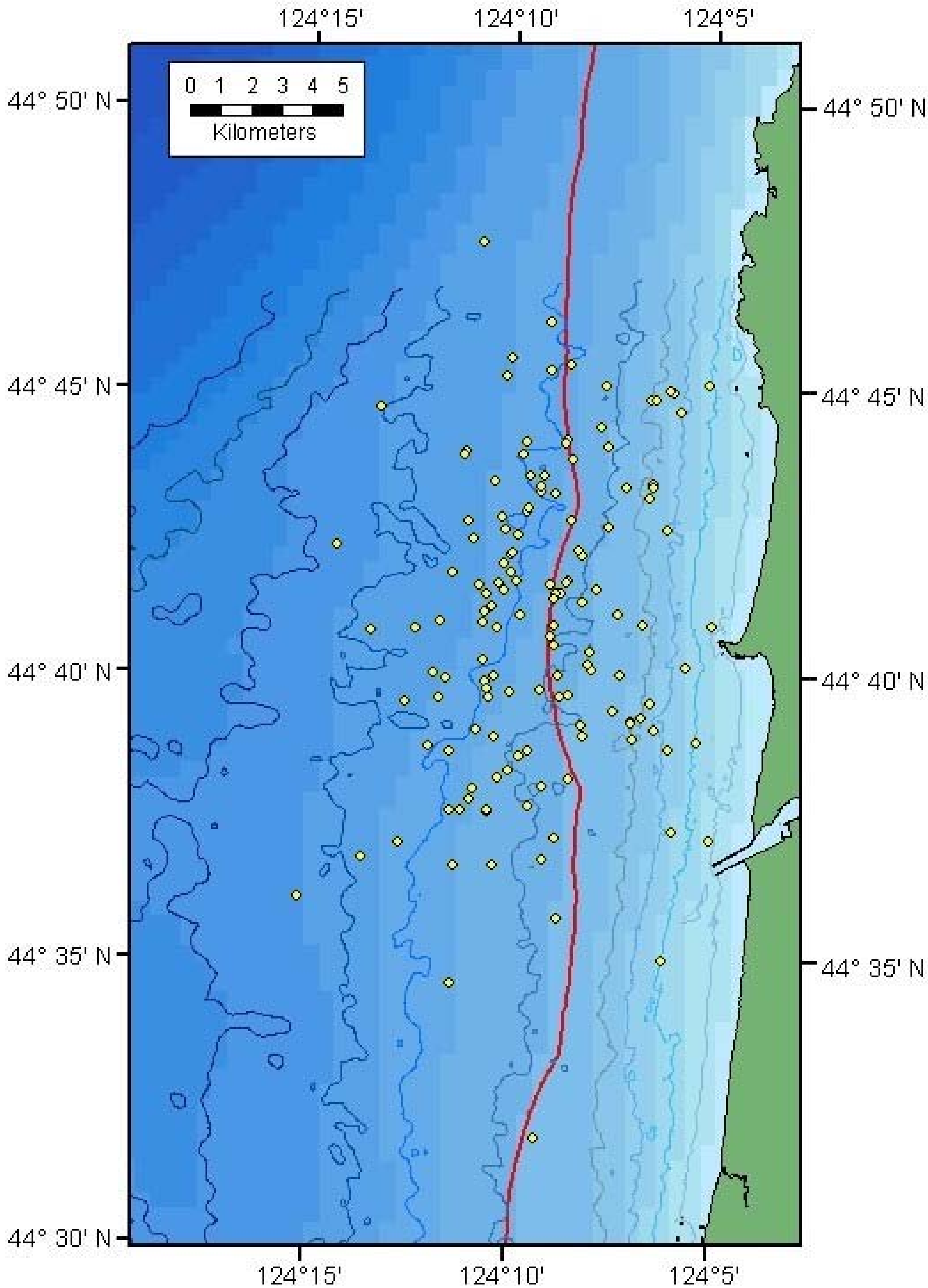

Figure 4. Locations of gray whale groups (yellow circles) observed on scan surveys off Yaquina Head during the southbound migration (December 27, 2007 – February 25, 2008). Contours indicate 10-18 meter isobaths (every 10 meters). The red line is the boundary of the State of Oregon territorial sea.

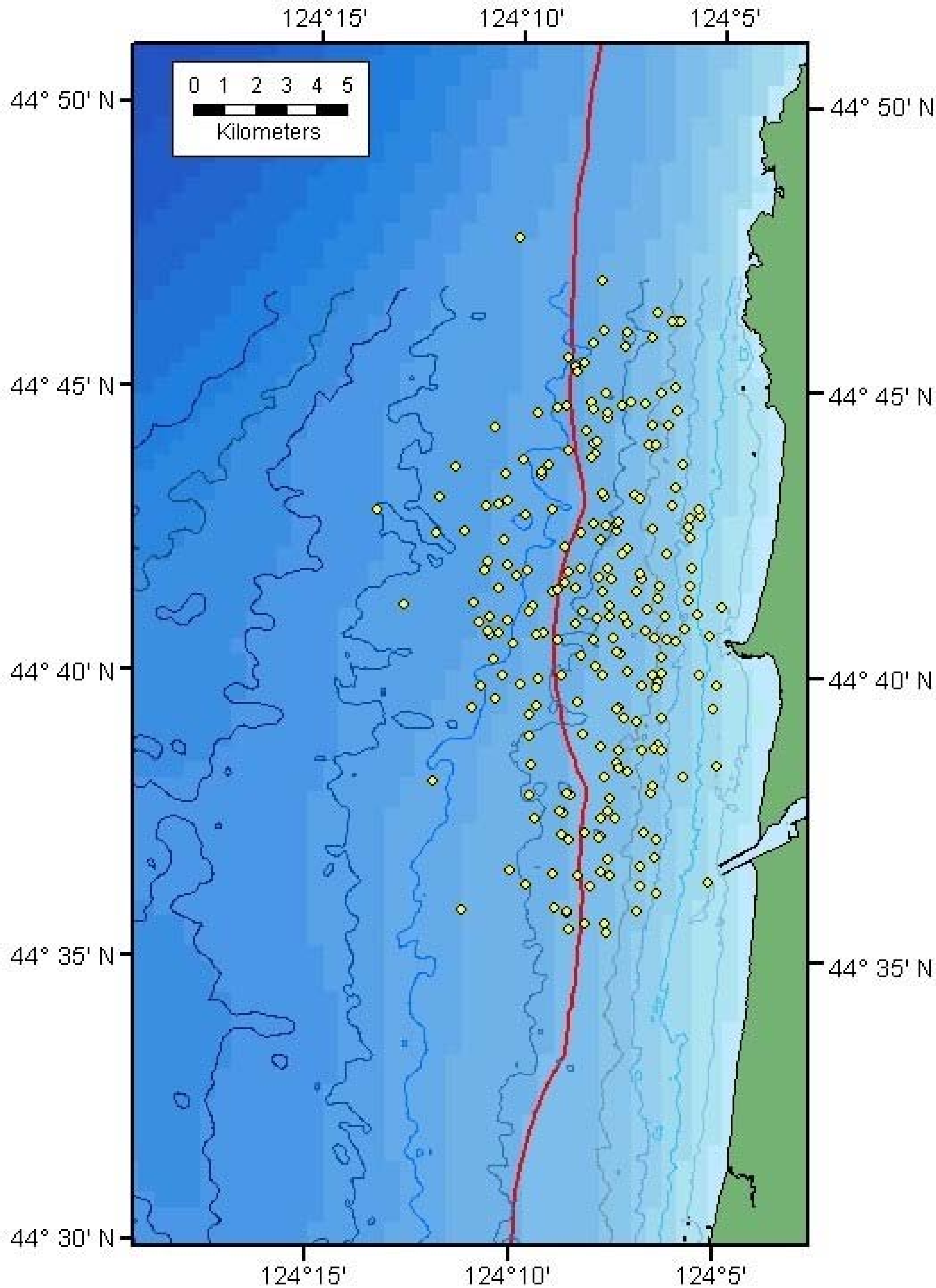

Figure 5. Locations of gray whale groups (yellow circles) observed on scan surveys off Yaquina Head during phase A of the northbound migration (February 26 – April 7, 2008). Contours indicate 10-18 meter isobaths (every 10 meters). The red line is the boundary of the State of Oregon territorial sea.

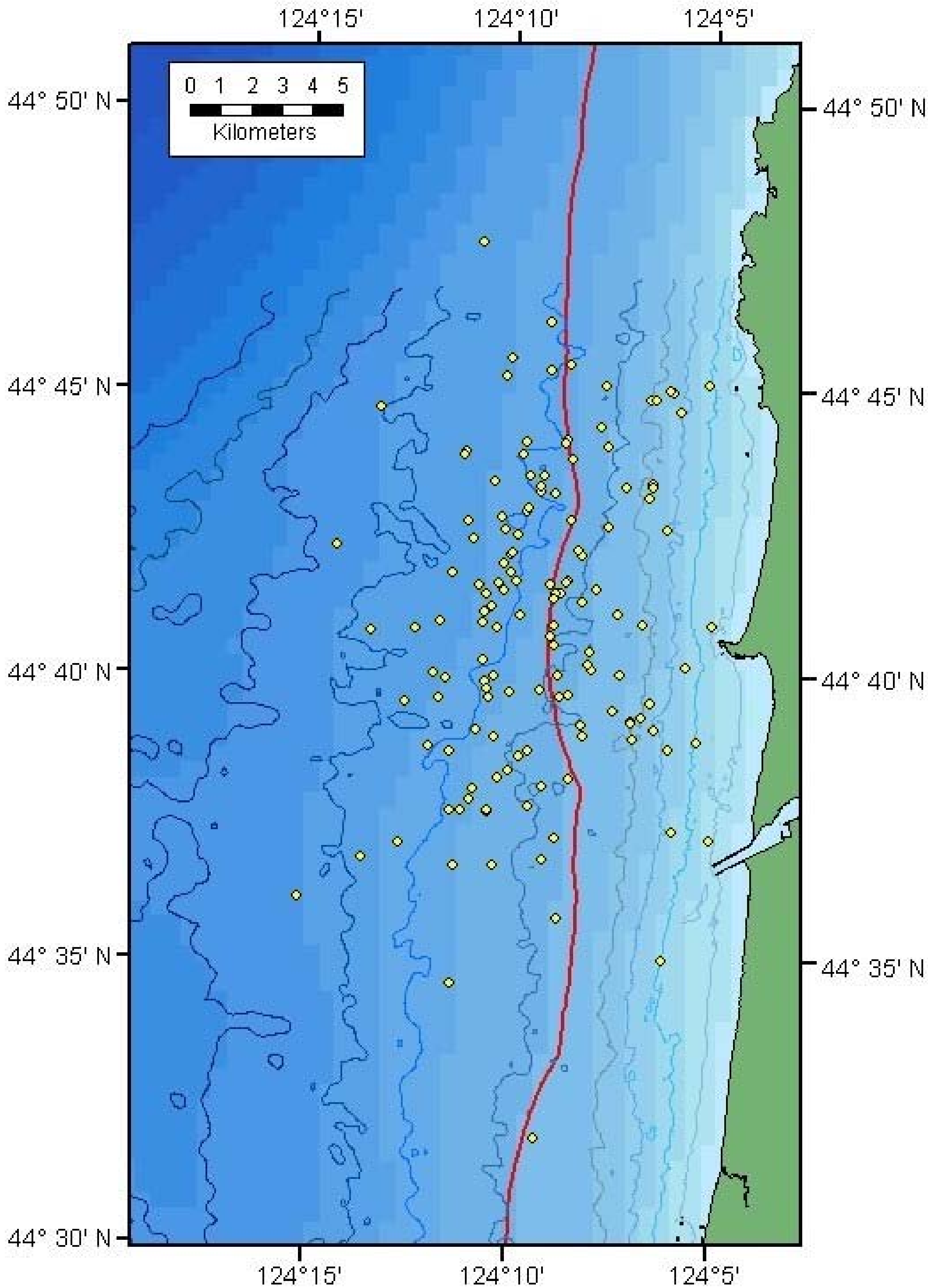

Figure 6. Locations of gray whale groups (yellow circles) observed on scan surveys off Yaquina Head during phase B of the northbound migration (April 7-May 29, 2008). Contours indicate 10-18 meter isobaths (every 10 meters). The red line is the boundary of the State of Oregon territorial sea.

Gray whale locations recorded during scan sampling events occurred in a bottom depth range of 12 – 75 meters. Average bottom depth at location of whale sightings was 46.3 m (S.D. 13.70). Similar to the differences in distance to shore, significant differences (Kruskal-Wallis Test statistic = 61.1, p = 0.0) were observed in median bottom depth of whale sighting location between the three migration phases (Fig. 7).

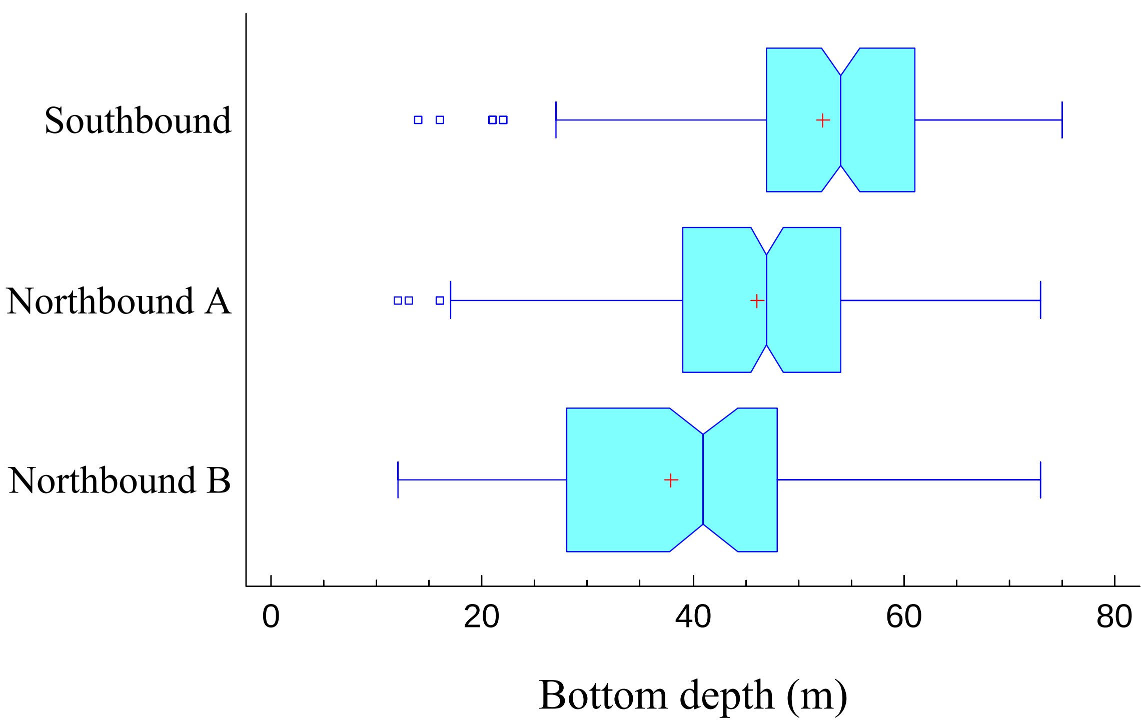

Figure 7. Box plot of bottom depth at gray whale locations recorded during the different migration phases. Average values are indicated by a cross. Boxes represent the interquartile range, the notch indicates the median value. Outlier values are indicated by squares.

Gray whales observed during this study migrate within the Oregon territorial sea, particularly during the northbound migration (Table 3). Migratory paths of some, but not all whales, pass by through areas of currently proposed wave energy development.

Table 3. Proportion of whale locations (scan survey data) inside and outside the Oregon territorial sea (OTS) during the different migration phases.

Migration phase	**Number of locations**	**Inside OTS**		**Outside OTS**	
Southbound	139	57	41.0%	82	59.0%
Northbound - Phase A	230	155	67.4%	75	32.6%
Northbound - Phase B	91	71	78.0%	20	22.0%
Total	460	283	61.5%	177	38.5%

Behavioral observations

Distance from the observation station to tracked whales ranged from 0.28 to 13.56 km ($\bar{x}$ = 5.02 km, *n* = 1956). Out of the 120 focal observations, only 110 tracked whales had enough data to conduct further behavior analysis. Significant differences were observed in the average speed of gray whales tracked during the different migration phases (*F* = 8.04, *p* = 0.0006, Fig. 8). Average speed of tracked whales was 6.74 km/h (S.D.= 1.382, *n* = 37) during the southbound migration, 6.05 km/h (S.D.= 1.094, *n* = 47) during phase A of the northbound migration, and 5.42 km/h (S.D.= 1.529, *n* = 26) during phase B. The migration paths of tracked whales are shown in figures 9-11.

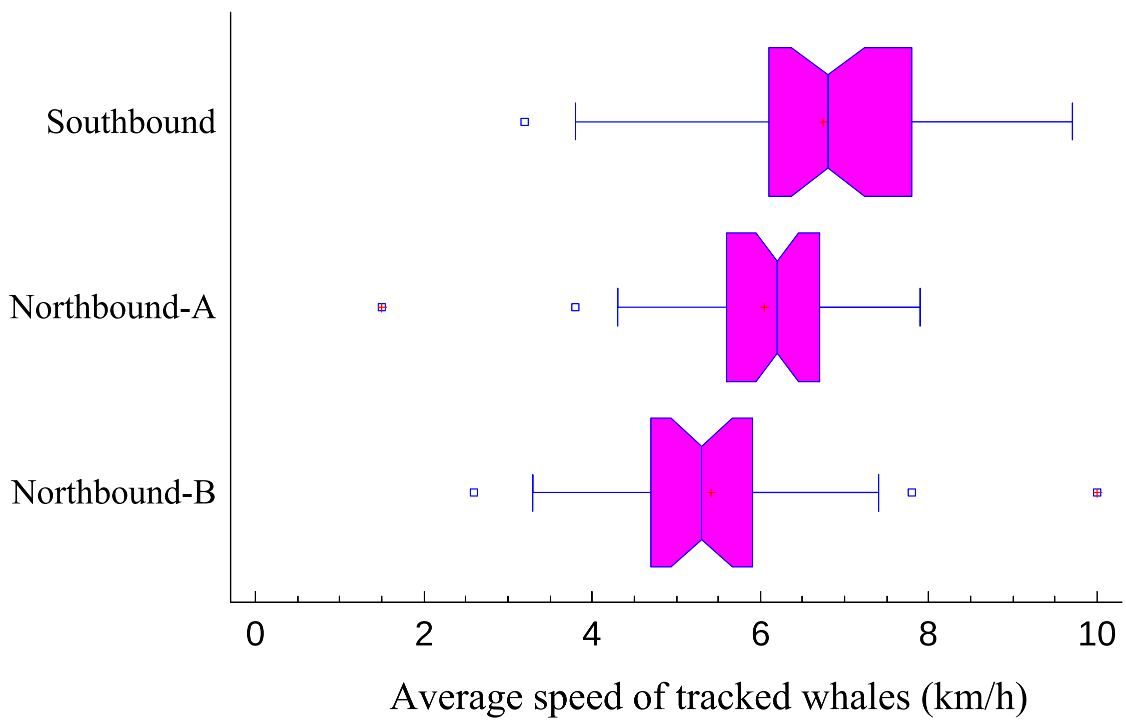

Figure 8. Box plot of speed of gray whales tracked during the different migration phases. Average values are indicated by a cross. Boxes represent the interquartile range, the notch indicates the median value. Outlier values are indicated by squares.

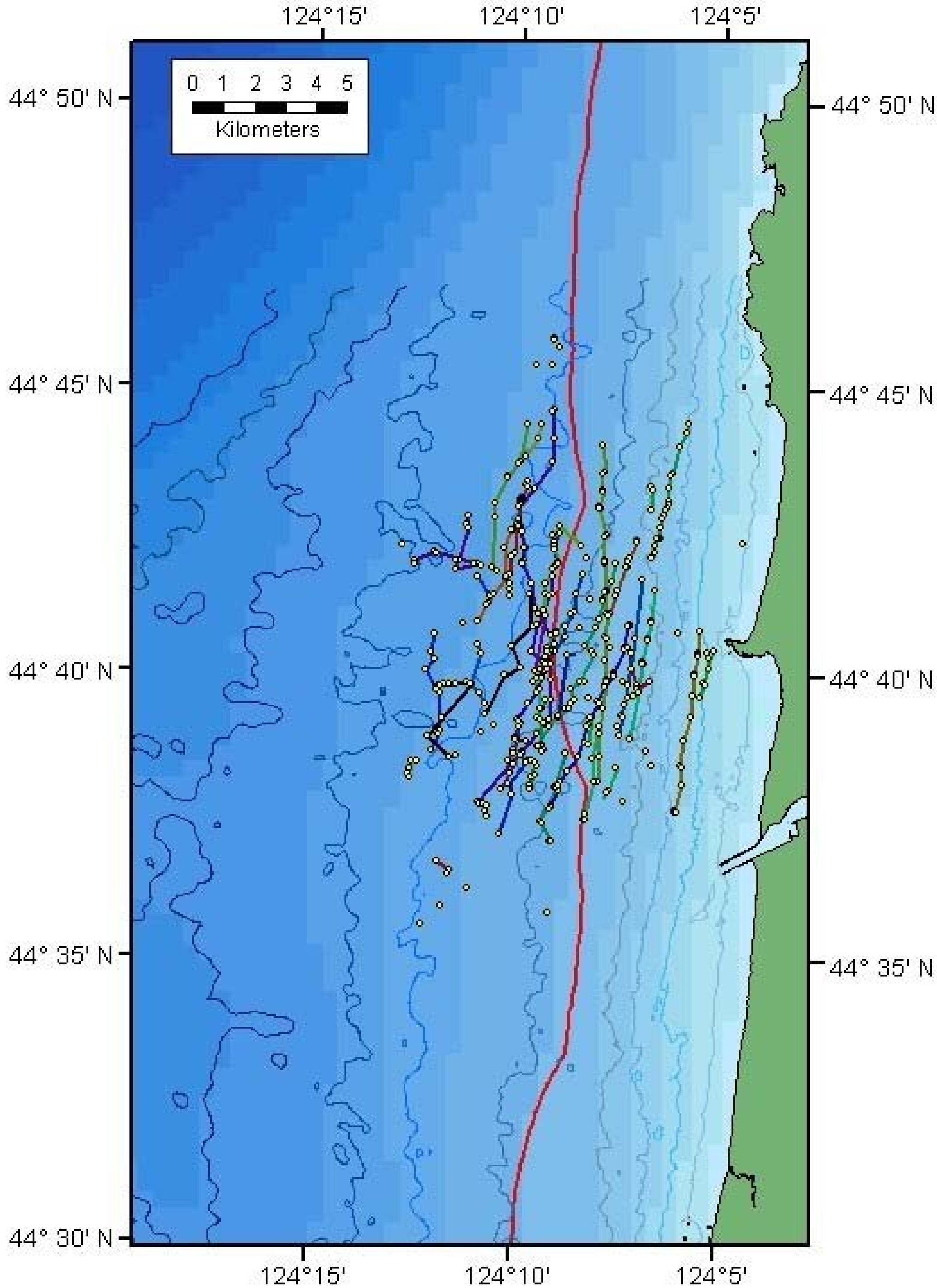

Figure 9. Migration path of gray whales tracked off Yaquina Head during the southbound migration (January 13-February 25, 2008). Contours indicate 10-18 meter isobaths (every 10 meters). The red line is the boundary of the State of Oregon territorial sea.

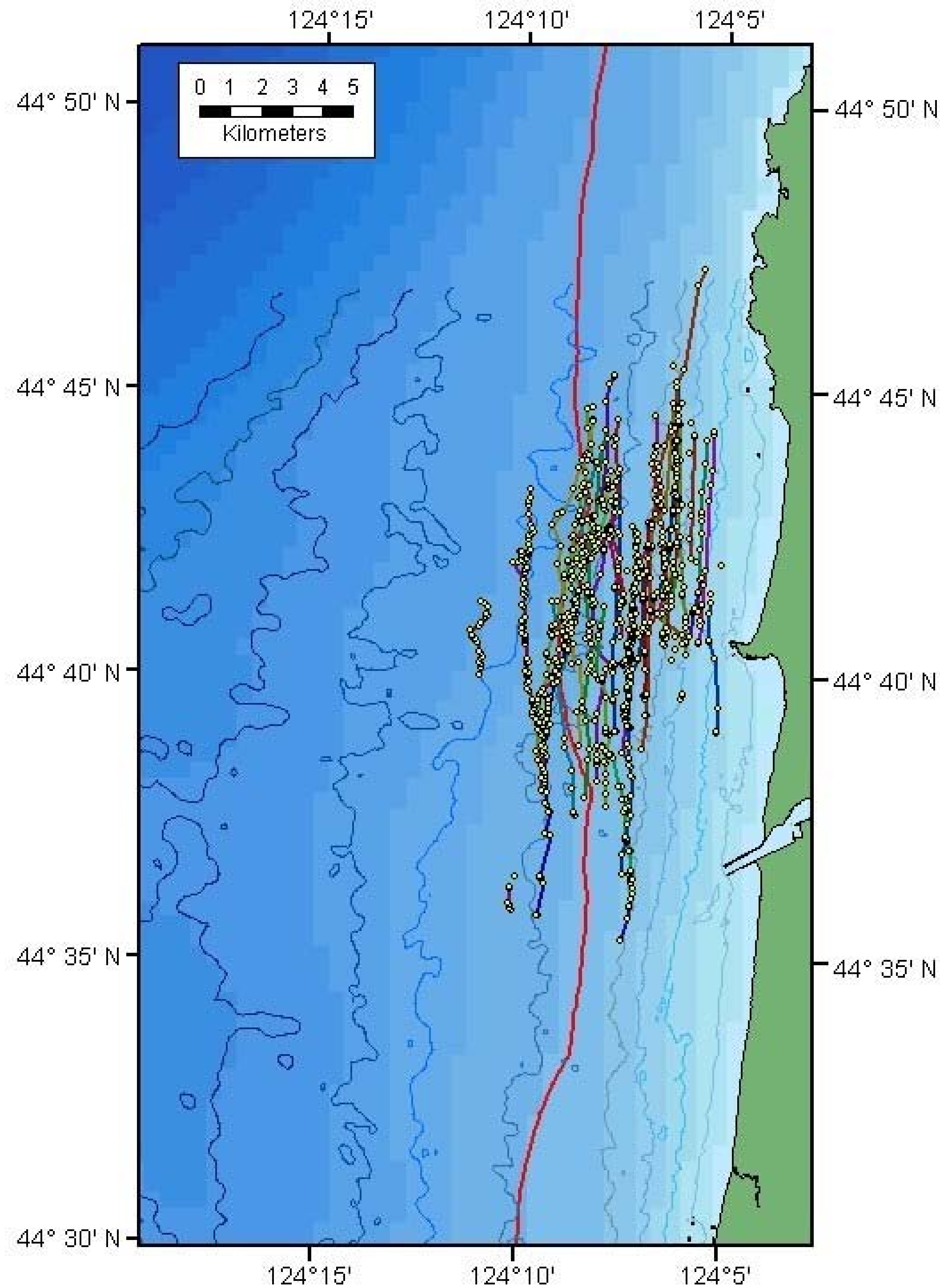

Figure 10. Migration path of gray whales tracked off Yaquina Head during the phase A of the northbound migration (February 26-April 7, 2008). Contours indicate 10-18 meter isobaths (every 10 meters). The red line is the boundary of the State of Oregon territorial sea.

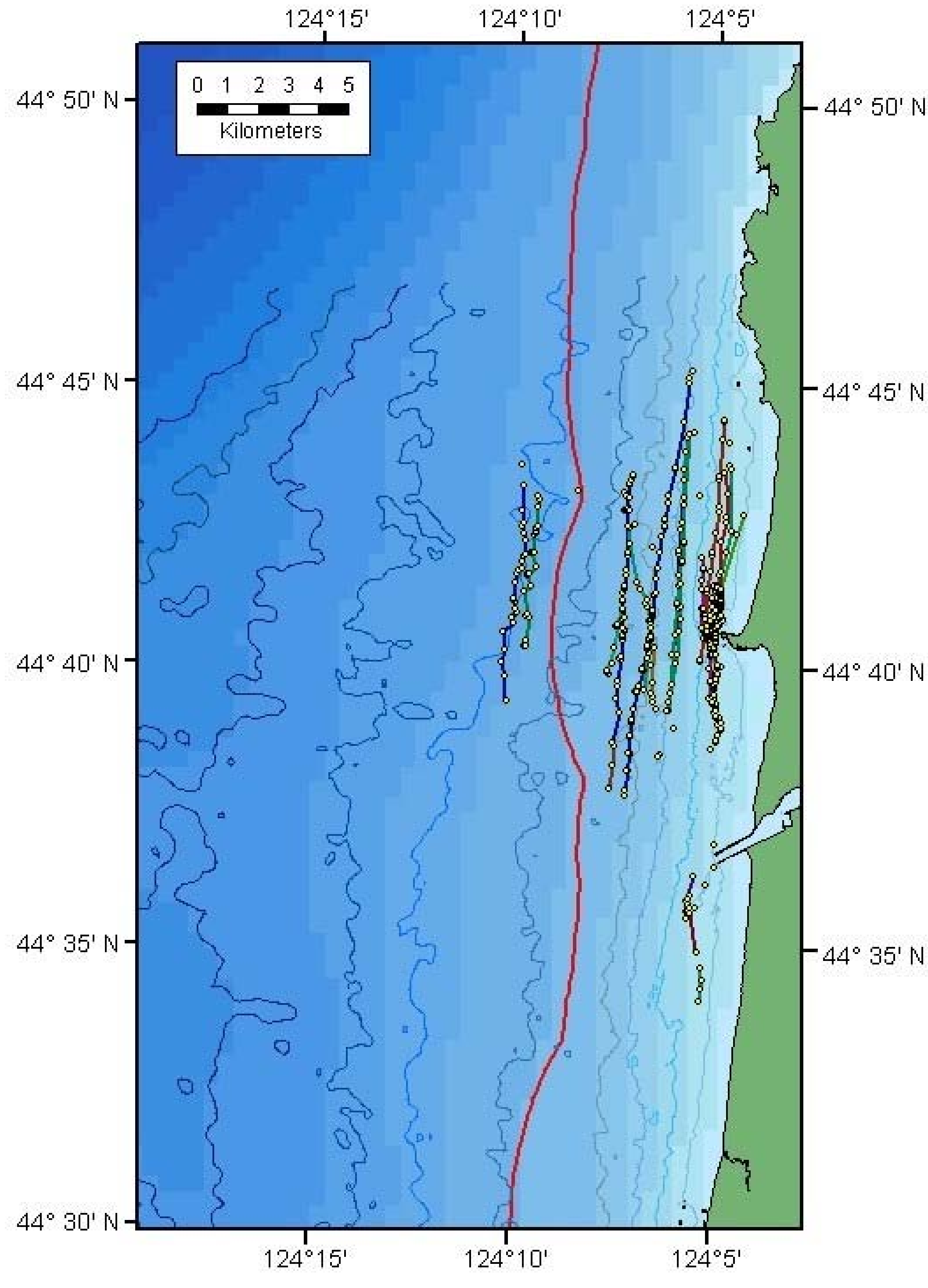

Figure 11. Migration path of gray whales tracked off Yaquina Head during phase B of the northbound migration (April 7-May 29, 2008). Contours indicate 10-18 meter isobaths (every 10 meters). The red line is the boundary of the State of Oregon territorial sea.

Discussion

This study presents up to date results on the migratory behavior of gray whales along the central Oregon coast. These results are in accordance with previous studies (e.g. Herzing and Mate 1984, Green *et al.* 1995) and add quantitative measurements of behavior that can be used as a baseline for future monitoring studies.

Shore-based observations are limited to the field of view, which is determined by distance to the horizon and obstructions in the area. The observation station at Yaquina head has an acceptable 180º field of view, with no obstructions and horizon estimated to be approximately 18 km (10 nautical miles). Gailey *et al.* (2007) limited their behavioral observations to within 4 km of their observation platforms which had a maximum height above sea level of 16 m. We conducted calibration tests by fixing a boat with the theodolite and comparing the location estimated by Pythagoras to the boat's GPS reading. At a distance of 7.6 km, the difference between the theodolite fix and the GPS was 232 m. Therefore, we consider that the elevation at Yaquina Head (26.9 m above mean sea level) allow reliable observations up to 8 km away from the station. Details about theodolite fixing related errors are discussed in Würsig *et al.* (1991). While limitations of the field of view at Yaquina Head are relevant for census studies (Green *et al.* 1995), we think that the coverage is appropriate for behavioral studies within the Oregon territorial sea. The 8 km from the station criterion was applied when choosing whales to be tracked and is reflected in a lower number of tracks further offshore, particularly during the northbound migration. The bias to track whales closer to the station must be considered before drawing conclusions from tracking location data. That is the reason why distance to shore, depth and percentage of locations within the Oregon territorial sea are only analyzed for scan sampling locations.

Some tracklines had very high speed estimates which were likely the result of theodolite fix errors. This problem was more prevalent during the first two months of the study as observers became familiar with the method. Nevertheless, the majority of the tracking data during the northward migration produced speed estimates well within the range of values reported in previous studies (*e.g.* Harvey and Mate 1984, Mate and Urban-Ramirez 2003).

The migration paths of tracked whales seem to follow a constant depth (isobath) rather that following exactly the shoreline. For example, some whales that we started tracking more than 3 kilometers away from the observation point maintained a straight path even as they approached Yaquina Head. Linearity of their path continued as they moved away from the Head. Nevertheless, we observed variability in the isobath followed by different whales within the same migration phase. Green *et al.* (1995) also observed this variability and mention that the migration corridor off the Oregon and Washington coasts is seasonally and annually "elastic".

Our results indicate that, as expected, the migration paths of some gray whales cross through areas of proposed wave energy development. Deployment of structures for wave energy farms (buoys, cables, mooring systems, etc.) in the migratory path of gray whales raises the possibility of collision, entanglement or displacement of the whales (Boehlert *et al.* 2008). Future observations can use the data presented here as a baseline to determine potential effects of wave energy farms on the migratory path of gray whales off the Oregon coast.

Acknowledgements

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ATTACHMENT 2

REPORTING PROTOCOL FOR INJURED OR STRANDED MARINE MAMMALS

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REPORTING PROTOCOL FOR INJURED OR STRANDED MARINE MAMMALS

NMFS Protected Resources Division provided the Company with the following protocol for reporting injured or stranded marine mammals (email from Bridgette Lohrman, NMFS, dated April 7, 2008). ODFW indicated its support of this protocol (email from Ken Homolka, ODFW, dated April 11, 2008)

Live marine mammals observed at sea.
The Platform of Opportunity Program (POP) is administered by the National Marine Mammal Laboratory. If interested in training or to obtain standardized reporting forms for reporting sighting data contact Sally Mizroch at (206) 526-4030.

Live marine mammals 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 are for the most part non-existent in Oregon. Therefore we recommend that monitors record the sighting as part of the monitoring report. The data should include; 1) species or common name or animal involved; 2) date of observation; 3) location (lat/long in decimal degrees); description of injuries or unusual behavior observed.

Live marine mammals 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. 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 towing gear give direction of travel and current speed; 6) local weather conditions (sea state, wind speed and direction). The disentanglement network will determine whether or not a response can be mounted immediately and will advise the reporting vessel on next steps.

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

Dead protected species found entangled or otherwise impinged at the project.
These should be reported as part of the monitoring report to NMFS 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 the buoy 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. Note: If listed species are entangled, injured or killed at the project the applicant should request re-initiation of consultation.

Reedsport OPT Wave Park, LLC.
Reedsport OPT Wave Park
FERC No. 12713

Issue Assessment
EMF
May 6, 2010

The Company has filed with FERC a License Application for a 35-year license to develop and operate the Project. The Project would consist of deployment and operation of 10 PowerBuoy® wave energy converters (WEC) having a total capacity of 1.5 megawatts (MW), to be located approximately 2.5 miles (4 kilometers) off the coast of Gardiner in Douglas County, Oregon (Figure 1). The ½-mile-by-½-mile (0.25 square miles) Project area represents the area within which the 10-PowerBuoy array would be deployed. The actual footprint of the constructed array is expected to be only about 1,000 feet by 1,300 feet (300 meters by 400 meters) or approximately 30 acres (0.05 square miles), excluding the navigation safety zone. The PowerBuoys will be deployed in an array of three rows, approximately in a northeast-southwest orientation and in an oblique orientation to the beach. Two rows will consist of three PowerBuoys, and one row will consist of four PowerBuoys (Figures 2 and 3). The Company plans to deploy the 10-PowerBuoy array during the summer of 2011. Prior to that, the Company also plans to install a single PowerBuoy in 2010, which will not be grid connected.

After issuance of the FERC License and prior to the deployment of additional PowerBuoys, the Company may install a transmission cable to collect data on the operation of a single PowerBuoy with a transmission cable. It is anticipated that this will be a brief period prior to the summer 2011 installation of the additional PowerBuoys. Availability of construction vessels in the Pacific Northwest will be one of the factors considered in making the determination regarding cable deployment. The Aquatic Resources and Water Quality Implementation Committee shall be consulted under the Adaptive Management Process in the event that connection of the cable to the single PowerBuoy is selected by the Company in advance of the array deployment.

1.0 Description of Issue

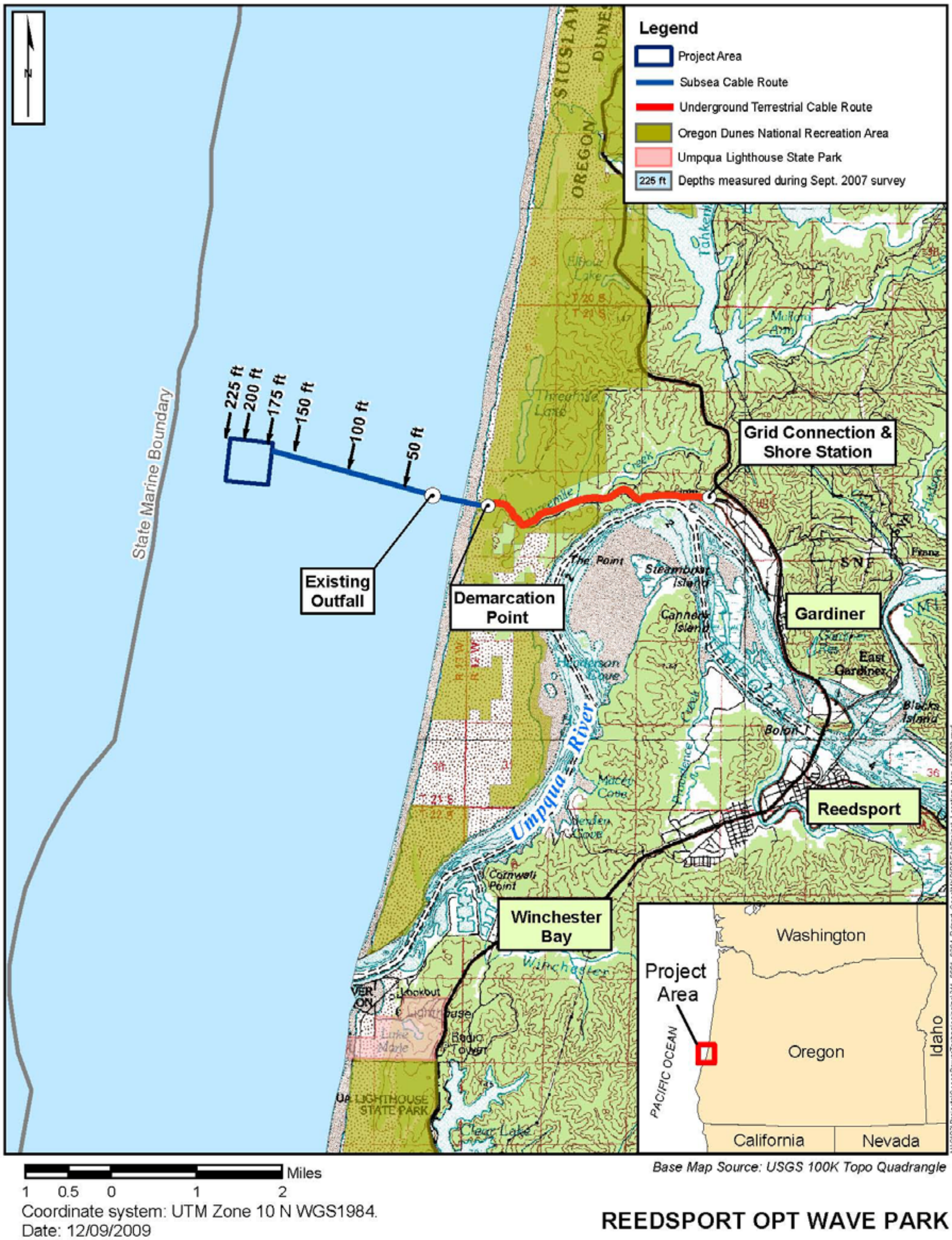
The Aquatic Species Subgroup and other stakeholders have raised the issue of the potential effects of the electromagnetic field (EMF) generated by subsea transmission cables and PowerBuoys on marine life, with particular concern expressed regarding elasmobranches, adult and juvenile salmon (*Oncorhynchus* spp.), green sturgeon (*Acipenser medirostris*), Dungeness crab (*Cancer magister*), and plankton. Specific concerns have been raised that EMF generated by the Project may disrupt migration or cause disorientation of salmon. Surfers and fishermen have expressed concern that the EMF may attract sharks (an electro-sensitive species). Agency staff are concerned that the Project differs from traditional sources of anthropogenic EMF in the ocean (underwater power cables). Specifically, agency staff noted that instead of a single cable lying on or under the seabed, the proposed Project represents 10 PowerBuoys and associated cables running through the entire water column before running along the seabed to connect with the subsea pod. There is therefore an identified need to further quantify EMF frequencies and field levels around the Reedsport Project components and to compare levels to known thresholds for species of concern.

2.0 Relevant Existing Information

2.1 Introduction

EMF originates from both natural and anthropogenic sources. Natural sources include the earth's magnetic field and different processes (biochemical, physiological, and neurological) within organisms. Marine animals are also exposed to natural EMF caused by sea currents traveling through the geomagnetic field. Human created sources of EMF emissions include radio and TV transmitters, radar and submarine telecommunications (fiber optic and coaxial), and

FIGURE 1
PROJECT LOCATION MAP



power cables. These cables are numerous and have been in use for many years all over the world.

EMF consists of both electric (E) and magnetic (B) field components. B fields have a second induced component, a weak electric field, referred to as an induced electric (iE) field. The iE field is created by the flow of seawater or movement of organisms through a B field. The strength of both fields (E and B) depends on the magnitude and type of current flowing through the cable and the construction of the cable. In addition, shielding of the cable can reduce or eliminate E fields.

Some animals have specialized organs to sense EMF, which allow for prey detection and ocean navigation. Members of the elasmobranch family can sense the weak E fields that emanate from their prey's muscles and nerves during muscular activities such as respiration and movement (Sound & Sea Technology Ocean Engineering [Sound & Sea] 2002). Organisms that can detect magnetic fields or B fields are presumed to do so by either iE field detection or magnetite-based detection. iE fields are detected either passively (where the animal senses the iE fields produced by the interaction between ocean currents with the vertical component of the earth's magnetic field) or actively (where the animal senses the iE field it generates by its own interaction in the water with the horizontal component of the Earth's magnetic field) (Paulin 1995; von der Emde 1998). The majority of these species are in the subclass Elasmobranchii. Magnetite plays an important role in geomagnetic field detection in a relatively large variety of organisms (Kirschvink 1997), although the process is still being researched (Lohmann and Johnsen 2000). 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). While data on B fields are limited, the ability of many organisms to detect magnetic fields suggests that potential interactions between B field and organisms could occur from the cellular to behavioral level (Gill et al. 2005). However, detection does not automatically translate to effect. ODFW noted (comments dated September 4, 2008) that fishermen of crustaceans (crabs, shrimp, etc.) have reported differences in fishing with different configurations of metals (e.g. new pots, exposed metals, zincs, etc.). Neither ODFW nor the Company has been able to find any documented basis for this, and it is not known if the reported attraction of crustaceans to metal would be relevant to EMF emitted from power production.

2.2 EMF Effects on Species of Concern

Below are summaries of the responses to EMF by species of particular concern in this study: elasmobranches, adult and juvenile salmon, green sturgeon, Dungeness crab, and plankton.

- **Elasmobranchs** - Elasmobranchs (sharks, skates, and rays), the majority of electroreceptive species, are physiologically adapted to detect E fields for the purpose of prey foraging through electro-receptors located in their Ampullae of Lorenzini. Sharks are known to use a hierarchical sense response for prey detection with sight, hearing, and particularly smell predominating at a distance, and electroreception taking a major role in the final 20 to 30 cm of a reaction to a stimulus source (Gill & Taylor 2001). This means that the E field sense is highly tuned for the final stages of feeding or detecting other animals (Gill et al. 2005).

  Elasmobranchs are capable of detecting artificial bioelectric fields as weak as 0.5 microvolts per meter (μV/m) (Kalmijn 1971; Murray 1974; Boord and Campbell

1997). Gill & Taylor (2001) found that the lesser spotted dogfish (*Scyliorhinus canicula*, also called small-spotted catshark) were attracted to an E field of 10 µV/m at a distance of 0.1 meters, which is similar to bioelectric fields emitted by dogfish prey. In the same experiment, Gill and Taylor found that dogfish avoided constant E fields of 1,000 µV/m. Valberg (2005) found that the AC frequency range of a shark's E field receptors is less than or equal to 1/8 to 8 Hz, with no demonstrated sensitivity around 50 to 60 Hz range (the frequency for AC E fields associated with the power transmission cables is 60 Hz).

The electric fields (iE fields) generated by sea currents interacting with the earth's B field can be sensed by elasmobranchs (Scottish Executive 2007). Sharks can similarly create an iE field (range 5 to 50 µV/m) around their bodies as they swim through the earth's magnetic field. This iE field may allow them to detect their magnetic compass headings (Scottish Executive 2007).

The sandbar shark (*Carcharhinus plumbeus*) and the scalloped hammerhead (*Sphyrna lewini*) have been shown, through behavioral experiments, to detect localized B fields of 25 to 100 micro-Tesla (µT) (Meyer et al. 2004). This study provides evidence that elasmobranchs can detect local changes in B field emissions against the earth's background geomagnetic field.

Elasmobranchs likely to be present in the Project area include big skate (*Raja binoculata*), soupfin shark (*Galeorhinus galeus*), and dogfish (*Sqalus acanthias*). White shark (*Carcharodon carcharias*), longnose skate (*R. rhina*), California skate (*R. inornata*), sandpaper skate (*Bathyraja kincaidii*), and Pacific electric ray (*Torpedo californica*) may also occur in the area.

- **Pacific Salmon** - Research has suggested that there are several potential mechanisms that Pacific salmon use for navigation, including orienting to the earth's magnetic field, utilizing a celestial compass (sun and moon), and using the odor of their natal stream to migrate back to their original spawning grounds (Groot and Margolis 1998; Quinn et al. 1981). Crystals of magnetite have been found in four species of Pacific salmon, though not in sockeye salmon (Mann et al. 1988; Walker et al. 1988). These magnetite crystals are believed to serve as a compass that orients to the earth's magnetic field. 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) further conclude that while salmon can apparently detect B fields, their behavior is likely governed by multiple stimuli as demonstrated by the ineffectiveness of artificial B field stimuli. These results were also demonstrated in studies conducted on another salmonid, Atlantic salmon (*Salmo salar*). Results of research of effects of EMF showed that navigation and migration of Atlantic salmon is not expected to be impacted by the magnetic field produced by an underwater cable (Scottish Executive 2007).

The primary Pacific salmon of concern that occur in the Project area are Chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*). There are a variety of stocks of these species that pass offshore of Oregon in the Pproject area. Threatened or endangered stocks are of particular interest and include southern Oregon/northern

California coast coho, Oregon Coast coho, Lower Columbia River coho, Lower Columbia River Chinook, Upper Columbia River Spring-run Chinook, Snake River Spring/summer-run Chinook, and Snake River fall-run Chinook Salmon. Steelhead (*O. mykiss*) and cutthroat trout (*O. clarkia*) originating from the Umpqua River may also pass through the Project area.

- **Green Sturgeon** - Green sturgeon (*Acipenser medirostris*) are a long-lived, slow-growing fish and the most marine-oriented of the sturgeon species. Although they are members of one of the oldest classes of bony fishes, the skeleton of sturgeons is composed mostly of cartilage. Like elasmobranchs, sturgeons are weakly electric fish that can utilize electroreceptor senses, as well as others, to locate prey. In the one report related to Sterlet sturgeon (*Acipenser ruthenus*) and Russian sturgeon (*A. gueldenstaedtii*) behavior in the presence of electric fields, Basov (1999) found varying behavior at different electric field frequencies and intensities:

  - At 1.0 to 4.0 Hz at 0.2 to 3.0 mV/cm, responses were searching for source and active foraging
  - At 50 Hz at 0.2 to 0.5 mV/cm, response was searching for source
  - At 50 Hz at 0.6 mV/cm or greater, response was avoidance

- **Dungeness Crab** - The Dungeness crab is a large edible crab and supports an important commercial and recreational fishery in Oregon. A review of the literature found no studies related to the Dungeness crab. Jernakoff (1987) attached electromagnetic tags which emitted a 31 kHz signal on to western rock lobster (*Panulirus cygnus*), which is a member of the same order (Decapoda) as Dungeness crab, with no reported ill effects. Western Atlantic spiny lobster (*P. argus*) orient to the earth's magnetic field during annual migration and diurnal travel (Herrnkind et al. 1973). Lohmann et al. (1995) demonstrated that the lobsters alter their course when subjected to a horizontal magnetic pole reversal in a controlled experiment. The Scottish Marine Renewables Strategic Environmental Assessment (Scottish Executive 2007) reported that there was no evidence that members of the subphylum Crustacea were sensitive to electric fields but that prawn had shown some attraction to the B fields of wind farm cable. However, it should be noted that the document upon which this statement is based (ICES 2003) found that only one species, common shrimp (*Crangon crangon*), was "sometimes attracted" to the cables.

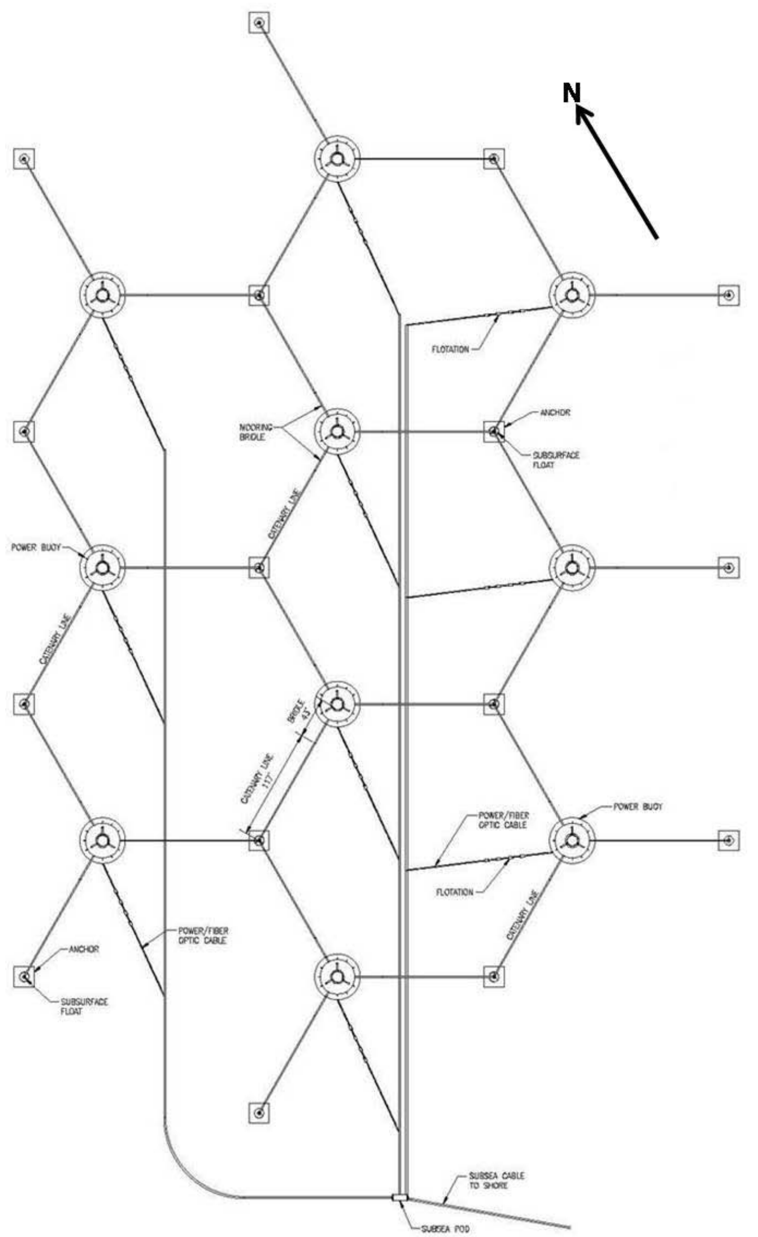
- **Plankton** - Plankton are found throughout the ocean and provides a base food source for marine inhabitants. Plankton motility is limited and organisms are unable to undulate with sufficient force to move against ocean currents. Any controlled movement is reduced to vertical migrations in the water column.

  Research conducted by Davies et al. (1998) assessed the effect of EMF on mobility and found mixed results. Effects on mobility from EMF fields were not readily repeatable, but did occur infrequently. Later research to explain these inconsistencies reached no definitive conclusions as to the root cause (Davies and Norris 2004).

3.0 Project Effects

The PowerBuoy generates power by taking the up-and-down motion of the surface waves and using it to cycle hydraulic cylinders. The hydraulic fluid is then pumped through a hydraulic motor, which is made to spin. In this way, the reciprocating motion is converted into rotational motion. In the PowerBuoy, the hydraulic motor is coupled to a generator which generates AC current that is smoothed into DC current, and then is converted back to 60 Hz synchronous three-phase power. This AC to DC to AC electrical conversion occurs in each PowerBuoy before exiting and being transmitted to the subsea pod. The subsea pod houses switching gear and a transformer, which is used to increase the voltage before the power is transmitted to shore (Figure 2). The subsea pod is about 6 feet in diameter and about 15 feet in length. It rests on the seabed below the PowerBuoys and is held down with pre-cured concrete ballast blocks. The power produced by the PowerBuoys is routed into the pod through watertight penetrators. The 10 PowerBuoys will share the one pod.

Figure 2
Reedsport Project PowerBuoy array



The generated power will be transmitted to shore for interconnection to the electrical grid via an armored subsea cable. The cable will be connected to the array and will follow an easterly course about 2 miles to the underwater outlet of an existing effluent discharge pipe, which is located about 0.5 miles from shore. This portion of the cable, seaward of the effluent pipe outfall, will be buried in the seabed to a minimum depth of about 3 to 6 feet (about 1 to 2 meters). The Company intends to use trenching or jet plowing to bury the cable, but final determination will be based on the selection of the cable deployment contractor.

Three components of the Reedsport Project represent sources of EMF: the PowerBuoys, the subsea pod, and the subsea transmission cables (including the power/fiber optic cable exiting the bottom of each PowerBuoy). The PowerBuoys produce power at frequencies between 1/12 and 1/8 cycles per second (Hz). The frequency is rectified to 60 Hz before exiting the PowerBuoy and being transmitted to shore via the subsea cable. The enclosed steel structure of the PowerBuoy and subsea pod designs will serve as Faraday cages, where an enclosure of conducting material results in an EMF shield.

A Faraday cage enclosure can be formed of solid material or screen material. Faraday cages are sold commercially and are used to shield objects from electromagnetic radiation and also acts to reduce emitted electromagnetic emissions from devices inside the enclosure/cage (Pepro 2008; Holland Shielding Systems 2008). An enclosure in an electric field, or an electric field present in a metal enclosure, causes free electrons to redistribute reducing/canceling the effects of the electric field such that there is no field present in the enclosure if subjected to the field and no field created outside the enclosure if an electric field is present inside the enclosure (Kimmel and Gerke 2006, IEeE Std 1100-1992[6]). The spar portion of the buoy is a cylinder made of steel totally enclosing all of the components located in the spar. The enclosure formed by the spar will therefore act as a Faraday cage (shield).

Because of this Faraday cage shielding, the PowerBuoys and subsea pod should not emit significant E field radiation. In addition, metallic sheathing and grounding on the transmission cables leading from the PowerBuoys to the subsea pod and from the subsea pod to shore will be used to significantly reduce or eliminate E fields from being emitted into the surrounding aquatic environment.

Results of model simulation studies showed that a cable with perfect shielding does not generate an E field directly, although a B field is generated in the local environment from the flow of electrical alternating current through the transmission cable. As explained above, the B field generates a weak iE field within close proximity to the transmission cable that is within the range of detectability of electro-sensitive species. Simulations with non-perfect cable shielding, where there is poor grounding of sheathes, showed that there is a leakage of E field, but it is smaller than the iE fields and unlikely to be additive (Centre for Marine and Coastal Studies [CMACS] 2003). The Faraday cages of the PowerBuoy and subsea pod and the metallic sheathing and burying of the Project subsea cables will significantly reduce or eliminate E fields from being emitted into the surrounding aquatic environment, so that there will be little effect of Project-produced E fields on the behavior of marine organisms.

[6] IEEE Std 1100-1992. IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment. Section 3.7. Approved March 22, 1999.

Research to date has shown that, while electro-sensitive species may be able to detect the EMF generated by subsea cables, the effects of the EMF on these species does not appear to be significant (Centre for Marine and Coastal Studies 2005; Scott Wilson Ltd. and Downie 2003; Sound & Sea 2002; USACE 2004; Scottish Executive 2007; World Health Organization 2005). In support of the OPT Kaneohe Bay project in Hawaii, Sound & Sea (2002) conducted an assessment of the potential behavioral effects of marine life in response to EMF generated by an OPT 40 kW PowerBuoy. This study concluded that EMF effects on marine organisms may range from no effect to avoidance of the immediate vicinity of the subsea cable. In the Environmental Impact Statement (EIS) for the proposed Cape Wind Energy Project in Massachusetts, the USACE (2004) analyzed potential impacts of EMF that would result from the Project's subsea transmission components to aquatic life and concluded that there would not be any adverse effects to the aquatic community from E fields and that any exposure would decrease rapidly with distance from the source. An environmental assessment of wave and tidal energy conversion devices in Scotland concluded that EMF generated by tidal and wave devices are likely to be small and within the variation range of naturally occurring fields in the North Sea (Scottish Executive 2007). The World Health Organization (2005) reports that "none of the studies performed to date to assess the impact of undersea cables on migratory fish (e.g., salmon and eels) and all the relatively immobile fauna inhabiting the sea floor (e.g., mollusks), have found any substantial behavioral or biological impact."

Resource agency staff are concerned that the Project differs from traditional sources of anthropogenic EMF in the ocean (underwater power cables). Specifically, agency staff note that instead of a single cable lying on or under the seabed, the proposed Project represents 10 PowerBuoys and associated cables running through the entire water column, as well as the multiple cables running along the seabed, converging on the subsea pod. Therefore, instead of a single linear source of EMF, as represented by the subsea cable running from the subsea pod to shore, the proposed Project represents a matrix of cables and PowerBuoys spanning the water column and converging on the seabed in the PowerBuoy array area.

4.0 Need for Additional Information

Resource agency staff believe that the potential effects of this unique EMF-generating array should be evaluated *in situ* and potential effects to identified marine life examined. Previous studies have identified the need to measure the response of electro-sensitive species with the characteristics and magnitude of cabling associated with off-shore energy projects (Centre for Marine and Coastal Studies 2005). Research related to these topics is currently being conducted by Collaborative Offshore Wind Energy Research Into the Environment (COWRIE) (2006), but the results of this study are not yet available.

Wave energy generation units, such as PowerBuoys, are a new technology, and there is no experience with wave energy projects along the Pacific coast. The Company is advancing the following work plan to evaluate the effects of EMF resulting from the proposed action on marine resources. The elements of this work plan are based on the criteria set forth in the Oregon Territorial Sea Plan, Part Two (Oregon Ocean Policy Advisory Council 1994). The Company believes that the proposed study methodology, within an adaptive management framework, will provide for a methodical and flexible approach to evaluate potential issues regarding EMF and Project area marine resources.

5.0 Study Plan

The purpose of this study is to:

1. Determine the physical characteristics of EMF likely to be generated by the single PowerBuoy and the 10-PowerBuoy array;
2. Anticipate which marine organisms might be adversely affected; and
3. Estimate the magnitude of potential effects.

The specific hypothesis to be tested is as follows:

> Based on published literature, the electromagnetic fields generated by the Project components (e.g., the PowerBuoys, the subsea pod, and the subsea transmission cables) do not represent levels likely to generate adverse response from species of concern.

To test this hypothesis, we will review research results on species of interest and taxonomically related species and describe their potential short-term response to the EMF. We will also explore the long-term consequences of such behaviors.

The methods, measurement protocols, and specific instruments employed by the project team to detect magnetic and electric fields on the ocean floor are based on lessons learned from previous commercial and military projects, tailored to this study. As the work progresses, the project team will also keep abreast of developments with the International Cable Protection Committee (ICPC), the European Marine Energy Center (EMEC), COWRIE, and other EMF studies conducted at offshore wind, wave, and/or tidal power projects (as available). It is therefore possible that the study team may, at a later date, wish to suggest modifications to the Project study design to take advantage of new data collection methods and protocols.

5.1 Sampling Methods and Rationale

During the Requirements Review Phase of the EMF Study, the source levels and field strengths at various distances from the PowerBuoys will be modeled and compared to naturally-occurring field levels and the appropriate sensor technology will be selected. At this point, installed sensors, diver hand-held instruments, and instruments mounted on a ROV are options.

The Company will test the appropriateness of all equipment proposed for use in the following manner: 1) modeling of instrument configuration; 2) laboratory calibration; 3) tank trials; and 4) bay trials and calibration. Statistical analysis of laboratory, tank, and bay testing will determine the repeatability of measurements. Statistical analysis of bay testing as well as baseline testing of the Project area and control site will determine the validity and repeatability of measurements by the instruments.

The E- and B-fields to be measured are expected to be low in comparison to existing background levels, and will likely change over time due to changes in environmental conditions such as sea-state, ocean currents, and other changes in environmental variables. As a result, statistical analysis methods will be employed to summarize results and establish relationships among environmental variables. The primary statistical methodology will use classical numerical averaging and regression analyses to characterize the temporal variability of field strength, including variance of field strength levels for both background environments and energized equipment conditions. Trends will be developed to relate results to environmental variables to establish. Fast-Fourier Transform (FFT) analyses will be conducted on AC sources to quantify field strength levels at applicable frequencies, including power spectrum; harmonic distortion and other non-linear affects associated with power generating equipment will also be assessed. Such data analyses will also use cross-spectrum and coherence techniques to ensure that field strength levels represent the energized source, and are not contaminated with background environment or other interfering noise sources. Trending of field strength variables will be conducted to establish comparison of measured range dependence to modeled predictions.

Final sensor and instrumentation selection will be determined following a literature review and technical analysis of variables involved to ensure that measured data will successfully capture a useful data set, including the sampling methodology. Calibration of sensors and instruments will be performed. In-lab test will be conducted to assess the precision and repeatability of the instrumentation and identify any instrumentation bias levels, and will be validated in controlled in-lab, tank, and field environments.

Baseline Sampling

Prior to deploying any PowerBuoys, baseline measurements of naturally occurring field strengths will be obtained at the Project site and a control site. The instrumentation employed will be that selected during the earlier portion of this study.

The E- and B-fields calculated during the Requirements Analysis and Literature Review phases of the EMF Study will be the basis for the standoff distance to the control site. Given the low levels expected, a distance of 100 to 1,000 meters is a reasonable distance. The candidate control site will have similar physical characteristics and will be reviewed to ensure that no man-made obstacles (e.g., the outfall) are in the area.

The control site will be located within 5 kilometers of the array. The control site will have similar physical characteristics and will be reviewed to ensure that no man-made obstacles are in the area. As discussed with the Aquatic Species Subgroup during a meeting on March 21, 2008, the exact location of the control site will be determined in the field and then reported to the subgroup.

Phase 1 Sampling

Phase 1 of the Project consists of deploying a single PowerBuoy in the Project area in 2010. The same instruments, either installed or hand-held, used to establish the baseline data will be employed to assess field strength around the PowerBuoy in both an energized and de-energized state. Because the unit will not be sending power to the grid, there will be no transmission cables or subsea pod. In the event a transmission line is installed to provide power to the single buoy, baseline data will be collected at points along the transmission line rather than continuously along the transmission cable. The number of points and locations shall be determined by the Aquatic Resources and Water Quality Implementation Committee.

Phase 2 Sampling

In Phase 2 of the Project, an additional 9 PowerBuoys will be deployed and 10 PowerBuoys will be connected to the grid via an Underwater Substation Pod and underwater cable. This is scheduled to occur during summer 2011- 2012. Installed and hand-held units will be employed to measure the EMF for the following components: 1) the 10 PowerBuoys; 2) the cables leading from the PowerBuoys to the subsea pod; and 3) the subsea pod.

To measure the EMF strength associated with the cable connecting the subsea pod to the shore, The Company will utilize either a permanently installed sensor system or an ROV-mounted cable tracking system. There are two ROV-mounted systems that the project team is currently considering:

1. **Innovatum Ultra-II Tracking System**: Designed to locate and track cables, pipelines and other objects buried beneath the seabed by means of their intrinsic magnetism or subtle disturbance of the earth's magnetic field, this system is also able to locate and track targets with existing AC or DC currents using their EMF. Using an ultra-low noise magnetic gradiometer and a highly sensitive triaxial fluxgate magnetometer, the instrument can simultaneously monitor passive and enhanced magnetization; active AC, and active DC. Innovatum staff had indicated a willingness to cooperate on the study's calibration and measurement efforts. Additional information on this system can be obtained at http://www.innovatum.net/brochures/Ultra%20II%20Brochure.pdf.
2. **TSS 350 Subsea Cable Tracking System**: The TSS system has been developed to provide accurate subsea cable location using a compact modular design. The system provides accurate survey, verifying the cable location and burial status. As the TSS is designed specifically for tracking tone-carrying cables, it is a strong candidate for use in Phase 2. Additional information on this system can be obtained at http://www.tss-international.com/pdf/tss%20350.pdf.

The project team will center its efforts on employing technologies designed to meet the international state of practice which are commercially available.

5.2 Sampling Frequency Needs to Meet Specific Objectives

During the operational phase of the single PowerBuoy (Phase 1), period measurements will be taken. Periodicity of measurements will be based on lessons learned during earlier testing stages, but at this point, the project team believes that quarterly assessment would be appropriate. The project team will submit an updated study plan to the Aquatic Resources and Water Quality Implementation Committee and other interested stakeholders prior to the initiation of any assessment activities.

Baseline measurements and installation measurements will be scheduled while crews and equipment are onsite. The post-installation sampling schedule is quarterly for the first year and, based on measured levels, semi-annually for the next two years. Given that higher sea states will both drive higher field strengths and increase the risk to divers and ROVs, data for higher field strengths may require the use of installed sensors during Phase 2 sampling.

To collect the data for the 10 PowerBuoys (Phase 2), the project team will review the results of the Phase 1 testing and either: a) continue with the same schedule; or b) modify the sampling frequency based on lessons learned during Phase 1. The project team will submit an updated study plan to the Aquatic Resources and Water Quality Implementation Committee and other interested stakeholders prior to the initiation of any assessment activities.

5.3 Metrics and Analyses

Magnetic field sensors and electric field sensors will be selected and calibrated to assess electrical fields (E-fields), as measured in microvolts per meter (μV/m), and magnetic fields (B-fields), as measured in nanotesla (nT). EMF values obtained in the vicinity of the PowerBuoys will be compared to known thresholds of sensitive species. Initial research on documented EMF thresholds of sensitive species is summarized in Attachment 1 of this document. Additional research of available EMF threshold information for aquatic species will be conducted as part of this study, and it is anticipated new information will be updated as future studies are completed (such as the COWRIE field study of the response of electro-sensitive species to EMF fields). Where threshold levels are not available in the literature for species of concern or appropriate surrogates, the Aquatic Resources and Water Quality Implementation Committee will be convened to determine appropriate steps through the Adaptive Management Process to understand the effects of the EMF on these species. In the event that it is shown that the EMF emissions from the project site could be detected by any of these sensitive species, a targeted literature review will be conducted to determine the likely response pattern (e.g., no effect, confusion, avoidance, attraction) and mitigation strategies will be suggested if adverse effects are predicted.

Literature values may not be available for species of interest or equivalent surrogates agreed upon by the Aquatic Resources and Water Quality Implementation Committee. The Aquatic Resources and Water Quality Implementation Committee shall determine the appropriate course of action for the species of interest where literature values are not available or values for suitable surrogates are not sufficient given the EMF levels measured. The Adaptive Management Process shall be employed to determine the appropriate course of action. This may include laboratory testing of the target species.

Study updates will be provided to the Aquatic Resources and Water Quality Implementation Committee in the quarterly updates, with particular focus on whether EMF levels are measured at higher levels than expected. Summary reports for the Baseline, Phase 1 (single PowerBuoy), and Phase 2 (10 PowerBuoys) stages of this study will be submitted to the Aquatic Resources and Water Quality Implementation Committee within three months of completing the associated fieldwork. Following review of the study report, the project team will initiate a discussion with the Aquatic Resources and Water Quality Implementation Committee to determine if additional actions are warranted.

6.0 Literature Cited

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ATTACHMENTS

ATTACHMENT 1

THRESHOLDS OF ELECTRO-SENSITIVE SPECIES

ATTACHMENT 1

THRESHOLDS OF ELECTRO-SENSITIVE SPECIES

Organism	Electric (E) Fields*					Reference
	Observation	Gradient		Upper Range		
		V/m	µV/m	V/m	µV/m	
Scalloped hammerhead sharks (juveniles) (*Sphyrna lewini*)	$4x10^{-8}$ V/m minimum E field intensity that elicited the **biting** of an electrode	4.E-08	0.04	-	-	Kajiura and Holland, 2002
Smooth dogfish (*Mustelus canis*) – large	~$5x10^{-8}$ V/m, 13% of the time, dogfish initiated well-aimed **dives at** electrodes from >38 cm	5.E-08	0.05	-	-	Kalmijn, 1982
Elasmobranchs	$5x10^{-7}$ to 10^{-3} V/m Species specific, mostly **attracted** to EMF	5.E-07	0.5	5.E-03	5,000	Gill & Taylor, 2001
Elasmobranchs	$5x10^{-7}$ V/m resulted in **detection** of E fields	5.E-07	0.5	-	-	Paulin, 1995
Stingray (*Urolophus halleri*)	$5x10^{-7}$ V/m resulted in electrical **orientation** in some rays	5.E-07	0.5	-	-	Kalmijn, 1982
Elasmobranchs	Response limited to frequencies < 8 Hz, evocation of well-oriented **behavioral responses** even at E fields of 10^{-6} V/m	1.E-06	1	-	-	Kalmijin, 2003
Elasmobranchs	10^{-6} V/m the **detection** threshold for moving animals	1.E-06	1	-	-	Kalmijin, 1966
Scalloped hammerhead sharks (juveniles) (*Sphyrna lewini*) and Sandbar sharks (*Carcharhinus plumbeus*)	<10^{-6} V/m initiated an **orientation response** for 35-40% of both species	1.E-06	1	-	-	Kajiura and Holland, 2002
Smooth dogfish (*Mustelus canis*) – large	< 10^{-6} V/m, 39% of the time, dogfish initiated well-aimed **dives at** electrodes from >30 cm	1.E-06	1	-	-	Kalmijn, 1982
Skate (*Raja clavata*)	Uniform fields of 5 Hz with a voltage gradient of 10^{-6} V/m exhibits a **cardiac** response	1.E-06	1	-	-	Kalmijn, 1982
Skate (*Raja clavata*)	10^{-6} V/m affected **respiratory** rhythm	1.E-06	1	-	-	Kalmijin, 1966
Smooth dogfish (*Mustelus canis*) – small	< $2x10^{-6}$ V/m, 12% of the time, dogfish initiated well-aimed **dives at** electrodes from >18 cm	2.E-06	2	-	-	Kalmijn, 1982

Organism	Electric (E) Fields*					Reference
	Observation	Gradient		Upper Range		
		V/m	μV/m	V/m	μV/m	
Smooth dogfish (*Mustelus canis*) – small	< $3x10^{-6}$ V/m, 36% of the time, dogfish initiated well-aimed **dives at** electrodes from 15 cm	3.E-06	3	-	-	Kalmijn, 1982
Small-spotted catshark (*Scyliohinus canicula*)	10^{-5} V/m Attraction at 0.1 meter from source. DC and low frequency AC (0.5-20Hz) responded to the most	1.E-05	10	-	-	Gill & Taylor, 2001
Small-spotted catshark (*Scyliohinus canicula*)	10^{-5} V/m caused **eyelid contractions**	1.E-05	10	-	-	Kalmijin, 1966
Scalloped hammerhead sharks (juveniles) (*Sphyrna lewini*) and Sandbar sharks (*Carcharhinus plumbeus*)	<10^{-5} V/m (2.5 to $3x10^{-6}$ V/m = median response threshold) was the **behavioral response** threshold	1.E-05	10	-	-	Kajiura and Holland, 2002
Smooth dogfish (*Mustelus canis*)	1 to $2x10^{-5}$ V/m **Orientation** to the bioelectric fields of prey in the wild	1.E-05	10	2.E-05	20	Kalmijn, 2000a
Skate (*Raja clavata*)	$4x10^{-5}$ V/m at 5 Hz slowed down **heart beat**	4.E-05	40	-	-	Kalmijin, 1966
Stingray (*Urolophus halleri*)	$5x10^{-5}$ V/m **Recognition** of EMF, undefined response	5.E-05	50	-	-	Kalmijn, 2000a
Sandbar sharks (*Carcharhinus plumbeus*)	$5x10^{-4}$ V/m minimum E field intensity that elicited the **biting** of an electrode	5.E-04	500	-	-	Kajiura and Holland, 2002
Small-spotted catshark (*Scyliohinus canicula*)	10^{-3} V/m **Avoidance** response	1.E-03	1,000	-	-	Gill & Taylor, 2001
Sterlet sturgeon (*Acipenser ruthenus*) and Russian sturgeon (*A. gueldenstaedtii*)	At 1.0-4.0 Hz at 0.2-3.0 mV/cm, responses were **searching** for source and active **foraging**	2.E-02	20,000	3.E-01	300,000	Basov, 1999
Sterlet sturgeon (*Acipenser ruthenus*) and Russian sturgeon (*A. gueldenstaedtii*)	At 50 Hz at 0.2-0.5 mV/cm, response was **searching** for source	2.E-02	20,000	5.E-02	50,000	Basov, 1999
Sterlet sturgeon (*Acipenser ruthenus*) and Russian sturgeon (*A. gueldenstaedtii*)	At 50 Hz at 0.6 mV/cm or greater, response was **avoidance**	6.E-02	60,000	-	-	Basov, 1999
Telecost (bony fish)	**No response** to fields below 6 V/m	6.E+00	6,000,000	-	-	Scottish Executive, 2007
Cetaceans (whales and dolphins)	No evidence to suggest impact from DC E fields	-	-	-	-	Walker, 2001
Crustacea	No evidence to suggest impact from E fields	-	-	-	-	Scottish Executive, 2007

Organism	Electric (E) Fields			Reference
	Observation	Frequency Range (Hz)		
Sharks	~<1/8 to 8 Hz was the operating range of shark low frequency AC receptors	1/8	8	Kalmijn, 2000b
Thornback ray (*Platyrhinoidis trisereata*)	>1/8 to 8 Hz **detectable** frequency range	1/8	8	Kalmijn, 2000a
Small-spotted catshark (*Scyliohinus canicula*)	10^{-5} V/m **attraction** at 0.1 meter from source. DC and low frequency AC (0.5-20Hz) responded to the most	1/2	20	Gill & Taylor, 2001
Sterlet sturgeon (*Acipenser ruthenus*) and Russian sturgeon (*A. gueldenstaedtii*)	At 1.0-4.0 Hz at 0.2-3.0 mV/cm, responses were **searching** for source and active foraging	1	4	Basov, 1999
Elasmobranchs	Response limited to frequencies < 8 Hz, evocation of well-oriented **behavioral responses** even at E fields of 10^{-6} V/m	5		Kalmijin, 2003
Skate (*Raja clavata*)	4x10^{-5} V/m at 5 Hz slowed down **heart beat**	5		Kalmijin, 1966
Skate (*Raja clavata*)	Uniform fields of 5 Hz with a voltage gradient of 10^{-6} V/m exhibits a **cardiac** response	5		Kalmijn, 1982
Sterlet sturgeon (*Acipenser ruthenus*) and Russian sturgeon (*A. gueldenstaedtii*)	At 50 Hz at 0.2-0.5 mV/cm, response was **searching** for source	50		Basov, 1999
Sterlet sturgeon (*Acipenser ruthenus*) and Russian sturgeon (*A. gueldenstaedtii*)	At 50 Hz at 0.6 mV/cm or greater, response was **avoidance**	50		Basov, 1999

Organism	Magnetic (B) Fields					Reference
	Observation	Gauss**		μT*		
Magnetic Field (magnetic flux density)						
Telecost (bony fish)	B fields of 1-100 uT have been found to delay embryonic development	0.01	1	1	100	Cameron et al. 1985 and 1993; Zimmerman et al. 1990
Elasmobranchs	Detection and response to B fields in the range 25 to 100 uT against the ambient geomagnetic field (~36 uT)	0.25	1	25	100	Meyer et al. 2004
Telecost (bony fish)	Some response by European eels to magnetic emissions from HVDC cables	-	-	-	-	Westerberg 2000
Crustacea	Prawn were "sometimes attracted" to B fields associated with a wind farm cable	-	-	-	-	Scottish Executive 2007
Magnetic Intensity Gradient (change with distance)						
Sharks	Movements associated with areas of high intensity slope in the Earth's magnetic field (0.37 mG/km)	0.00037		0.037		Walker et al. 2003
Scalloped hammerhead sharks (*Sphyrna lewini*)	Sensitive to 0.374 mG/km B field up to 175 meters depth	0.000374		0.0374		Klimley 1993
Scalloped hammerhead sharks (*Sphyrna lewini*)	Sensitive to 12 mG/km B field	0.012		1.2		Klimley 1993
Changes in Magnetic Field						
Black sea skates (*Trigon pastinaca*)	2,000 mG/s change in B field evoked a neuronal response (constant B field failed to do so)	0.2		20		Brown et al. 1974
Elasmobranchs	Changing B fields around rate of 20,000 mG/sec evokes a neurological response in the acoustico-lateralis of the medulla oblongata	20		2000		Brown et al. 1974

* As indicated in the APEA and study plan, the PowerBuoys produce power at frequencies between 1/12 and 1/8 cycles per second (Hz). The frequency is rectified to 60 Hz before exiting the PowerBuoy and being transmitted to shore via the subsea cable. The enclosed steel structure of the PowerBuoy and subsea pod designs will serve as Faraday cages, where an enclosure of conducting material results in an EMF shield. Because of this Faraday cage shielding, the PowerBuoys and subsea pod should not emit significant E field radiation. In addition, metallic sheathing and grounding on the transmission cables leading from the PowerBuoys to the subsea pod and from the subsea pod to shore will be used to significantly reduce or eliminate E fields from being emitted into the surrounding aquatic environment.
** Earth's magnetic field = 0.5 gauss.
1 Tesla = 10,000 gauss
1 μT = 0.01 gauss

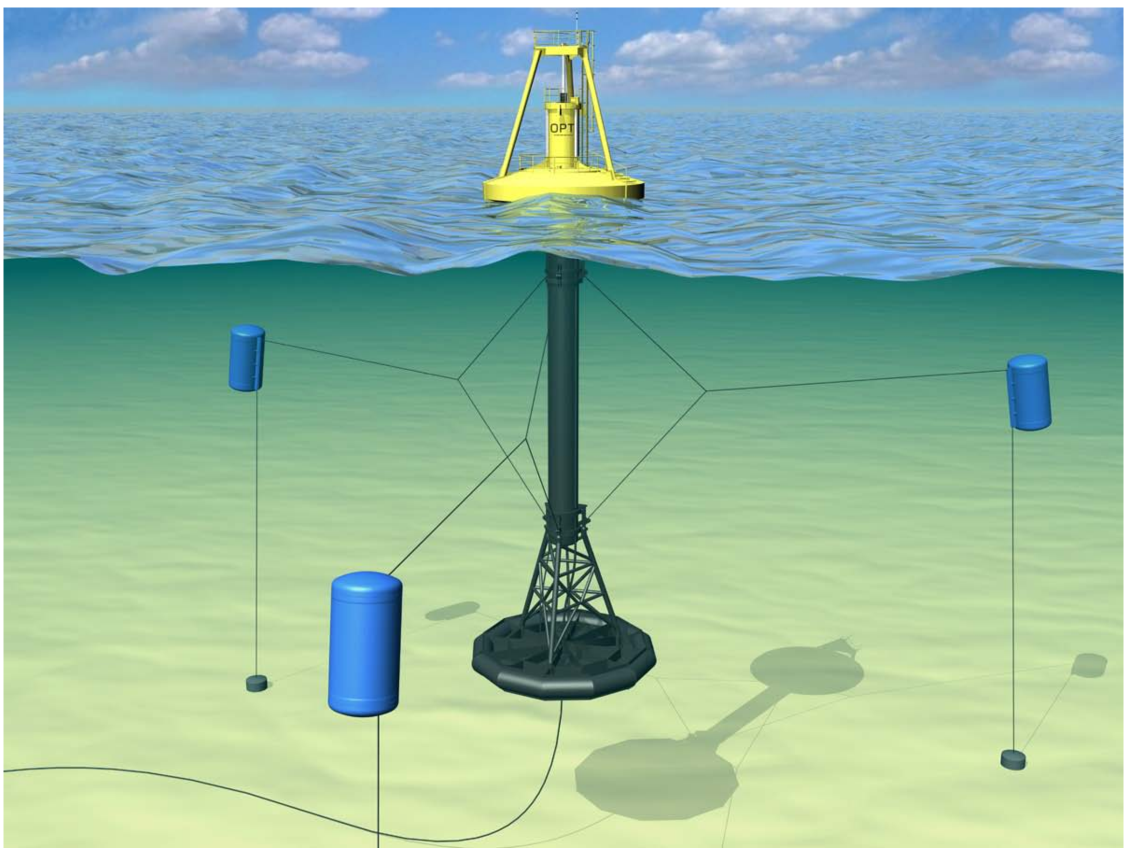
Reedsport OPT Wave Park, LLC.
Reedsport OPT Wave Park
FERC No. 12713

Issue Assessment
Pinnipeds
May 6, 2010

1.0 Description of Issue

The above-water portion of the PowerBuoy includes a sloped float surface (Figure 1). Pinniped use of the PowerBuoys® is undesired as it may be detrimental for resource management reasons as well as for power production. As outlined in the Declaration of Cooperation[7] and subsequent meetings, the Aquatic Species Subgroup has raised the issue of pinnipeds using the PowerBuoy floats as haul-outs and identified the need to further define options to prevent pinnipeds from resting on the float and to evaluate their effectiveness. In addition, there is concern that if salmon are attracted to the PowerBuoys, pinnipeds may then be drawn to the area to prey on the salmon.

FIGURE 1
ILLUSTRATION OF POWERBUOY
(GRAVITY BASE ANCHORS NOT REPRESENTED)



[7] The Aquatic Species Subgroup evaluated the potential project effects of the Project to the marine community, and concluded that, for a PowerBuoy, the potential impact or exposure to pinnipeds was high. In other words, pinnipeds would likely use PowerBuoy floats as haul-outs.

2.0 Relevant Existing Information

Pinniped species that occur in Oregon coastal waters include harbor seal (*Phoca vitulina richardii*), northern elephant seal (*Mirounga angustirostris*), California sea lion (*Zalophus californianus*), and Steller sea lion (*Eumetopias jubatus*) (U.S. Fish and Wildlife Service [USFWS] 2007). In addition, northern fur seals (*Callorhinus ursinus)* can be present, but are rare. Pinnipeds feed on migratory species (e.g., hake, clupeids, salmonids) as well as non-migratory species (e.g., rockfish, lingcod) (Orr et al. 2004).

Harbor seals are commonly found year-round along the shore of coastal waters, bays, estuaries, or sandy beaches and mudflats and are permanent residents along the Oregon Coast (USFWS 2007). Hundreds of harbor seals haul-out in the mouth of the Umpqua and along the beach in the vicinity of the Project area (Table 1). Harbor seals are not migratory, though local movements are driven by season, pupping, and prey location. The population of harbor seals in Oregon grew following protection under the Marine Mammal Protection Act of 1972 until stabilizing in the early 1990s. The estimated population of harbor seals (all age classes) during the 2002 reproductive period was 10,087 individuals (Brown 2005). In Oregon, seals are born from March to May (USFWS 2007).

TABLE 1
PINNIPED SPECIES AND ABUNDANCE AT HAUL-OUT SITES IN PROJECT VICINITY
(LANE, DOUGLAS, AND COOS COUNTIES)

Haul-out	Species	Abundance
Sea Lion Caves	Steller sea lions	Variable; up to 1,000 nonpups
	California sea lions	Variable; nonpup males
Siuslaw River	Harbor seals	100-200 nonpups; 10-15 pups
Siltcoos Outlet	Harbor seals	100 nonpups; 5 pups
Takenitch Outlet	Harbor seals	0-10 nonpups
Umpqua River	Harbor seals	600-700 nonpups; 100 pups
Tenmile Outlet	Harbor seals	0-50 nonpups; 1-2 pups
Coos Bay	Harbor seals	250-350 nonpups; 50 pups
Cape Arago	Steller sea lions	Variable; up to 600 nonpups
	California sea lions	Variable; up to 2,000 nonpup males
	Harbor seals	400-500 nonpups; 100-200 pups
	Northern elephant seals	20-30; a few pups

Source: Pers. comm. ODFW Marine Mammal Research Program, September 7, 2007.

Northern elephant seals are found in the North Pacific and range from Baja Mexico to the Gulf of Alaska (USFWS 2007). The number of northern elephant seals likely to be found in the Project area is much lower than that for California sea lions, harbor seals, and Steller sea lions. Although adult northern elephant seals are rarely reported in Oregon, juvenile northern elephant seals routinely come ashore typically during the April to August molting season. Individuals remain mostly onshore during the molt, for around 2-3 weeks (NOAA 2007*e*; Brueggman et al. 1992). Outside of molting periods, northern elephant seals live offshore. Northern elephant seals can dive to depths of 5,000 feet. Breeding generally occurs in the winter in Mexico and southern California. The northernmost breeding ground on the Pacific coast is Shell Island (approximately 30 miles south of the Project site; USFWS 2007). Cape Arago, south of Coos Bay, is the nearest haul-out location of northern elephant seals (Table 1).

California sea lions reside in nearshore waters along the Pacific Coast. They range from Vancouver Island, British Columbia to Baja Mexico. California sea lions do not breed in Oregon or Washington (Brueggeman et al. 1992). In habitat north of California, the hauling out grounds are only occupied by males (USFWS 2007; Pers. comm. ODFW Marine Mammal Research Program, September 7, 2007). Males migrate north for the winter, but females and their pups remain in California year-round (USFWS 2007). Therefore, only male sea lions are present off Oregon from fall to spring, with minimal numbers in the summer (ODFW letter dated September 4, 2008). The primary haul-out areas along the Oregon Coast are Rogue Reef, Three Arch Rocks, Cascade Head, Orford Reef, Sea Lion Caves, Columbia River, South Jetty, and Shell Island of Simpson Reef, the latter two of which are within Cape Arago (USFWS 2007; Pers. comm. ODFW Marine Mammal Research Program, September 7, 2007); Pers. Comm. ODFW, September 4, 2008).

The Steller sea lion has a distribution that is widespread, occurring from Japan to the Western Gulf of Alaska and along the West Coast to northern California (ODFW pers. comm. September 7, 2007). The eastern designated population segment (DPS), listed as federally threatened, and exists along the Northern California, Oregon, and Washington coastline north to the Eastern Gulf of Alaska (NOAA 2007*a*, ODFW pers. comm. September 7, 2007). Preferred terrestrial habitat is primarily on exposed rock shorelines associated with shallow well mixed waters, average tidal speeds and gradual bottom slopes (NOAA 2007*a*), although Steller sea lions can be found on gravel or cobbles beaches. Additional potential haul-outs include a variety of habitats, such as jetties, breakwaters, navigational aids, floating docks, and sea ice (NOAA 2007*a*). Based on studies on California and Oregon populations, prey species consist of rockfish, hake, flatfish, salmon, herring skates, cusk eel, lamprey, squid, and octopus. They are also known to consume an occasional bird or other marine mammal (NMFS 2007).

Steller sea lion breeding primarily occurs during June and July on rookeries situated on remote islands, rocks, and reefs (NOAA 2007*a*). NMFS has identified two critical rookery habitat locations within Oregon: Rogue Reef and Orford Reef (NOAA 2007*a*). The Rogue Reef is approximately 91 miles from the Project site and the Orford Reef is approximately 66 miles from the Project site. The total number of non-pup sea lions counted during the breeding season surveys at these two sites has increased from 1,461 in 1977 to 4,169 in 2002 (Brown et al. 2002). These sites are also used for haul-outs outside of the breeding season (NMFS 2008). During the fall and winter many Steller sea lions disperse from rookeries and increase use of haul-outs (NMFS 2008).

Some Steller sea lion haul-outs are used year-around while others only on a seasonal basis (NMFS 2008). Like other pinnipeds, Steller sea lions use haul-outs for molting, resting, and non-breeding activity (NMFS 2008). ODFW identified Sea Lion Caves, located about 25 miles north of the Project, and Cape Arago, located about 30 miles south of the Project, as two significant haul-out sites that Steller sea lions use along the Oregon coast. Steller sea lion abundance was characterized as variable but up to 1,000 non-pups for Sea Lion Caves and up to 600 non-pups for Cape Arago (Pers. comm. ODFW September 7, 2007). Outside of the peak of breeding season (mid-June), the number of Steller sea lions on individual haul-outs can vary considerably from day to day (NMFS 2008). While these haul-out sites are more than 25 miles from the Project area, they are within the Steller sea lions foraging range.

The eastern DPS, as a whole, has been increasing steadily at a rate of three to four percent annually for the past 30 years (up to 2002). The current recovery plan stated the eastern DPS was stable and recommended it be considered for delisting (NMFS 2008).

Northern fur seal is a migratory species that is currently listed as depleted under the Marine Mammal Protection Act (MMPA) but is not listed under the Endangered Species Act (ESA) (National Marine Fisheries Service [NMFS] 2006). Fur seals migrate in the early winter through the eastern Aleutian Islands into the northern Pacific Ocean. Upon entering the northern Pacific Ocean, they move into coastline habitat off British Columbia, Washington, Oregon, and California. Older males stay near the northern part of the range, while young males and females spend the winter-feeding in the southern area. Migrants feed at sea on small pelagic fish and squid (NMFS 2006). The northward migration begins in March. This migration returns the animals back to the breeding colonies, and the general cycle is repeated. Numbers of Northern fur seals found to occur in the Project area are expected to be very low (Pers. comm. ODFW Marine Mammal Research Program, September 7, 2007).

A map of pinniped sightings in the Project vicinity conducted during aerial surveys from 1989 to 1990 is presented in Figures 2 and 3. Based upon existing documentation and aerial surveys, pinniped species generally occur along small island haul-outs and coastal shoreline. Figure 4 shows the locations of pinniped haul-outs in the vicinity of Reedsport, as well as location fixes for California sea lions instrumented with satellite transmitters over the past several years. Location accuracy ranges from several hundred meters to several kilometers (Pers. comm. ODFW Marine Mammal Research Program, September 7, 2007). Table 1 shows the species abundance at the haul-out sites. Cape Arago is also the largest area haul-out for a number of pinniped species (Table 1).

While harbor seals are the most abundant species along the Oregon coast, California sea lions are generally found further offshore, where the Project is located, and therefore are more likely to use the PowerBuoys as haul-out sites (Pers. comm. ODFW Marine Mammal Research Program, September 7, 2007). Hundreds of harbor seals haul-out in the mouth of the Umpqua and along the beach in the vicinity of the Project area (Table 1).

The closest California sea lion and Steller sea lion haul-out areas along the Oregon Coast are Sea Lion Caves, located about 25 miles north of the Project, and Cape Arago, located about 30 miles south of the Project (Pers. comm. ODFW Marine Mammal Research Program, September 7, 2007; USFWS 2007). Foraging sea lions can easily cover 100 miles per day and therefore, the Project is within range of a number of haul-out sites as well as to other sea lions migrating through the area (Pers. comm. ODFW Marine Mammal Research Program, September 7, 2007).

Research has shown that a variety of variables, including season, weather (e.g., wind speed, temperature), and ocean factors (e.g., wave height, surf extent) can effect seal haul-out behavior (Watts 1996). Human disturbances have also caused seals to abandon haul-out areas (Mortenson et al. 2000; Allen et al. 1984). However, while haul-out selection process for phocids or true seals has been discussed extensively (Sjoberg and Ball 2000; Bjorge et al. 2002; Nordstrom 2002; Reder et al. 2003), information regarding habitat preferences for otariids (eared seals) such as sea lions is largely anecdotal in nature (Ban and Tries 2007). The general consensus is that sites tend to be rocky areas that are exposed to the water (Lyman 1989; Kastelein and Weltz 1991).

FIGURE 2

PINNIPED SIGHTINGS DOCUMENTED IN AERIAL SURVEYS FROM 1989 TO 1990

Note: Eared seals represent a general name that represents both fur seals and sea lions.
Map data from Oregon and Washington Marine Mammal and Seabird Survey (Bruggeman et al. 1992).

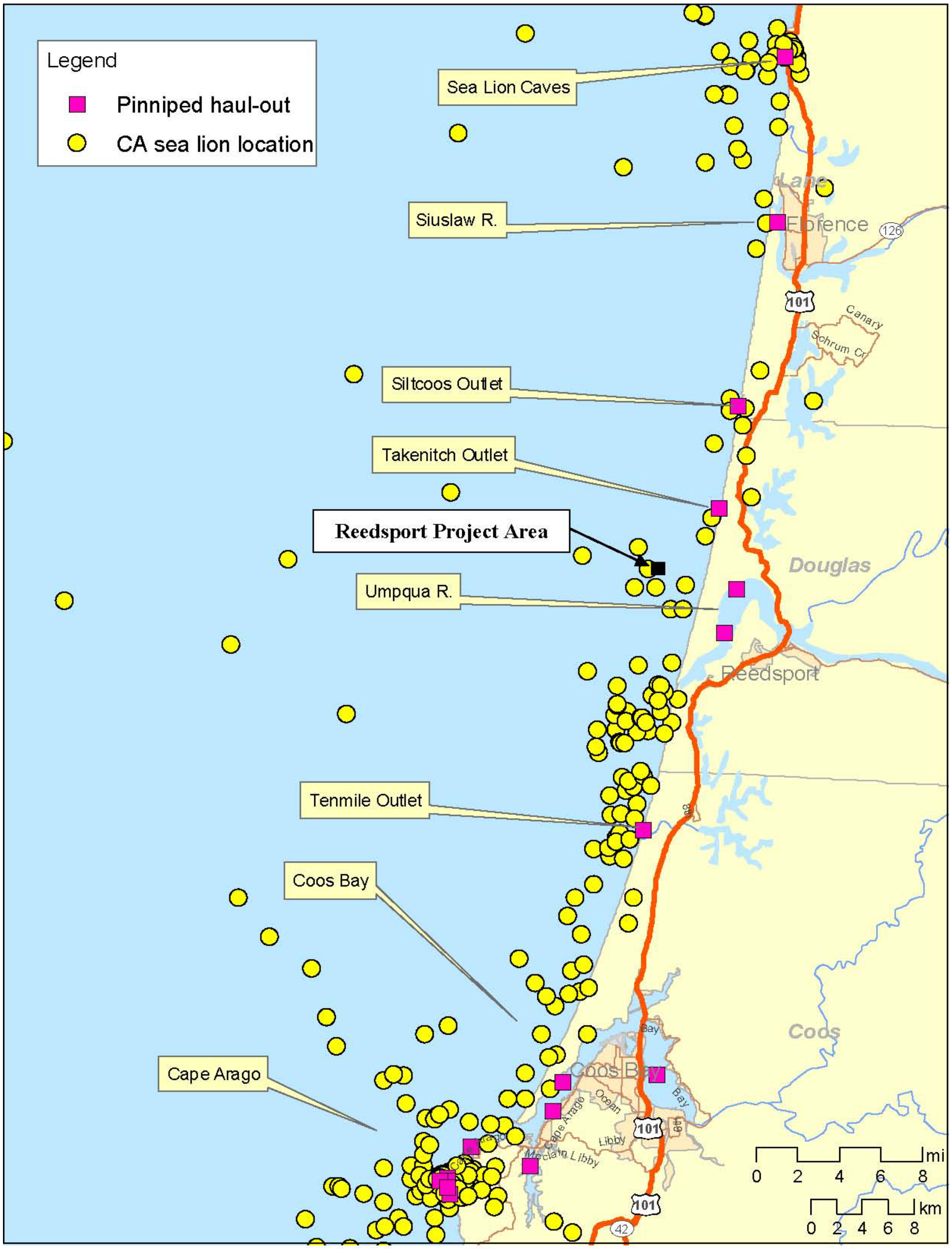
FIGURE 3

STELLER SEA LION SIGHTINGS DOCUMENTED IN AERIAL SURVEYS FROM 1989 AND 1990

Map data from Oregon and Washington Marine Mammal and Seabird Survey (Bruggeman et al. 1992).

FIGURE 4

PINNIPED HAUL-OUT SITES AND CALIFORNIA SEA LION SATELLITE-TAG LOCATIONS FOR PROJECT VICINITY (LANE, DOUGLAS, AND COOS COUNTIES)*



*Location fixes for California sea lions instrumented with satellite transmitters over the past several years. Location accuracy ranges from several hundred meters to several kilometers. Species that use each haul-out noted in Table 1 (Pers. comm. ODFW Marine Mammal Research Program, September 7, 2007).

Source: ODFW unpublished data.

With the passage of the MMPA in 1972, populations of California sea lions and Pacific harbor seals increased significantly while the populations of many coastal fish declined. Of particular concern is predation by increasingly abundant pinnipeds on endangered salmonids, as this may hinder the recovery of depressed stocks (Independent Multidisciplinary Science Team 1998). Predation is thought to effect salmonid abundance primarily when: a) other prey species are unavailable to the pinnipeds; and b) when "physical conditions, such as narrow river mouths or human-made barriers such as fishing locks, lead to the concentration of adult and juvenile salmonids" (NOAA 2007*c*). In response to examples of the latter, "hazing" of sea lions and other mitigation measures have been explored on the Columbia River to prevent predation on the migrating Chinook salmon and steelhead fish that congregate below the Bonneville Dam before utilizing fish ladders (NOAA 2007*b*). To date, there is no single non-lethal deterrence method known to be universally effective in discouraging harbor seals and sea lions from engaging in problem behaviors (NOAA 2006).

3.0 Project Effects

The floats of the PowerBuoy system present an opportunity for pinniped species to haul-out onto the float. Pinnipeds are known to haul-out on navigation and data collection buoys offshore. Crew of the U.S. Coast Guard (USCG) Cutter *FIR*, the buoy tender that services navigation aids in the region between the months of May and October, estimate that, when they are servicing the aids, they see seals and sea lions about 25 percent of the time, both on the buoys and in the water (Pers. comm. Lt. Fred Seaton, USCG, June 27 and 28, 2007). Pinniped use of the PowerBuoys is undesired as it will be detrimental to power production and a risk to maintenance workers that will require access to the PowerBuoys from time to time. In addition, there is concern that if salmon are attracted to the PowerBuoys, pinnipeds may then be drawn to the area to prey on the salmon.

4.0 Need for Additional Information

Wave generation units, such as PowerBuoys, are a new technology, and there is little experience with wave energy projects along the Pacific coast. The Company is advancing the following study plan to evaluate whether pinnipeds haul out on the floats and to evaluate if pinnipeds are attracted to the PowerBuoy array. The elements of this study plan are based on the criteria set forth in the Oregon Territorial Sea Plan, Part Two (OPAC 1994). The Company believes that the proposed study methodology, within an adaptive management framework, will provide for a methodical and flexible approach to evaluate potential issues regarding pinnipeds and the Project.

5.0 Study Plan

The Company submitted an initial and subsequent drafts of the study plan to the Aquatic Species Subgroup for their review in fall 2007, January 2008, with the draft FERC license application and PDEA in July 2008, and with the License Application in February 2010. The study plan has been prepared taking into consideration the comments raised by stakeholders.

The goal of this study is to assess pinniped presence and abundance at the proposed Project. The primary objectives would include: (1) observe pinniped use or non-use of the single PowerBuoy; (2) determine if pinnipeds are prevented from hauling out on the PowerBuoy in the presence of either ultra high molecular weight polyethylene coating (UHMWPE) or fencing (to test the hypothesis: there is no haul-out use of the single PowerBuoy by pinnipeds); and (3) collect information on pinniped presence and abundance in and around the wave park when there is a single PowerBuoy (Phase I) and 10 PowerBuoys (Phase II).

5.1 Haul-Out Study

As discussed earlier, the objective of this study will be to observe whether or not pinnipeds haul-out on the single PowerBuoy. Specifically, the study will monitor the effectiveness of one or potentially more deterrence mechanisms (e.g., UHMWPE or fencing) in preventing this behavior.

To prevent haul-out behavior at the PowerBuoys, the Company plans to coat the float of the initial unit (Phase I, scheduled to be deployed in 2010) with UHMWPE material. UHMWPE is generally described as having a very low friction coefficient (thereby making it slippery), high impact strength, low moisture absorption rate, and is non-corrosive. The material is also self-lubricating, so no regular maintenance will be required. The Company anticipates that the rocking of the PowerBuoy by waves in combination with the slippery surface will be sufficient to deter pinniped haul-out, as they would have difficulty staying on the float under these conditions. The Company has not, at this time, chosen a specific UHMWPE product but a review of the technical information provided by a sample of manufacturers (e.g., Röchling Engineered Plastics; Lennite; Tivar) indicates that material is not soluble in water and is considered a non-hazardous product.[8] When the Company does select a UHMWPE product, it will make sure that the selected product is not soluble in water and is considered a non-hazardous product.

UHMWPE is commonly used in marine, seaports, transportation, and warehousing applications for ultra low friction, high impact surfaces. Common uses in marine environments include coatings on dock fenders, weather strips, and piling rub strips. Such commercial marine applications of UHMWPE have been tested for periods over 20 years in salt water, direct sunlight, and in cold weather[9].

The Company recognizes the untried nature of this design, which represents an innovative approach to this problem. Accordingly, in the event that it is determined that the UHMWPE coating does not adequately keep pinnipeds from using the float, the Company will, in consultation with NMFS and the Aquatic Resources and Water Quality Implementation Committee, install fencing around the perimeter of the float[10]. Fencing has been successfully used to prevent haul-out behavior on buoys and docks by sea lions (NMFS 1997). If fencing does not prevent pinniped haul-out, the Company will consult with the Aquatic Resources and Water Quality Implementation Committee to identify and implement an appropriate alternative measure.

[8] MSDS sheets of these examples of UHMWPE can be viewed at http://www.roechling-plastics.us/polymmsds.html; http://www.sdplastics.com/plasmap.html; http://www.redwoodplastics.com/files/website_videos/TIVAR.pdf.

[9] Quadrant Plastics DockGuard Flier http://www.quadrantepp.com/default.aspx?pageid=257.

[10] During fabrication, the Company will outfit the single PowerBuoy with the needed attachment points for the fencing option.

Sampling Methods and Rationale

Direct observations will be used to establish pinniped haul-out behavior with regard to the single PowerBuoy. Direct observations are one of the most commonly used sampling methods in pinniped research. This approach has been employed successfully to assess haul-out preferences (Matthews and Pendelton 1997; Terhune and Almon 1983; Stewart 1984), the effectiveness of deterrents (Yurk and Trites 2000; Lelli and Harris 2001), and salmonid predation rates (Haaker et al. 1984; London et al. 2001), despite the fact that much of this latter activity occurs below the water surface.

Sampling Frequency Needs to Meet Specific Objectives

The Company proposes to conduct sampling on an opportunistic basis. Following deployment of the first unit, the Company anticipates that direct observations of the PowerBuoy and any pinnipeds on the unit can be made by:

- Supervisor inspection of the PowerBuoy from shore via binoculars (weekly);
- Preventative maintenance/site inspection visits (monthly);
- Unplanned Maintenance;
- Cetacean Study visits to the PowerBuoy area;
- Fish and Invertebrates Study visits; and
- Offshore Avian Use Study visits.

Observers, including appropriate Company staff, will receive training for identifying and recording observations of pinnipeds. The Company proposes to conduct sampling for a full year following deployment of the single PowerBuoy, and will conduct a minimum of 75 direct observation events. It is anticipated this number of observations, conducted throughout the year as described below, will provide sufficient statistical power to determine if pinnipeds are hauling out on the PowerBuoys. Each of the listed bullets above represents an observation event; multiple observations in a single day will constitute a single observation event; therefore, at least 20 percent of the days in each year would have one or more observations. Observation events will vary in time, ranging from the supervisor surveying the PowerBuoys from shore (approximately one minute), to more repeated observations during visits to the Project vicinity during other listed observation opportunities (representing cumulative tens of minutes). Observations will occur throughout the year (e.g., supervisor inspections to occur weekly, site inspections to occur monthly, Offshore Avian Use Study surveys to occur monthly for multiple days). If feasible, observers will take photographs of any pinniped that is hauled.

Metrics and Analyses

Due to the binary nature of this evaluation, the only metric of concern will be whether or not pinnipeds are observed on the PowerBuoy. If pinnipeds are observed on the PowerBuoy after deployment, the Company will provide notice to the Aquatic Resources and Water Quality Implementation Committee within two weeks that describes the event observed. The Company will also initiate a discussion on how to best respond to the event, including the potential of implementing the fencing mitigation measure. The Company will also provide a summary of observations to the Aquatic Resources and Water Quality Implementation Committee in periodic updates, schedule of which will be determined by the Aquatic Resources and Water Quality Implementation Committee. If no pinniped haul-out behavior is observed, the Company will provide a summary report to the Aquatic Resources and Water Quality Implementation Committee within six weeks of completing the direct observations of the single PowerBuoy.

5.2 Presence and Abundance

Stakeholders have raised the issue that the introduction of the Project's underwater infrastructure may affect the existing predator/prey interactions through changes in the benthic and marine community composition and habitat. Of particular concern is the potential that salmon may be attracted to the PowerBuoy array's structure, in much the same way an artificial reef will serve as habitat for some species and that pinniped species may in turn be drawn to the area to feed on them.

While the Fish and Invertebrates Study will be conducted to assess potential changes in the marine community (including salmon) following Project deployment, this study (the Pinniped Study) proposes to collect observational data about the number of pinnipeds in and around the wave park following the deployment of the single unit and after deployment of the 10 units. This qualitative methodology is consistent with other preliminary studies involving new technologies, in that they tend to be oriented towards "hypothesis generation" or observational and descriptive in nature rather than "hypothesis testing" (Hartwick and Barki 1994).

Sampling Methods and Rationale

As with the haul-out study, direct observations will be used to establish, in this case, pinniped presence and abundance following deployment of the single and then multiple PowerBuoy array. However, due to the necessity of being able to identify species type and numbers, observations will occur from vessels in close proximity to the generating unit.

Sampling Frequency Needs to Meet Specific Objectives

As with the haul-out study, the Company proposes to conduct sampling on an opportunistic basis. Following deployment of the first unit and again after deployment of the 10-unit array, the Company anticipates that direct observations of pinnipeds in and around the PowerBuoy can be made by:

- Preventative maintenance/site inspection visits (monthly);
- Unplanned maintenance;
- Cetacean Study visits;
- Fish and Invertebrates Study visits; and
- Offshore Avian Use Study visits.

Observers, including appropriate Company staff, will receive training for identifying and recording observations of pinnipeds. The Company proposes to conduct sampling as follows:

- Following single-PowerBuoy deployment (Phase I) - observations will be made opportunistically as outlined above for a full year.
- Following 10-PowerBuoy deployment (Phase II) - observations will be made opportunistically as outlined above during Years 1, 2, 5, 10, and 15. Direct observation events will occur throughout the year. To ensure seasonal distribution, at least three

observations events occurring in spring, summer, and fall; winter observations will be made as weather conditions permit.

As the purpose of this study is to establish a qualitative evaluation of pinniped presence and abundance in and around the wave park, there are no statistical thresholds to meet at this time.

Metrics and Analyses

The Company will develop data sheets for recording the following information:

- Species and number of pinnipeds present;
- Number of pups present;
- Closest observed distance from the PowerBuoy; and
- Estimated swell height, Beaufort state, date/time of observation, and weather conditions (e.g., precipitation, air temperature, cloud cover).

Observers will record any other information that they consider relevant for understanding the relationship between pinniped species and the PowerBuoys (e.g., general condition of pinnipeds).

The Company will provide a summary of study progress to the Aquatic Resources and Water Quality Implementation Committee in periodic updates, the schedule of which will be determined by the Aquatic Resources and Water Quality Implementation Committee. In addition, the Company will provide a summary of results of the Phase I (single PowerBuoy) observations within six weeks of completing the direct observations of the single PowerBuoy, and will provide final results in an annual report. For Phase II (10 PowerBuoys) observations, the Company will provide a summary of results in an annual report.

Constraints, Limitations, and Feasibility

Direct observation of pinniped presence and abundance offers a straightforward, repeatable means for assessing the effectiveness of haul-out deterrents. While the nature of limited sampling periods means that events may occur that are unobserved, this type of uncertainly is inherent in any animal study. We expect that this study will be supplemented by anecdotal evidence of pinniped responses to the PowerBuoy, which the Company will share with the Aquatic Resources and Water Quality Implementation Committee.

Sampling success will be partially dependent on ocean conditions. During adverse weather conditions, it may not be possible to view the PowerBuoy or to access the site. The Company's reports will note incidents where site conditions influenced sampling activities.

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Reedsport OPT Wave Park, LLC.
Reedsport OPT Wave Park
FERC No. 12713

Issue Assessment
Alteration of Habitat/Effects of Project Installation
(Fish and Invertebrates Study)
May 6, 2010

1.0 Description of Issue

Project construction and operation will alter habitat in the Project area by installing Project components and creating new habitat features (hard structure in surface, water column, and benthic habitats). Resulting potential environmental effects include:

- Direct effects to the benthic community from placing Project mooring components and subsea transmission cable on the seabed, and
- Changes to marine community composition and predator/prey interactions.

2.0 Relevant Existing Information

The Applicant Prepared Environmental Assessment (APEA) provides an extensive characterization of the marine geology and marine community that occurs in the Project area.

3.0 Project Effects

The installation of the transmission cable, mooring system, and PowerBuoys involves the use of heavy construction equipment including cranes, barges, tugs, and trenching equipment. The disturbance of the seabed may affect the local benthic community, specifically within the footprint of the gravity base anchors and along the cable route.

The proposed Project will consist of approximately 16 steel-reinforced concrete anchors having dimensions of approximately 32.8 feet in diameter by 24.6 feet in height (10 meters in diameter by 7.5 meters high). The anchors are presently designed to protrude above the ocean floor. The Project will also consist of synthetic mooring lines that may become encrusted with biofouling[11]. This biofouling will potentially have some effect on food supply and may have an impact on the quantity and type of fish species that will be located in and around the proposed Project. The Aquatic Species Subgroup identified the need to better quantify the effect and assess the potential mooring line biofouling impacts, whether positive or negative.

The introduction of the Project's underwater infrastructure mentioned above may affect the existing predator/prey interactions through changes in the benthic and marine community composition and habitat. Aquatic Species Subgroup members are particularly concerned that Pacific salmon and their predators may be attracted to the PowerBuoy array area and that accelerated predation on salmon may occur.

These potential effects are discussed further below.

[11] The PowerBuoys, subsurface floats, and subsea pod will have antifouling paint applied to all (in-water) surfaces to inhibit growth of biofouling species.

3.1 Direct Effects to the Benthic Community from Placement of Project Components on the Seabed

Benthic biota includes bivalves, snails, worms, and other species of immobile or slow-moving benthic organisms. If in the path of the transmission cable or directly beneath the mooring line anchors, these organisms could be covered, disturbed, or injured during the Project installation. Pelagic fish are highly mobile and therefore would not be affected during installation of the PowerBuoys, associated moorings, and the subsea transmission cable. Bottom-dwelling fish and other mobile organisms, such as crabs, would likely move to nearby areas during construction activities (Federal Energy Regulatory Commission [FERC] 2007). Each anchor will cover an area approximately 845 square feet, and the total area of the seafloor ultimately covered by 16 anchors would be 13,526 square feet (0.31 acres), or 0.95 percent of the actual PowerBuoy array footprint, including navigational safety zone. The subsea cable will be buried at a minimum of three to six feet beneath the seafloor stretching about two miles from the subsea pod to the effluent pipe. The Company intends to use trenching or jet plowing to bury the cable, but the method will be determined by final selection of a cable deployment contractor.

The presence of the anchors may slightly reduce available soft bottom foraging habitat and temporarily displace proximal habitat usage during installation. Further, the anchor systems could potentially alter sediment composition and distribution patterns, which may mildly alter the habitat near the anchor system.

Any effects related to construction of the project are expected to be minor and short term. After Project construction is completed, sediments around the subsea cable and anchors will quickly redistribute, benthic organisms will resettle in disturbed areas, and groundfish and other fish use of the area will, perhaps immediately, return to preconstruction levels.

The turbulence created by the displacement of seawater during the transmission cable installation would likely result in trenched sand being deposited in the proximal area from the centerline of the subsea cable. Because the sediment is sand and not finer grained substrate, the suspended sediment is expected to quickly settle into or near the disturbed area. As proposed in the water quality component of the Fish and Invertebrates Study Plan (Section 5.3.8), prior to, and during, deployment of the single PowerBuoy and the 10-unit array, the Company will measure near-bottom turbidity at a location near an anchor deployment and the subsea cable route.

3.2 Changes to Marine Community Composition and Predator/Prey Interaction

The anchoring and mooring system will provide habitat for marine life including biofouling organisms. Common biofouling species include barnacles, mussels, bryozoans, corals, tunicates, and tube dwelling invertebrates that are composed of a hard calcium carbonate exterior. Other biofouling species include algae and soft organisms such as sponges and hydroids. Biofouling organisms have been observed to thrive from the surface to depths ranging from 660 to 6,600 feet (200 to 2,000 m) (Hart 2005), so it is reasonable to expect biofouling on the anchors and the mooring lines.

Fish typically seek areas of shelter, structure, or cover for protection from predators (Johnson and Stickney 1989). Artificial structures such as docks can represent attractive sources of cover and refuge, especially hard substrate having a vertical orientation (U.S. Army Corps of Engineers

[USACE] 2004), because many marine areas have comparably little structure associated with the seabed. Colonization by marine life that otherwise would not occur in a particular area, in turn, attracts other predatory fish (Ogden 2005). At the Vindeby offshore wind farm along the Danish Coast, sampling conducted before and after installation found that fish abundance increased and that other flora and fauna generally improved (Robert Gordon University [RGU] 2002). The Minerals Management Service's (MMS) Rigs to Reefs program reported 20 to 50 times more fish near artificial reefs with biofouling than in the surrounding waters (MMS 2007*a*). Previous environmental assessments for wave energy projects have referred to marine biofouling as a potential direct benefit to marine biological resources (Department of the Navy 2003).

The PowerBuoy deployed in New Jersey has been onsite for a combined total of 24 months. Periodic inspections were performed both above and below the water at one- and two-month intervals. Biological growth in the form of bivalves has occurred primarily on the mooring lines. The PowerBuoy structure itself is coated with an anti-fouling paint that has been effective in deterring biological growth.

Changes to the local habitat associated with the deployment of a wave energy array may attract structure-oriented fish, such as rockfish. This effect is not necessarily negative; artificial structures may benefit rockfish (Love et al. 2006) and may enhance local fisheries. However, the Project does differ from many artificial reefs in that the PowerBuoy mooring structures are widely spaced in the array, the mooring lines are only 5 inches in diameter, and the anchors are located at depths of at least 204 feet (62 meters); artificial reef structures are often in shallower water. Therefore, to what degree the Project structures will serve as artificial reefs is uncertain.

The PowerBuoy array may also act as a Fish Aggregation Device (FAD) for pelagic fish and invertebrates. While there are few empirical studies that link the availability of physical structure in the mid-water or near-surface to aggregations of fish in cold temperate waters, there are numerous documented cases of drift algae as well as more durable flotsam attracting fish (Crawford and Jorgenson 1993; Dempster and Taquet 2004; Druce and Kingsford 1995; Kokita and Omori 1998; Mitchell and Hunter 1970; Parin and Fedoryako 1999; Safran and Omori 1990). The state of Hawaii deployed FADs off the coast of the Hawaiian Islands starting in the late 1970s with a considerable increase in fish catch around the FADs (University of Hawaii 2007).

Related to potential marine community changes associated with the Project, subsequent changes in predator-prey interactions are also possible, specifically as they relate to salmon. Members of the Aquatic Species Subgroup are concerned that juvenile salmonids may be attracted to the Project structure for food or cover, which may increase their risk of predation by pinnipeds or other fish that also are attracted to the Project area.

Also related to potential marine community changes associated with the Project, changes in the distribution and abundance of marine species within the array, relative to areas outside of the array, are also possible. However, habitat alterations attributable to this Project would almost certainly be negligible (the total footprint is about 30 acres [0.12 km^2]) and an effect on populations of affected species is unlikely. Nonetheless, the Company's proposed Fish and Invertebrates Study will monitor the marine community in the PowerBuoy array before and after deployment (see below), to collect data to evaluate potential Project effects on the distribution and abundance of key species and provide information for use in adaptive management, and informing future discussions of development of larger projects.

4.0 Need for Additional Information

As previously discussed, some ecological changes are anticipated. However, specific Project effects are not known. Therefore, additional study is warranted. As a result, the Company has developed this Fish and Invertebrates Study.

5.0 Fish and Invertebrates Study Plan

5.1 Introduction

The potential effects of the Project on habitat in the Project area include disturbing benthic habitat associated with moorings and cables, and creating new habitat features, such as hard structures in surface, water column, and benthic habitats. This study is proposed to characterize and describe key fish and invertebrate species in the Project area and evaluate potential effects of the Project on these resources.

The Company submitted initial and subsequent drafts of the Fish and Invertebrates Study Plan to the Aquatic Species Subgroup for their review in Fall 2007, January 2008, as part of the Preliminary Draft Environmental Assessment (PDEA) in July 2008, and with the License Application in Feburary 2010. The study plan has been prepared taking into consideration the comments raised by stakeholders.

The objectives of this study are to:

1. Characterize and describe the presence and abundance of key fish and invertebrate species in the Project area, prior to deployment of the 10-PowerBuoy array; and
2. Evaluate the potential effects of the Project on these resources following Project deployment.

Any additional sampling or studies not included in this plan will be determined through the process agreed to within the Adaptive Management Process (Exhibit B of the Agreement).

5.2 Species and Life Stages of Concern

To better define the suite of species of concern and possible indicator species and groups associated with the Project and Project area, the scientific literature was reviewed and input was gathered from the Aquatic Species Subgroup and state and federal agency scientists, from peer-reviewed journals and other recent research, and from local dredge spoil site-monitoring reports. The species and life stages of concern, their timing, and potential biological and ecological effects associated with the Project were considered. General agreement on the indicator species (Table 1) was reached at an Aquatic Species Subgroup meeting in Newport, Oregon, in January 2008 and with subsequent discussion with the agencies.

Criteria for selection included:

- marine and anadromous fishes and invertebrate species that could occur in the Project area before and/or after Project construction;
- their potential value as indicators of local ecological processes (Kwak and Peterson 2007; Roset et al. 2007);
- their regulation under governmental statutes (e.g., Essential Fish Habitat, Endangered Species Act); and

- Their commercial or recreational importance.

The likely periods of occurrence, their peaks in abundance in the Project area, and the durations of those periods, were tabulated for the selected fish and invertebrate species and life stages (Table 1). This information will assist in designing monitoring timing and frequency.

5.3 Species Groups and Specific Indicator Species for Evaluation

Based on the criteria above, the major species/life stage groupings selected for evaluation are:

- Juvenile salmon;
- Rockfishes;
- Dungeness crab;
- Green Sturgeon;
- Flatfish and epibenthic invertebrates;
- Pelagic fish and invertebrates;
- Biofouling community; and
- Benthic infauna.

Sampling methods, frequencies, data analyses and metrics, and other sampling and analytical constraints, are discussed for each selected species or group, in the following sections. Water quality will also be addressed in this study plan, as described below.

5.3.1 Juvenile Salmon

Juvenile salmonid monitoring is proposed; however, evaluation of effects on populations or run status of salmonids is not proposed. State and federal agency monitoring of commercial and recreational fisheries will provide population information that will be considered in the analyses of juveniles. The Company has proposed a separate study of electromagnetic fields (EMF) associated with wave energy conversion installations; that study will address the magnitude and opportunity for adult and juvenile salmonid interactions with Project-associated EMF.

5.3.1.1 Sampling Methods and Rationale

Salmonid[12] use of marine environments remains the least understood aspect of salmonid biology (Brodeur et al. 2000; Brodeur et al. 2003). Little is known about where they go or the relative importance of the diverse ecological factors that affect their growth and survival at sea. Nevertheless, potential effects on salmonids in nearshore habitats are an important concern. The objective of monitoring juvenile salmonids is to develop a tractable means for acquiring information about salmonid interactions with wave energy installations. The plan design assumes that the juvenile stage is more vulnerable to environmental impacts (e.g., local increases in predator abundance) than adult forms. The potential effects of the wave energy array on juvenile salmonids include: 1) attraction to the array; 2) avoidance of the array; 3) attraction of predatory fish species to the array; and 4) attraction of predatory bird and mammal species to the array.

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[12] We restrict our use of the term "salmonid" here to members of the genus *Onchorhynchus* that spawn in freshwater habitat in Washington, Oregon and California, but spend some portion of their life history in the marine environment.

TABLE 1

MARINE AND ANADROMOUS FISHES AND INVERTEBRATES SELECTED AS INDICATOR SPECIES OF CONCERN AND THEIR LIKELY PERIODS OF NEARSHORE OCCURRENCE OFF OF THE CENTRAL OREGON COAST

Species	Life stage	Month			peak (legend)	peak period			possible (legend)	possibly present			
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pacific Sardine	Larvae							possible	possible	peak	peak	possible	
	Juvenile	peak	peak	possible	possible	possible	possible	possible	possible	possible	possible	possible	peak
	Adult						possible	peak	peak	peak	possible		
Northern Anchovy	Larvae						peak	peak	peak	possible			
	Juvenile/Adult				possible	possible	possible	peak	peak	peak	possible		
Whitebait Smelt	Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Eulachon	Adult	possible	possible	peak	peak	possible	possible	possible	possible	possible	possible	possible	possible
Coastal Cutthroat Trout	Smolt				possible	peak	peak	peak	possible				
	Adult	possible					possible	peak	peak	possible	peak	possible	possible
Chinook Salmon, Spring-Run	Smolt	possible	possible	possible	peak	peak	peak						
	Adult	possible	possible	possible	possible	peak	peak	possible	possible	possible	possible	possible	possible
Chinook Salmon, Fall-Run	Smolt								possible	peak	peak	possible	
	Adult	possible	possible	possible	possible	possible	possible	possible	possible	peak	peak	possible	possible
Coho Salmon	Smolt				possible	peak	peak	peak	peak				
	Adult	possible	possible	possible	possible	possible	possible	peak	peak	peak	possible	possible	possible
Steelhead	Smolt				possible	peak	peak	peak	peak				
	Adult	possible	possible	possible	possible	possible							possible
Crangon spp	Adult	possible	possible	peak	peak	possible	possible	possible	possible	possible	peak	peak	possible
Mysida (Order)	Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Dungeness Crab	Megalops			possible	peak	peak	possible						
	Juveniles						possible	possible	possible	possible			
	Adult	peak	peak	peak	peak	peak	possible	possible	possible	possible	possible	possible	peak
Humboldt Squid	Adult*					possible	possible	possible	possible	peak	peak	peak	possible
Weathervane Scallop	Larvae, Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Pacific Tomcod	Juvenile/Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Black Rockfish	Larvae	possible	possible	peak	peak	peak	possible						
	Juvenile/Adult	peak	peak	peak	peak	peak	peak	peak	peak	peak	peak	peak	peak
Blue Rockfish	Larvae	peak	possible	possible							possible	possible	peak
	Juvenile/Adult	possible	possible	possible	peak	peak	peak	possible	possible	possible	possible	possible	possible
Bocaccio	Larvae	possible	possible	possible	possible								possible

Species	Life stage	Month Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					peak	peak period			possible	possibly present			
	Juvenile/Adult	possible	peak	peak	peak	peak	peak	peak	peak	possible	possible	possible	possible
Canary Rockfish	Larvae				possible	peak	peak	possible					
	Juvenile/Adult	peak	peak	peak	peak	peak	peak	peak	peak	peak	peak	peak	peak
China Rockfish	Larvae	possible	possible	possible	peak	peak	peak						
	Juvenile/Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Copper Rockfish	Larvae					peak	peak	possible					
	Juvenile/Adult	possible	possible	possible	peak	peak	peak	peak	peak	possible	possible	possible	possible
Quillback Rockfish	Larvae				possible	peak	peak	possible					
	Juvenile/Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Yelloweye Rockfish	Larvae				possible	peak	peak	peak	possible	possible			
	Juvenile/Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Cabezon	Larvae	peak	peak	peak								peak	peak
	Juvenile/Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Kelp Greenling	Larvae	peak	peak										peak
	Juvenile/Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Lingcod	Juvenile				possible	peak	peak	peak	possible	possible			
	Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Speckled Sanddab	Juvenile/Adult	possible	possible	possible	possible		possible	peak	peak	peak	peak	possible	possible
Pacific Sanddab	Juvenile/Adult	possible	possible	possible	possible	possible	peak	peak	peak	peak	peak	peak	peak
Butter Sole	Juvenile/Adult	possible	possible	possible	possible	possible	peak	peak	peak	peak	peak	possible	possible
Sand Sole	Juvenile/Adult		possible	peak	peak	possible	possible	possible	possible				
Rex Sole	Juvenile/Adult						possible	possible	possible	possible	possible		
Petrale Sole	Juvenile/Adult						possible	possible	possible	possible	possible		
English Sole	Juvenile/Adult	peak	peak	peak	peak	possible							possible
Pacific Halibut	Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Big Skate	Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Spiny Dogfish	Adult					possible	possible	possible	possible	possible			
Soupfin Shark	Adult				possible	possible	possible	peak	peak	peak	possible		
Green Sturgeon	Adult	possible	possible	possible	peak	peak	possible	possible	peak	peak	peak	possible	possible
Pacific Herring	Juvenile/Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Didemnum vexillum	Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Botrylloides violaceus	Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Botryllus schlosseri	Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
Styela clava	Adult	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible	possible

* Egg masses of Humboldt squid have been found in the Gulf of California and spawning is thought to also occur in the Costa Rican Dome; no spawning has been reported in temperate waters.

Trawling has provided some of the best available information about juvenile salmonids at sea, and these efforts have indicated that the marine distribution of juvenile salmonids is closely associated with changeable oceanographic conditions (Schabetsberger et al. 2003; Brodeur et al. 2004; Emmett et al. 2004; Brodeur et al. 2005; Emmett et al. 2006). The distribution of juvenile salmonids is probably related to improving foraging opportunities. However, these results also suggest that trawling is not an effective method for evaluating the site-specific effects of a Project, in which sampling would necessarily focus on a single, size-limited impact site and several comparably sized control sites. In addition, an effective trawl-sampling program for juvenile salmonids requires a relatively large vessel, capable of tows at 3 knots, and an intensive sampling regime.

Marking or tagging studies are classic methods for estimating abundance or tracking movement patterns, but neither method was selected for evaluating juvenile salmonids. From catch-per-unit-effort studies, we anticipate that relative abundance estimates can be used with a "Beyond Before-After-Control-Impact" (BBACI) design, to complete an impact study with greater statistical power and less effort than a mark-recapture effort. A mark-recapture study would require large numbers of tagged fish and a very substantial recapture effort. Regarding movement studies, we know so little about how juvenile salmonids move in marine habitats, that attempting to track them in this environment is premature. Instead, the study plan proposes an intensive, multi-method sampling effort at the Project site and at several control sites, to determine first if juvenile salmonids approach the Project site.

Relative abundance: Multimesh gillnet catch-per-unit-effort (CPUE). Multimesh gillnets will be used to capture small, medium and large fishes (sizes ranging from outmigrating salmonid smolts to adult Chinook salmon) at the Project site and at two control sites, following a BBACI experimental design. The gillnets used in this study will be sized to capture both juvenile and adult salmonids as well as other comparably sized fishes, including predators of juvenile salmonids, which should provide information on presence of juvenile and adult life stages at the Project and control sites. Given acceptable sample sizes, CPUE will be calculated as a measure of relative abundance for comparisons among sites. Gillnets are likely to result in mortality of fish captured, and are a highly effective sampling device, particularly where a spatially explicit approach is mandated (Rotherham et al. 2006).

Predation: Gut contents analysis. To measure the relative risk of predation on juvenile salmonids, this plan proposes sampling for juveniles using gut content analysis from predators caught using multimesh gillnets, hook and line methods, and possibly traps. Predators include *Sebastes* spp., *Ophiodon elongatus, Microgadus proximus, Psettichthys melanostictus*. Tracking gut contents of potential predators will measure the relative risk of predation to juvenile salmonids as well as predation rates for key fish predators in the vicinity of the Project and at control sites. This approach will:

- Assess the presence of salmonids;
- Identify the fish predators of juvenile salmonids.

Sampling of predators will occur during the late spring and early summer, when juvenile salmonids are likely entering the nearshore environment. Sampling will be conducted following a BBACI design. There is the possibility of integrating this sampling effort with a recreational fishing tournament, using commercial passenger fishing vessels. This would have the advantages of reducing cost, developing community involvement, and increasing sampling effort. However, fishing effort would need to be standardized and documented. The stomach contents of captured fishes will be analyzed to assess species or species-group predation rates on juvenile salmonids.

5.3.1.2 Sampling Frequency

Relative abundance: Multimesh gillnet CPUE – Multiple sampling efforts are proposed, two each year (occurring late spring and early summer, to cover peak periods when juvenile salmonids are expected to be present in the area). Sampling would begin prior to the installation of the planned array. Soak times will depend on results from initial efforts to avoid excessive fish mortality. Overnight soaks may be employed if initial efforts indicate improved salmonid sampling efficiency. Following installation of the Project, sampling will be repeated yearly for three years in years 1, 2, and 3, to allow for some degree of community maturation. This procedure is designed to evaluate the changing fish community associated with the Project, assuming that the Project does alter the local abundance of potential predators. The two efforts per year (late spring and early summer) would capture those periods when Chinook and coho salmon outmigrations are near their respective peaks.

Predation: Gut Contents Analysis - Four sampling efforts each year are proposed, including one prior to the installation of the PowerBuoy array and during years 1, 2, and 3 following installation. Sampling during each year is intended to address the possibility that the temporal distribution of juvenile salmonids is wider than the peak period of outmigration (late spring/early summer) suggests.

5.3.1.3 Metrics and Analyses

Data from stomach contents of piscivorous fishes will be used to develop an index of relative importance (e.g., Barry et al. 1996); this metric will permit the direct comparison of potential predators on juvenile salmonids. Data analysis for the gillnet CPUE experiment will employ asymmetrical analysis of variance (Underwood 1994) on the capture rates (number of fish captured per hour).

5.3.1.4 Constraints, Limitations, and Feasibility

Both gut content analyses and gillnet CPUE experiments offer straightforward, repeatable means for assessing key aspects of ecological impacts attributable to wave energy installations. However, neither approach will likely permit an absolute estimate of predation on juvenile salmonids, because that would require an estimate of the number of salmonids likely to encounter predators associated with the PowerBuoy array.

Unlike towed nets, these approaches are unlikely to be hampered by difficulties with sampling in close proximity to or even within the PowerBuoy array. Because of the comparatively minor logistical challenges, these techniques make suitable sample sizes far more achievable.

5.3.2 Rockfish

5.3.2.1 Sampling Methods and Rationale

Rockfishes comprise a diverse and ecologically important component of the nearshore marine community in the temperate eastern Pacific Ocean (Dean et al. 2000; Hobson 1994; Love et al. 2002). They are important predators of invertebrates and fishes (Love and Westphal 1981; Miller and Geibel 1973; Prince and Gotshall 1976; Singer 1985); as such, they offer an excellent, albeit non-random, means of sampling these organisms. Rockfishes and other groundfish species (e.g., *Ophiodon elongatus*, *Psettichthys melanostictus*) will be collected to assess possible changes in their distribution due to installation of the Project, and to determine the potential effect of these predators on smaller fishes, particularly juvenile salmonids (*Oncorhynchus* spp.) but also pelagic fish and invertebrates. Assessment of the latter will rely on analyzing gut contents. We anticipate that the changes to the local habitat associated with the deployment of a wave energy array may attract rockfishes to the structure.

The plan proposes a BBACI design (Kingsford 1999); sampling these piscivores at the Project will occur before installation and after installation, and concurrently at multiple control sites (see Section 5.3.11 for further discussion of control sites) that are chosen for their comparable environmental characteristics (depth, exposure, substrate, etc.). We anticipate sampling these fishes primarily using hook and line methods and multimesh gillnets, but some trapping may also be warranted (e.g., for *Scorpaenichthys marmoratus*). Gut contents would be preserved following standard techniques (Barry et al. 1996), and identified in the laboratory to the lowest reasonable taxonomic group.

This effort would accomplish two goals: to record potentially changing distributions in the fish fauna at the Project site, and to assess predation patterns associated with the Project. These are important considerations because significant changes in faunal distributions would likely be indicative of some form of habitat conversion, and spatial alterations in the risk of predation to small fishes could have negative, unintended consequences for some species of concern (e.g., *Oncorhynchus* spp). Changes in distributions are not always negative; artificial structures may benefit rockfishes (Love et al. 2006) and may enhance local fisheries.

Limited visual survey data from maintenance dives and/or remotely operated vehicle (ROV) surveys will be performed by the Company as part of its Operations and Maintenance (O&M) Plan. As specified in the O&M plan, which is included as an attachment to the APEA, Project components will be visually inspected by SCUBA divers or ROV. This will be carried out every three to four months, weather permitting, for the first two years, and annually thereafter. Video camera recordings will be performed during underwater inspections during the first two years and year 5 of the Project. Video footage from these operations and maintenance surveys could provide information on young-of-the-year rockfish recruitment and the qualitative abundance of these and other small, cryptic fishes.

5.3.2.2 Sampling Frequency

Sampling will be conducted four times per year to cover probable seasonal changes, with at least one year's sampling prior to the installation of the Project. Sampling will also occur after installation in years 1, 2 and 3, because the array may function as an artificial reef/FAD (Love et al. 2006; Wilhelmsson et al. 2006) with a community that matures over time. Video footage collected during underwater O&M inspections of Project components will be taken approximately every 3 to 4 months in years 1 and 2 and during the annual inspection in year 5. All footage from years 1, 2 and 5 will be evaluated by a marine biologist.

5.3.2.3 Metrics and Analyses

The metrics for these rockfish studies would include:

- Species and numbers collected;
- Catch-per-unit-effort;
- Species-specific prey, taxonomic group; and
- Species-specific prey, frequency.

The rockfish/groundfish assemblages will be characterized at the Project and control sites using species lists. Species richness will be directly compared across sites and sampling dates. Fishing effort and species-specific numbers will be used to calculate CPUE to compare fish abundance between sites and dates. Gut content data will be used to calculate an index of comparative importance from both a predator and prey perspective; the former will identify the relative consequence of different prey items for individual piscivores, and the latter will rank the importance of different predators in the ecology of a given prey species. These will be limited to those species for which sufficient data are available. In all instances, a BBACI design is recommended (Kingsford 1999; Underwood 1994) to develop an asymmetrical ANOVA model for comparing sites (spatial effects) and temporal effects, and for measuring interactions. Results of the gut content analysis will be evaluated alongside results of the Pinniped Study results (Issue Assessment 3) to examine overall predation issues.

The O&M video footage would be reviewed with a goal of identifying small, cryptic fish species, including juvenile rockfishes, and evaluating changes in species richness. Qualitative assessments of relative abundance will also be conducted.

5.3.2.4 Constraints, Limitations, and Feasibility

Sampling success will be partially dependent on ocean conditions; this may limit the availability of suitable days for accessing sites, particularly in the winter months. Hook and line capture techniques are biased towards specific species and sizes, although this is also an advantage in that it permits targeted sampling for the principle species of interest and at the sizes most likely to be of consequence in understanding predation on juvenile salmonids.

5.3.3 Dungeness Crab

The potential effects of the Project on Dungeness crab are: 1) changes to the habitat associated with structure that decrease available habitat; 2) changes to the predatory species assemblages associated with the Project that decrease crab abundance in the Project area; 3) attraction of crabs to the Project; or 4) avoidance of the Project area. If these effects occur, it is anticipated that they would become apparent relatively soon after the project is built. Each of these potential effects would result in a change in the distribution and abundance of crabs within the array, relative to areas outside of the array. However, habitat alterations attributable to the Project would almost certainly be on such a small spatial scale (the total footprint is about 30 acres [0.12 km^2]) that a population effect is unlikely. Therefore, the objective of the Dungeness crab studies is primarily to evaluate if the Project affects the local distribution and abundance of sub-adult and adult Dungeness crab (with "local" defined here as tens of meters). Juvenile crabs will likely appear both in the gut content studies and in the beam trawl survey used to sample small benthic fishes and epibenthic invertebrates. These data will be used to record the presence of juvenile crab across impact and control sites and among seasons and years.

5.3.3.1 Sampling Methods and Rationale

The proposed sampling method is to use baited traps to determine if crab distribution and abundance is altered within the array, when compared to three control areas, two located adjacent to the array and one at a distance from the array, for example between the proposed Coos Bay and Reedsport projects. The benefits of using commercial crab traps include the possibility of being able to compare data with commercial catches, and the opportunity to involve the local commercial fishing community. By coordinating with the fishing community, sample sizes will increase, as will the certainty that Dungeness crab will be collected. To retain smaller crabs, trap escape rings will be blocked. Trap surveys using catch per unit effort (CPUE) are an effective means for Dungeness crab population assessment. Traps may exhibit seasonal and sex-specific biases; beam trawl data collected concurrently (section 5.3.5) will be used with trap survey data, to assess and correct for any trap CPUE bias. Trap- and larger trawl-collected crabs will be tagged with a uniquely numbered Floy tag to control for potential multiple capture events.

5.3.3.2 Sampling Frequency

Dungeness crab are likely to be present in the winter/spring in the Project area (Table 1). However, the best time to sample is expected to be before the commercial fishery starts in late fall, when adult and potentially juvenile crabs are likely to be most abundant in the Project area, and when females are less likely to be ovigerous (carrying eggs). Using a BBACI sampling design (Kingsford 1999), sampling will occur at least once in November/December, prior to the commercial season opening, and once in the summer when sea conditions are most conducive for sampling near and/or in the array. Sampling will occur in March before Project installation (i.e., before installation of multiple PowerBuoys pursuant to the License) and after Project installation in years 1, 2, and 3.

Sets of traps will be standardized (e.g., using the same bait species and quantity per trap), and soak times will be documented. Set times will be standardized, using a minimum of twenty traps at each site (array and controls), checked at least once every 24 hours, and reset over a period of at least three days. Local commercial fishermen will be consulted to further refine and implement this study.

5.3.3.3 Metrics and Analyses

Relative abundance metrics will be used (e.g., CPUE or modeled density estimates). The data will likely not meet the assumptions for parametric statistical analyses. Relative abundance will likely be estimated assuming a non-normal distribution (e.g., Poisson), and will be analyzed using log-linear models or other multivariate approaches.

5.3.3.4 Constraints, Limitations, and Feasibility

One potential constraint is the feasibility of working within the Project array using traps that require anchoring and buoy lines for retrieval. Traps may need to be deployed using methods that minimize impacts to the array, including but not limited to specially designed anchoring and deployment devices into or on the array, to minimize the potential for trap entanglement with the moorings and tethers.

5.3.4 Green Sturgeon

5.3.4.1 Sampling Methods and Rationale

Very little is known of the marine ecology of sturgeon (*Acipenser* spp.) (Moyle 2002), although available information indicates that Green Sturgeon migrate extensively in long-shore coastal waters (NOAA 2005; Erickson and Hightower 2007; Lindley et al. 2008). Due to their population status and the lack of basic ecological knowledge, no obvious and reasonable means are available for assessing possible environmental impacts of wave energy devices on these species. In the vicinity of the Project, traditional means of sturgeon sampling—trawl, gillnet, hook and line—are extremely questionable, because the possibility of harm is likely as high as the possibility of encounter is low.

On-going and proposed studies involving acoustic and pop-up satellite tagging methods are likely to allow additional characterization of how sturgeon use nearshore habitats (Erickson and Hightower 2007; Lindley et al. 2008). In particular, several studies are employing acoustic tags, with increasing numbers of adult and juvenile sturgeon receiving tags. Hydrophone receivers on the Project components may be able to detect nearby tagged sturgeon.

After deployment of the PowerBuoy array, two hydrophone receivers (VEMCO VR2W) will be fastened to the array within safe SCUBA range (<50 meters depth). Two (2) additional hydrophones will be located at control site(s) for a total of four (4) hydrophones deployed, including the two (2) at the PowerBuoy array. The Aquatic Resources and Water Quality Implementation Committee shall determine if one (1) hydrophone is deployed at each control site or both are deployed at one of the control sites. Orientation and placement of the receivers within the control site(s) will be determined by the Aquatic Resources and Water Quality Implementation Committee. Hydrophone receiver data will contribute to on-going efforts to track coastal migrations of Green Sturgeon.

The open-water working range of the VEMCO VR2W receiver, where detection rate is near 100 percent, varies primarily as a function of ocean condition and signal strength (Pincock 2008) (Table 2). We expect that, as part of existing tagging programs, Green Sturgeon are likely to be tagged with high-powered tags (150-165 dB) and that smaller fish such as rockfish may be tagged with lower powered tags (142-150 dB).

Table 2
Estimated detection range (m) of hydrophone receivers for two different tag types and different sea states

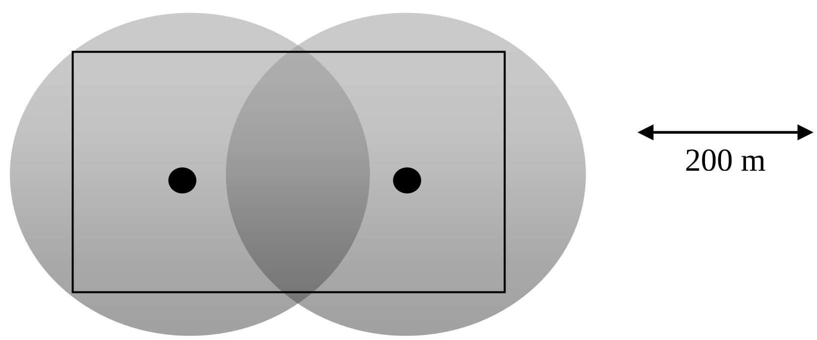
Sea State	Range (148 dB)	Range (154 dB)

0	564	729
1	548	710
3	429	577
6	301	429

Because of the many factors that may affect detection range (Miyagi et al. 2008; Simfendorfer et al. 2008), we reduce the 301 meters "worst-case" range to an even more conservative 200 meters radius. Figure 1 illustrates the coverage provided by two such receivers for the planned wave energy array. The dark rectangle shows the outline of the Project footprint (300 x 400 m). The black dots show the receiver locations at either end of the array. The gray circles illustrate the areas of near 100 percent detection probability for a relatively weak signal under poor conditions. Where the gray circles overlap, the signal is almost certain to be detected by both receivers simultaneously. The location and orientation of the two (2) receivers within the PowerBuoy array shall be determined by the Aquatic Resources and Water Quality Implementation Committee.

Figure 1

Coverage provided by two receivers for the planned wave energy array[13]



5.3.4.2 Sampling Frequency

After deployment of the PowerBuoy array, two (2) hydrophone receivers (VEMCO VR2W) will be fastened to the array within safe SCUBA range (<50 meters depth) for 3 years, and two (2) hydrophone receivers will be placed at one control site or one each at both of the control sites. Orientation and placement of the receivers within the control site(s) will be determined by the Aquatic Resources and Water Quality Implementation Committee. Receivers will be retrieved two times per year for data recovery and maintenance.

5.3.4.3 Metrics and Analyses

Data will be provided to the California Fish Tracking Consortium database, managed by NOAA Southwest Fisheries Science Center in Santa Cruz, California. This database makes telemetry data available to consortium members that include West Coast sturgeon researchers.

13 Orientation relative to the array shown for illustration purposes only.

5.3.4.4 Constraints, Limitations, and Feasibility

If tagged sturgeon are detected, then evidence supports that these fish will on occasion encounter the Project. These data, coupled with tag and release dates and detection data from other receiver arrays located along the West Coast will provide researchers with information that can be used to inform survivorship, migration corridors, travel rates and limited habitat use by Green Sturgeon. Analysis will require that comparable data from other coast-wide studies be available. However, the sort of spatially detailed behavioral information necessary to measure a Project-caused ecological impact on sturgeon is not likely to be obtained.

5.3.5 Flatfish and Epibenthic Invertebrates

Potential Project effects on flatfish and epibenthic invertebrates are: 1) habitat changes associated with introduced artificial structure that decreases available soft bottom habitat; 2) Project-associated changes to the predatory species assemblages, which decrease flatfish and invertebrate abundance in the Project area; 3) flatfish and invertebrate attraction to the Project; or 4) flatfish and invertebrates avoidance of the project area. These effects are anticipated to manifest themselves relatively soon after the Project is built. Each of these potential effects would result in a change in the distribution and abundance of flatfish and invertebrates within the array, relative to areas outside of the array. Therefore, the objective studying flatfish and invertebrates is to evaluate if the Project affects the distribution and abundance of juvenile and adult flatfish and invertebrate species.

5.3.5.1 Sampling Methods and Rationale

Bottom trawling using otter trawls or beam trawls is an effective method to survey for flatfish and epibenthic macrofauna on the Oregon coast (Krygier and Pearcy 1986; Pearcy 1978). While trawling will not be feasible within the array, a trawl could be deployed adjacent to the array during the day, to detect those changes that occur outside the footprint of the array. These data will also provide information on Dungeness crab sex ratios and size frequency, which will correct potential biases in the crab trap sampling (section 5.3.3). In addition, gut contents of selected fish species from beam trawls can be evaluated to get additional information on epibenthic invertebrate prey.

Given consideration of these issues, the proposed sampling method is to use a small 3-mm mesh beam trawl (2m) to survey adult and juvenile flatfish (Kramer 1990; Kramer 1991) and epibenthic invertebrates (e.g., *Crangon* spp., mysids, and Dungeness crab). Sampling will be conducted adjacent to the array during the day, and at two control sites, one nearer to the array but well outside its influence (exact location to be determined), and the other control site to be located farther away, such as the proposed site between Reedsport and Coos Bay. Trawl effort will be based on area swept by the trawl; the trawl will be fitted with a device to measure distance trawled on the bottom.

5.3.5.2 Sampling Frequency

Trawls performed adjacent and parallel to the array will be conducted three times per year in February/March, April/May, and late summer to capture juveniles and adults of flatfish and epibenthic invertebrate species anticipated to be in the Project area (Table 1). The Aquatic Resources and Water Quality Implementation Committee shall review the proposed trawl plan prior to commencing trawls given the northeast-southwest orientation of the PowerBuoy array.

At the array and each control site, five 10-minute trawls will be made. Trawling is expected to occur in March prior to Project installation and after installation in years 1, 2, and 3.

5.3.5.3 Metrics and Analyses

Metrics will be used to describe community composition, species diversity, and species richness. For key species (e.g., those species captured in great enough numbers, and those listed in Table 1), length frequency distributions and densities (number/area trawled) will be determined. Multivariate analyses will be conducted on different species and size classes of fish, where appropriate. A cluster analysis of species abundance by individual haul and site by year will be conducted.

5.3.5.4 Constraints, Limitations, and Feasibility

Although trawling is a proven method for assessing epibenthic fish and invertebrates, within the array, this method is not feasible. Daytime sampling adjacent to the array is feasible but may not sufficiently describe Project effects.

5.3.6 Pelagic Fish and Invertebrates

The Project's potential effects on pelagic fish and invertebrate species are: 1) Project-induced changes to habitat associated with introduced artificial structure; 2) Project-associated changes to the predatory species assemblages that may decrease fish and invertebrate abundance in the Project area; 3) pelagic fish and invertebrate attraction to the project area; or 4) pelagic fish and invertebrate avoidance of the Project area. These effects are anticipated to manifest themselves relatively soon after the Project is built. Each of these potential effects could result in a key species change in distribution and abundance within the array, relative to control sites outside of the array.

The Project array may act as a Fish Aggregation Device (FAD) for pelagic fishes and invertebrates. Although few empirical studies link physical structure availability in mid-water or near-surface to fish aggregations in cold temperate waters, numerous documented cases link drift algae and more durable flotsam to fish aggregations (Crawford and Jorgenson 1993; Dempster and Taquet 2004; Druce and Kingsford 1995; Kokita and Omori 1998; Mitchell and Hunter 1970; Parin and Fedoryako 1999; Safran and Omori 1990). Oil platforms also support dense aggregations of fishes, although available information implies that, in temperate waters, the attracted fish are species typically reef-associated rather than pelagic species (e.g., Love et al. 2006). In the eastern Pacific Ocean, the pelagic stingray (*Pteroplatytrygon violacea*) and manta rays (family: *Mobulidae*) are the only pelagic fishes that are more common in the vicinity of drifting FADs than in open water (Nelson, unpublished data). Sampling pelagic fish and invertebrates within the array using "traditional" towed net approaches is not feasible. Gear selectivity, time of sampling (day vs. night), tow duration and speed all influence the species and life stages capable of being sampled. Adults of predatory fish species such as mackerel or hake and associated fish (sardines, anchovy, etc.) are unlikely to be captured without large, high-speed nets, or large seines (for examples see Brodeur et al. 2004; Emmett et al. 2004; Krutzikowsky and Emmett 2005; Miller and Brodeur 2007).

FAD-associated fish assemblages have been successfully surveyed using purse seines (Hunter and Mitchell 1967; Wickham and Russell 1974), direct visual observations (SCUBA or free-diving) (Dempster 2005; Nelson 2003), and hook and line (Buckley and Miller 1994; Ibrahim et al. 1996). Seines, as well as surface or mid-water trawl, would be inoperable within the array, as discussed above. Direct visual observations have some potential given appropriate water clarity, but should probably be used as an ancillary technique. Hook and line techniques, and multimesh gillnet sampling, allow sampling of a range of species and sizes from within the array and at control locations. Furthermore, the collection of mid-sized to larger fishes (>15 cm TL) offers the possibility of using additional gut content analyses to "sample" smaller pelagic organisms difficult to collect otherwise.

5.3.6.1 Sampling Methods and Rationale

To address the potential effect of predation on key species of concern, gut content data will be collected from fish that are available from all sampling methods (hook and line, gillnet, and trawl). Stomach contents analysis will be conducted on predatory fishes in the array and at control sites; the methodology is described in Section 5.3.1.

This plan also proposes to complement the predatory fish stomach analysis with SCUBA to collect quantitative information on fishes and invertebrates associated with the Project array. Point count or linear transects in mid-water (at level with the base of the wave PowerBuoys) and near the surface (at approximately 3-m depth) may be appropriate; benthic surveys using conventional SCUBA are likely to exceed a safe working depth and bottom time would be too limited to be of sufficient value. Visual counts could contribute to studies of rockfish, pelagic species, and biofouling, but success will depend largely on the predictability of suitable environmental conditions. Control surveys away from the array would be difficult to conduct safely and would offer only marginally comparable data; therefore, we advise against control surveys, in favor of using the visual survey data to assess annual changes at the impact site, and in favor of supplementing hook-and-line-sampling. SCUBA surveys would be conducted during efforts to evaluate the biofouling community (see section 5.3.7) and limited visual survey data (video footage) from SCUBA or ROV inspections of Project components, planned as part of O&M surveys, will be evaluated for abundance information for pelagic fish and invertebrate species (see Section 5.3.2).

5.3.6.2 Sampling Frequency

See the rockfish study described in Section 5.3.2.2. Also, refer to biofouling study (see Section 5.3.7).

5.3.6.3 Metrics and Analyses

See the rockfish study described in Section 5.3.2.3. Point counts or visual transects would offer, at a minimum, species counts (richness), but also could offer estimates of abundance (Dempster 2005; Dempster and Taquet 2004).

5.3.6.4 Constraints, Limitations, and Feasibility

Because many of the species are mobile and highly patchily distributed, the ability to detect signal (project effect) from noise (natural variability) may not be possible without an intensive, long-duration monitoring regime. Similarly, visual assessments using SCUBA may require much more time underwater for quantitative abundance estimates; we anticipate that conditions will generally be such that an intensive visual sampling effort using SCUBA is unlikely to be successful (too many days with poor visibility and/or undivable conditions); however, selective use of the technique could add to the other efforts described here.

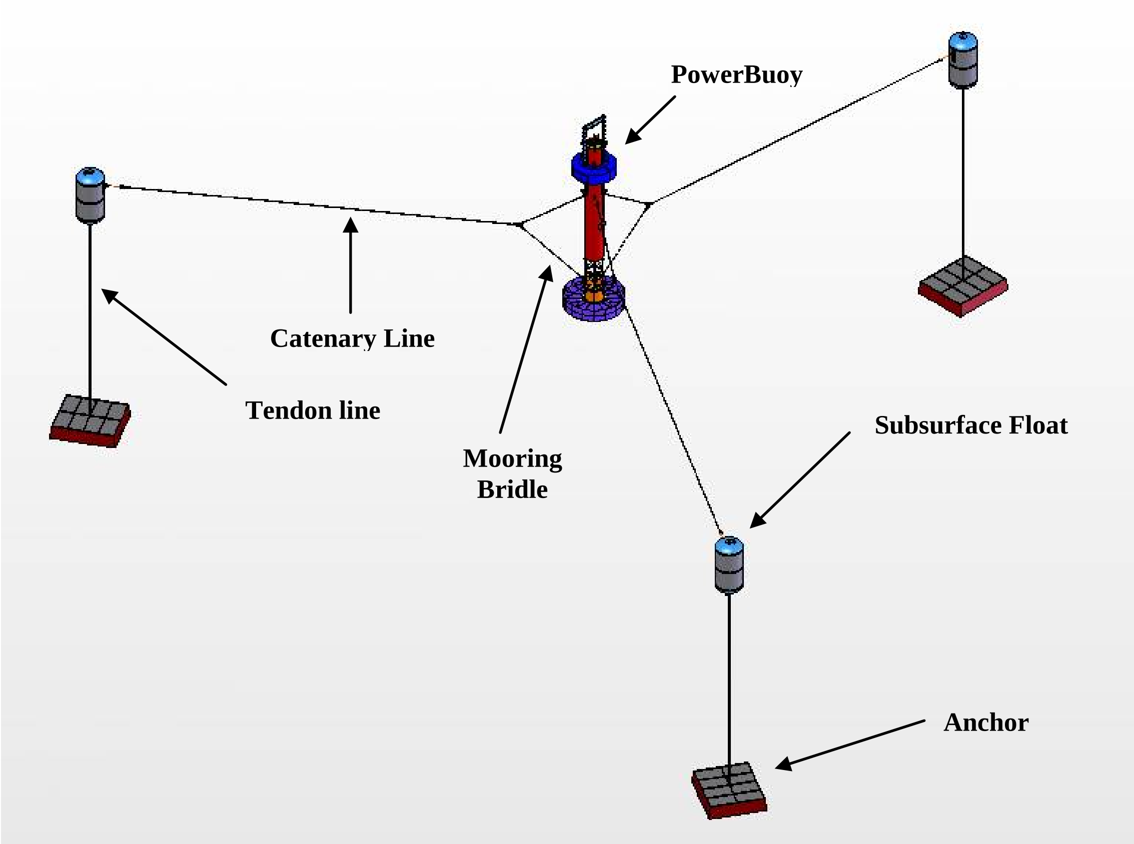
5.3.7 Biofouling Community

Each of the 10 PowerBuoys will be moored with three lines arranged symmetrically around the unit (120-degree separation). The Project's mooring and anchoring line system utilizes subsurface floats (SSFs) (Figure 2). The SSFs will measure 10 feet in diameter and 20 feet in height. The tops of the SSFs will be located at a depth of approximately 50 feet; however, depths could be as little as 30 feet, depending on loads and conditions. The SSFs are buoyant to achieve tension within the moorings, eliminating any interaction of the mooring lines with the seabed and maintaining the PowerBuoy within a specified watch circle. The catenary lines will extend from the buoys to the SSFs and will range to a maximum depth of 30 to 50 feet. The 5 to 6-in diameter mooring lines are of synthetic polyester material, having minimum breaking loads twice that of the design maximum. The mooring lines will connect to 16 steel-reinforced pre-cured concrete anchors approximately approximately 32.8 feet in diameter by 24.6 feet in height (10 meters in diameter by 7.5 meters high) The anchors are expected to settle into the sediment and extend above the seabed approximately 5.6 feet (1.7 meters).

Because of the considerable sizes of the PowerBuoys and lengths of their mooring lines, combined with the limitations of using SCUBA in deep water depths, the goal of the evaluation will be to perform a general qualitative overview of the biofouling community on the Project components.

FIGURE 2

POWERBUOY AND MOORING SCHEMATIC



Ameron's "ABC3 Antifouling" will be used to coat the floats, spars, and SSFs of the proposed Project. "ABC3 Antifouling" is a self-polishing organotin-free antifoulant coating specifically designed for use in the marine environment. The Company may also use SigmaGlide paint on the SSFs. SigmaGlide is made by SigmaKalon Marine and Protective Coatings BV. SigmaGlide is biocide-free, and its high solids content (low volatile organic content) and long service life contribute to low solvent emissions. However, algal and invertebrate species are still expected to recruit to and colonize hard surfaces associated with the PowerBuoys and mooring gear.

5.3.7.1 Sampling Methods and Rationale

To assess this expected change in the local community, the Company will deploy ceramic tiles and settlement plates, the latter of which are composed of materials the same as those used in the PowerBuoy array. The ceramic tiles will be the controls for comparing the biofouling community associated with the PowerBuoys and attendant gear. In addition, the Company will conduct SCUBA analysis of biofouling. Limited visual survey data from maintenance dives and equipment ROV surveys would complement these efforts, possibly providing information on recruitment rates and changing community structure of the biofouling community.

Settlement Plates

The biofouling assessment will be initiated following deployment of the 10-unit PowerBuoy array. Each biofouling assessment "settlement unit" will consist of one of each of the following:

- Ceramic tile, dimensions 10.2 cm x 10.2 cm;

- Metal plate of material and antifouling treatment equivalent to that used in the fabrication of the PowerBuoy, dimensions 10.2 cm x 10.2 cm; and
- Mooring cable of type, diameter, and antifouling treatment equivalent to that used in the array, dimension 1-m length

Three settlement units will be deployed at each of three depths, at approximately 3-m subsurface, mid-depth, and at the bottom, at three PowerBuoys (each PowerBuoy representing a replicate). One settlement unit will be removed from each of the three depths at years 1, 2, and 5, following deployment of the settlement units. The settlement plates will be evaluated for biofouling growth, including invasive and non-native species.

SCUBA Evaluation

Qualified biologists using SCUBA will conduct a survey of biofouling on three PowerBuoys and their associated single mooring lines (mooring bridle, catenary line, and tendon line) to a depth of no more than 100 ft. The PowerBuoys will be selected to represent spatial distribution among the 10 units. The evaluation will occur on a calm day to minimize heaving of the PowerBuoy and mooring lines, and will occur before the first scheduled cleaning of the mooring lines following deployment of the array. The biologists will identify, and estimate general abundance of biofouling species, invasive and non-native species, and observed finfish or other free-swimming marine life (see Section 5.3.6).

Because of the considerable size of the PowerBuoy and length of the mooring lines, combined with the limitations of using SCUBA in deep water depths, the goal of the evaluation will be to perform a general qualitative overview of the biofouling community on the Project components.

ROV (Remotely-Operated Vehicle)

Using an ROV as part of regular equipment maintenance surveys offers a similar opportunity to obtain valuable qualitative information on biofouling communities, and on substrate-associated fishes. Video recordings during these surveys will be reviewed by a marine biologist to track seasonal and year-to-year changes in community structure.

While the Company plans to annually clean the catenary lines and mooring bridle of accreted biofouling, the tendon lines will not be cleaned. As such, monitoring of the biofouling of the tendon lines will provide insight into how the biofouling community changes with time and a measure of the artificial reef potential of the mooring system. This biofouling monitoring program will also provide insight into the effectiveness of the antifouling paint on the PowerBuoys.

The Project will be located in water depths of 204 to 225 feet. The Company anticipates that commercial divers or other suitable underwater inspection techniques will be used to perform inspections of the anchors annually for inspection, and perhaps more often if needed (e.g., following large storm events). Pictures and/or videos of representative anchors and any associated shell mounds, if present, are planned to be taken. Biologists will review these pictures and/or videos to evaluate the accreted biofouling as well as fish species associated with these habitats. Videos will be provided to the Aquatic Resources and Water Quality Implementation Committee members upon request. The Company will copyright all photographs and videos.

Videos and photographs shall be returned to the Company upon completion of their review by biologists or participants of the Agreement.

5.3.7.2 Sampling Frequency

One settlement unit will be removed from each of the three depths, at the three PowerBuoys, during years 1, 2, and 5 after deployment of the 10-PowerBuoy array. Following deployment of the 10-unit PowerBuoy array, the biofouling visual assessments using SCUBA will be conducted during years 1, 2 and 5. In the event that one of the PowerBuoys is removed for maintenance, an adjacent PowerBuoy will be evaluated. ROV surveys will be performed every three to four months, weather permitting, for the first two years, and in year 5. Underwater inspections will be otherwise conducted annually. Video recordings will be evaluated for years 1, 2, and 5 after initial deployment. This sampling strategy will allow the Company to track temporal changes in the biofouling community. Videos will be provided to the Aquatic Resources and Water Quality Implementation Committee members upon request. The Company will copyright all photographs and videos. Videos and photographs shall be returned to the Company upon completion of their review by biologists or participants of the Agreement.

5.3.7.3 Metrics and Analyses

Metrics for settlement plates will include identifying and counting organisms to the lowest practical taxa. Analyses will include community analyses such as cluster analysis and multidimensional scaling, and analysis of variance for temporal impact effects (see below). Multivariate analyses (e.g., non-metric multidimensional analysis) may be employed, particularly if the data are far from normally distributed. Biologists will identify, and estimate general abundance of biofouling species.

For the settlement plates, a quantitative assessment of temporal changes to the biofouling community at the mid-water and surface depths will be conducted using asymmetrical ANOVA to explore impact effects. The choices of settlement unit configurations and materials are intended to offer a control-type material, known to lend itself well to a variety of biofouling organisms, as well as units mimicking the PowerBuoy array with its antifouling treatment. Findings of invasive and non-native species will be communicated to the Aquatics Implementation Committee in periodic updates (see Section 5.3.12).

5.3.7.4 Constraints, Limitations, and Feasibility

Although near-surface and mid-water controls are proposed for measuring biofouling, they may not be feasible because they would require some form of structure in order to be deployed; the deployment itself would be an artificial structure and would no longer constitute a control. Using settlement plates deployed at/near the bottom should provide a reasonable alternative for analyzing temporal impacts. SCUBA and ROV surveys should provide additional information on biofouling organisms that may not be attracted to settlement plates, as well as fish species.

5.3.8 Water Quality

The Project's potential effect on water quality would be change in water quality associated with installation and operation of the array. Any effects will likely be manifested relatively soon after the Project is built. Any potential effects would result in water quality changes within the array relative to control sites outside the array.

5.3.8.1 Sampling Methods and Rationale

Vertical profiles of water quality in the water column will be taken within the array and at control sites. Water quality parameters to be measured include temperature, pH, dissolved oxygen, chlorophyll-*a*, optical characteristics, and conductivity *in-situ.*

Prior to and during deployment of a single PowerBuoy and the 10-unit array, the Company will measure near-bottom turbidity at a location near an anchor deployment and the subsea cable route.

During planned inspection of the mooring system (every three to four months, weather permitting, for the first two years, and annually thereafter), the Company will monitor the seabed for accumulation of biofouling debris. In the event that build up of biofouling debris is seen to occur, the Company will consult with the Aquatic Resources and Water Quality Implementation Committee on the need to evaluate potential related water quality concerns (e.g., total organic carbon, biological oxygen demand).

5.3.8.2 Sampling Frequency

During consultation in October 2007 and following review of the proposed draft methods submitted October 4, 2007, DEQ stated, "Because data are available DEQ is not requesting the applicant to collect additional water quality data prior to submission of the 401 application. Currently the applicant proposes to collect water quality data when sampling is conducted for the fisheries, invertebrates, and plankton study. DEQ expects that water quality data will be collected following a QA/QC plan as described in EPA document "EPA requirements for quality assurance project plans EPA QA/R-5" available at the following site, http://www.epa.gov/quality/qs-docs/r5-final.pdf." The Company will conduct the water quality monitoring consistent with the guidelines referenced in the Environmental Protection Agency (EPA) document.

During each day that sampling is conducted for the Fish and Invertebrates Study, at least one vertical profile will be taken at the Project area (within and adjacent to the array) and at each of the control sites.

5.3.8.3 Metrics and Analyses

The water quality data will be collected and stored electronically during end-of-the-day downloads, to ensure proper data management and quality control. The standard t-test is one analytical data treatment proposed.

5.3.8.4 Constraints, Limitations, and Feasibility

No constraints or limitations are identified currently.

5.3.9 Benthic Infauna

The potential effects of the PowerBuoy array on benthic infaunal species are: 1) changes in habitat associated with introduced artificial structure; 2) changes to predatory species assemblages that may decrease benthic infaunal species abundance in the PowerBuoy array area; 3) benthic infaunal species attracted to the PowerBuoy array; or 4) benthic infaunal species avoiding the PowerBuoy array area. These effects would manifest relatively soon after the PowerBuoy array is built. These potential effects could result in changes in the distribution and abundance of key species within the array, relative to control sites outside of the array. The "footprint" of the array (anchors, etc.) is expected to be approximately 30 acres (0.046-square mile array), so the PowerBuoy array impact is expected to be spatially small compared to nearby ocean dredge spoil sites, which are typically about 0.3 square miles (Marine Taxonomic Services, Ltd. 2008).

5.3.9.1 Sampling Methods and Rationale

As with the other studies, a BBACI design (Kingsford 1999) is proposed, to assess spatial and temporal differences in benthic infauna. Samples will be taken using two types of grab sampler; one is a damped gravity corer designed by Oregon State University for coring sandy sediments and for collecting undisturbed cores that retain an intact surface sediment layer. The other type of grab sampler is a 0.1-m^2 Gray-O'Hara box core (to compare with nearby U.S. Army Corps of Engineers [USACE] dredge site evaluations, a Gray-O'Hara box core would be appropriate). The benthic samples will be sieved through a 0.5-mm sieve with the retained material placed into an appropriately sized plastic container and preserved with a 10 percent by volume buffered formalin solution. These samples will be rewashed after 72 hours to remove the formalin solution and transferred to 70 percent alcohol. The samples will be sorted under a dissecting microscope to remove all animals and animal parts from the detritus. The removed material will be sorted into four groups (polychaetes, mollusks, crustaceans, and miscellaneous). Each group will be identified to the lowest practical taxa and counted. Wet-weight biomass will also be determined after combining lowest practical taxa into higher-order taxa. Methods will be consistent with USACE's benthic sampling for the Umpqua River Ocean Dredged Material Disposal Site. For each sample, sediment will also be analyzed to determine percent organics and grain size. Any evidence or indications of oxygen depletion will be noted, such as presence of organic material.

No sampling is proposed along the transmission line at this time, as the footprint of the transmission line cable is expected to be small relative to the Project footprint, with burial of the cable three to six feet resulting in temporary, short-term effects on benthic infauna.

As indicated above in Section 5.3.8.1, during planned monitoring of the mooring system, the Company will monitor the seabed for accumulation of biofouling debris. In the event that build up of biofouling debris is seen to occur, the Company will consult with the Aquatic Resources and Water Quality Implementation Committee on the need to evaluate potential related water quality concerns (e.g., total organic carbon, biological oxygen demand).

5.3.9.2 Sampling Frequency

Benthic infauna will be sampled at the project area and at two control sites. Sampling will be performed initially at least once before the PowerBuoy array is installed, and then three times (years 1, 2 and 3) after installation in June and September. Within the PowerBuoy array area (0.25 square miles, 800 meters by 800 meters), three samples at each site (five replicates per sample) will be taken, to determine within-station variability; five replicates should be sufficient because grain size analysis indicates homogenous conditions at the array site, with fine sands ranging from 170 to 190 microns (Sea Engineering 2007). In addition, the footprint of the PowerBuoy array is relatively small (approximately 30 acres). At control sites, three samples will be taken (five replicates per sample) to evaluate between-station variability. The control sites will be chosen for their comparable environmental characteristics to that of the PowerBuoy array site. The sample locations within each site will be positioned randomly. The Marine Geophysical Survey that was conducted during the week of September 17, 2007 documented that the seafloor of the PowerBuoy array and cable areas is homogenous, consisting of sand; three samples taken in the array area should therefore provide adequate coverage (Sea Engineering, Inc. 2007). The Company proposes using data from the Umpqua River Ocean Material Disposal Site sampling as one of the control sites.

5.3.9.3 Metrics and Analyses

Metrics will include density, diversity, species richness, and equitability. Analysis will include standard statistical analysis (e.g., analysis of variance) and community and multivariate analyses, such as cluster analysis and multidimensional scaling (Clarke and Ainsworth 1993; Ter Braak 1986).

5.3.9.4 Constraints, Limitations, and Feasibility

Use of the Umpqua River Ocean Material Disposal Site sampling data (from the control site, not the dredge spoils disposal site) will depend on comparable environmental characteristics. The same sampling methods are proposed. Sampling and statistical methodologies may be amended to allow inclusion of comparable data from the dredge spoil site(s).

5.3.10 Larval Fish, Invertebrates, and Key Forage Plankton

The Project's potential effects on larval fish and invertebrate plankton species are: 1) habitat changes associated with introduced artificial structure; 2) Project-associated changes to the predatory species assemblages that may decrease planktonic larval fish and invertebrate abundance in the Project area; 3) planktonic larval fish and invertebrates attracted to the Project; or 4) planktonic larval fish and invertebrates avoiding the Project area. Due to the broad spatial and temporal distribution of these life stages, and their comparatively poor swimming capabilities, Project effects associated with behaviors such as attraction or avoidance are unlikely (Neira 2005). However, studies off the Gulf Coast addressing larval fish assemblages at offshore petroleum platforms indicated that postflexion larvae, which have better swimming capabilities than preflexion larvae, may indeed be attracted to structure, especially those species that are substrate-limited (Lundquist et al. 2005). The effects of petroleum platforms on larval fish populations may be positive due to increased food sources associated with the biofouling community, or effects could be negative if larval fish are eaten by predators.

5.3.10.1 Sampling Methods and Rationale

Given the spatial and temporal variability in distribution and the poor swimming capabilities of small larval fish, fish eggs and zooplankton, the effort to evaluate Project effects would need to be substantial and would require using multiple gear types (Hernandez and Shaw 2003; Lindquist et al. 2005). Therefore, Project effects on small larval fish and invertebrates are not proposed to be evaluated, with larger larval and juvenile fish and larger forage invertebrates to be evaluated as described above (see section 5.3.6).

5.3.10.2 Sampling Frequency

Larval fish and invertebrates are not proposed to be evaluated.

5.3.10.3 Metrics and Analyses

Larval fish and invertebrates are not proposed to be evaluated.

5.3.10.4 Constraints, Limitations, and Feasibility

Larval fish and invertebrates could be sampled using towed plankton nets; however, towing nets in the array is not feasible. Vertical plankton tows could be conducted within the array but given the variability and patchiness of ichthyoplankton and pelagic invertebrates coupled with the small areal extent of the Project site, this method is unlikely to provide the statistical power to detect differences between the Project and control sites. Push nets (bow-mounted plankton nets) could be used to evaluate ichthyoplankton and zooplankton in surface waters within the array, but would be selective for life stages and species at the surface (neuston). Light traps have been used off the Oregon coast to collect primarily larval sardines, anchovy, black and copper rockfish, and Dungeness crab megalopae (Miller and Shanks 2004). Light traps tend to capture larger stages of larval fish than traditional ichthyplankton net sampling, but light traps are selective for species attracted to light, have relatively poor capture efficiency (Miller and Shanks 2004, 2005), and are susceptible to changes in ambient light conditions (Lindquist et al. 2005). Pump sampling is another means for evaluating pelagic species such as zooplankton and small larval and egg stages of fish that are not very mobile; pump sampling could be conducted at various depths in the array but larger, more mobile stages of larval fish and zooplankton would not be effectively sampled.

5.3.11 Control Sites

The numbers and approximate locations of the control sites for the proposed studies are summarized (Table 3).

Table 3

Control sites for proposed studies

Monitoring Method	Study Plan Section	Number of Control Sites	Proposed Control Site Location(s)*
Hook and Line (predator and gut content sampling)	Juvenile salmon 5.3.1; Rockfish 5.3.2; Pelagic fish and invertebrates 5.3.6	2	Control sites would be located in the vicinity of the array, within 5 kilometers of array, but outside of the Project influence. One site will be north and one site will be south of the Project area, and likely some of the same control sites can be used for the relative abundance experiment. Control sites would be located within the same "area of influence" of the Project site relative to the Umpqua River with comparable water quality characteristics (turbidity, salinity, temperature).
Multi-mesh gillnet (relative abundance, gut content sampling)	Juvenile salmon 5.3.1; Rockfish 5.3.2; Pelagic fish and invertebrates 5.3.6	2	Control sites would be located in the vicinity of the array, within 5 kilometers of array, but outside of the Project influence. One site will be north and one site will be south of the Project area, and likely some of the same control sites as hook and line predator surveys.
Trapping	Dungeness crab 5.3.3	3	Control sites would be located within 20 kilometers of the array. One control site will be located approximately equidistant between the mouth of the Umpqua River and Coos Bay**. The other two control sites will be located closer to the Project area but outside of Project influence, to the north and south of the Project area.
Trawling	Flatfish and epibenthic invertebrates 5.3.5	2	Control sites would be located within 20 kilometers of the array. One control site will be located approximately equidistant between the mouth of the Umpqua River and Coos Bay. The other site will be located closer to the Project area but outside of the Project influence.
Grab samples	Benthic infauna 5.3.9	2	Control sites would be located within 5 kilometers of the array. One control site will be located at USACE control site (clean site) to provide additional years of data for comparison purposes (from past work done at the site).

* All proposed control sites to be comparable to Project area with respect to depth, substrate and exposure.

** It is approximately 36 kilometers from the mouth of Coos Bay to the mouth of the Umpqua River and within the same littoral cell [http://hmsc.oregonstate.edu/waveenergy/WaveEnergyEffectsBriefingPaper.pdf].

As discussed with the Aquatic Species Subgroup during a meeting on March 21, 2008, the exact location of the control sites will be determined in the field and then a description of the selected control sites, including location and site characteristics (e.g., depth, substrate), will be reported to the Aquatic Resources and Water Quality Implementation Committee for their confirmation.

5.3.12 Reporting

Progress will be communicated to the Aquatic Resources and Water Quality Implementation Committee in periodic updates and annual reports. Final results will be provided as reports become final and included in annual reports. It is anticipated that there would be an annual meeting of the Aquatic Resources and Water Quality Implementation Committee to review and discuss the information to date.

5.3.13 Summary

The studies described above were categorized by species or species groupings with specific objectives. Several study objectives are addressed using the same methods, but at different times of year or different frequencies (Table 4).

Table 4
Summary of monitoring methods and frequencies

Monitoring method	**Species addressed**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Years**
Hook and Line	Salmonids					X	X	X		X				Before installation and years 1, 2, and 3 after installation
	Rockfish			X		X		X				X		Before installation and years 1, 2, and 3 after installation
	Pelagic fish and invertebrates			X		X		X				X		Before installation and years 1, 2, and 3 after installation
Multimesh gillnet	Salmonids, rockfish, pelagics					X		X						Before installation and years 1, 2, and 3 after installation
Trapping	Dungeness crab							X				X		Before installation and years 1, 2, and 3 after installation
Acoustic telemetry	Sturgeon	X	X	X	X	X	X	X	X	X	X	X	X	Years 1, 2, and 3 after installation
Trawling	Flatfish and epibenthic invertebrates			X		X				X				Before installation and years 1, 2, and 3 after installation
Settlement plates	Biofouling													One settlement unit will be removed from each of the three depths, at the three PowerBuoys, during years 1, 2, and 5 after deployment of the 10-PowerBuoy
Grab samples	Benthic infauna						X			X				Before installation and years 1, 2, and 3 after installation
SCUBA/ROV	Pelagic Fish and invertebrates								X					Years 1, 2, and 5 after installation
	Biofouling								X					Years 1, 2, and 5 after installation
	Fish and invertebrates - O&M video footage				X*			X*			X*			Video footage of Project components will be taken approximately every 3-4 months in the first two years and in year 5. Underwater inspections will be performed annually thereafter. All video footage from years 1, 2 and 5 will be evaluated by a marine biologist. * The O&M schedule timing has not yet been developed, so actual timing of video footage may vary from what is shown and will be weather dependent.

Monitoring method	Species addressed	J	F	M	A	M	J	J	A	S	O	N	D	Years
Water quality	Water quality			X		X	X	X	X	X		X		During fish and invertebrate monitoring

6.0 References

Full citations referenced in Sections 1 through 4 above are provided in the Literature Cited section of the APEA. Citations for Section 5 are provided below.

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Reedsport OPT Wave Park, LLC.
Reedsport OPT Wave Park
FERC No. 12713

Issue Assessment
Impacts to Offshore Avians
May 6, 2010

1.0 Description of Issue

The Company has filed with FERC a License Application for a 35-year license to develop and operate the Project. The Project would consist of deployment and operation of 10 PowerBuoy® wave energy converters (WEC) having a total capacity of 1.5 megawatts (MW), to be located approximately 2.5 miles (4 kilometers) off the coast of Gardiner in Douglas County, Oregon (Figure 1). The ½-mile-by-½-mile (0.25 square miles) Project area represents the area within which the 10-PowerBuoy array would be deployed. The actual footprint of the constructed array is expected to be only about 1,000 feet by 1,300 feet (300 meters by 400 meters) or approximately 30 acres (0.05 square miles), excluding the navigation safety zone. The PowerBuoys will be deployed in an array of three rows, approximately in a northeast-southwest orientation and in an oblique orientation to the beach. Two rows will consist of three PowerBuoys, and one row will consist of four PowerBuoys (Figures 2 and 3). The Company plans to deploy the 10-PowerBuoy array during the summer of 2011. Prior to that, the Company also plans to install a single PowerBuoy in 2010, which will not be grid connected.

Because of the size (29.5 feet above the water's surface) and the presence of lighting at the top of these PowerBuoys, the U.S. Fish and Wildlife Service and the Oregon Department of Fish and Wildlife are concerned about possible collision-caused fatalities of threatened/endangered species (e.g., Marbled Murrelet, Short-tailed Albatross) and other migratory birds at the proposed wave park. The listed species in the Project area are protected under the U.S. Endangered Species Act (16 USC 1531), and, although the other migratory species are not in danger of extinction, they are protected under the U.S. Migratory Bird Treaty Act (16 USC 703).

WEC, such as PowerBuoys, are a new technology, and there is little experience with wave energy projects along the Pacific coast. Information on both the probability of birds colliding with wave energy structures and the numbers and species of birds present in the proposed development area is incomplete. As a result, the Company is advancing the following work plan to evaluate the effects of the proposed action on marine resources. The elements of this work plan are based on the criteria set forth in the Oregon Territorial Sea Plan, Part Two (Oregon Ocean Policy Advisory Council [OPAC] 1994).

2.0 Relevant Existing Information

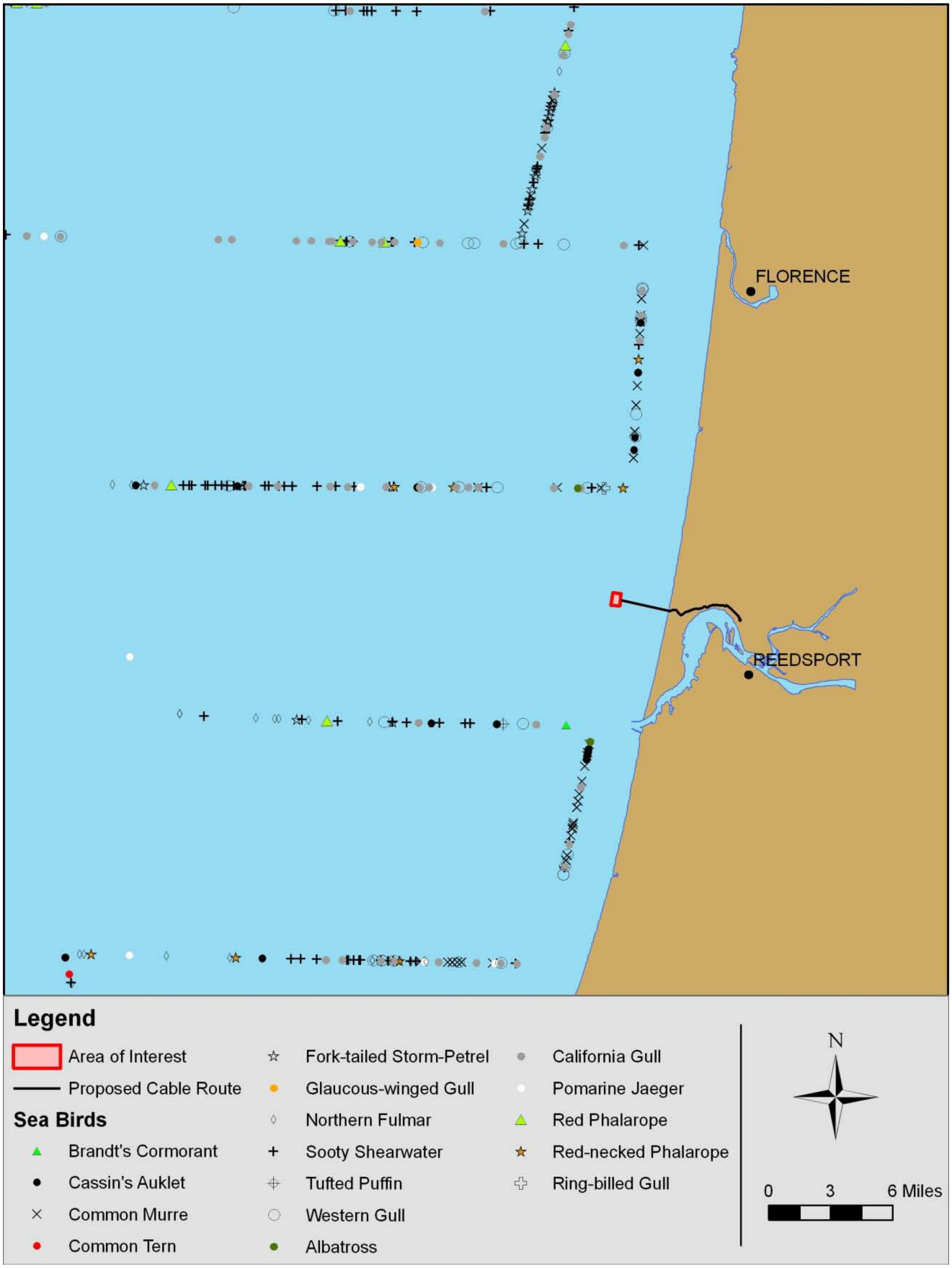
The coastal province of Douglas County offers an expansive coastline and open-marine near shore foraging area for resident and migrant seabirds throughout the year. The outer coast is predominately sandy beaches and dunes. There are dense patches of upland salal, evergreen huckleberry, rhododendron, and other shrubs. Other outcrops of Douglas fir, lodgepole pine and, to a lesser extent, Sitka spruce occur behind the beach areas (Contreras 1998). During summer, a variety of seabirds are known to fly along the outer coast in search of food (Table 1 and Figure 1). Double-crested cormorants (*Phalacrocorax auritus*) and marbled murrelets (*Brachyramphus marmoratus*) are the only seabirds known to nest in Douglas County; however, several other species breed along shorelines and offshore islands of adjacent counties and may forage in the vicinity of the Project site. These species include Leach's storm-petrels (*Oceanodroma leucorhoa*), Brandt's (*Phalacrocorax penicillatus*) and pelagic (*Phalacrocorax pelagicus*) cormorants, common murres (*Uria aalge*), pigeon guillemots (*Cepphus columba*), western gulls (*Larus occidentalis*), tufted puffins (*Fratercula cirrhata*), and rhinoceros auklets (*Cerorhinca monocerata*) (Contreras 1998). During non-breeding seasons, large numbers of other species; especially loons (*Gavia* spp.), sooty shearwaters (*Puffinus griseus*), and scoters (*Melanitta* spp.); also migrate through and/or overwinter in the area.

TABLE 1

SEABIRDS IDENTIFIED IN THE PROJECT VICINITY DURING THE 1989 OREGON AND WASHINGTON MARINE MAMMAL AND SEABIRD SURVEY

Common Name	Scientific Name	August 7, 1989	August 9, 1989	August 10, 1989	August 11, 1989	Bird Count
Albatross	*Phoebastria Spp.*		1	1		2
Brandt's Cormorant	*Phalacrocoraxs penicillatus*		1			1
California Gull	*Larus californicus*	12	29	39	3	83
Cassin's Auklet	*Ptychoramphus aleuticus*		12	12		24
Common Murre	*Uria aalge*	6	35	19		60
Common Tern	*Sterna hirundo*		1			1
Fork-tailed Storm-Petrel	*Oceanodroma furcata*	24	3	2		29
Glaucous-winged Gull	*Larus glaucescens*			1		1
Northern Fulmar	*Fulmarus glacialis*	1	45	8		54
Pomarine Jaeger	*Stercorarius pomarinus*		3	4		7
Red Phalarope	*Phalaropus fulicarius*	1	3	8		12
Red-necked Phalarope	*Phalaropus lobatus*		4	34		38
Ring-billed Gull	*Larus delawarensis*			1		1
Sooty Shearwater	*Puffinus griseus*	16	377	45	19	457
Tufted Puffin	*Fratercula cirrhata*		1			1
Western Gull	*Larus occidentalis*	6	21	30	6	63
	Daily Survey Count	**66**	**536**	**204**	**28**	**834**

FIGURE 1
SEABIRDS IDENTIFIED DURING THE 1989 OREGON AND WASHINGTON MARINE MAMMAL AND SEABIRD SURVEY*



*Surveys occurred along transects.
Source: Bruggeman et al. 1992

Existing data on abundance of birds in the Project area is scant, with the only documented information being from irregular, incidental bird observations during other research activities and a bird distribution study conducted almost two decades ago. Boat-based surveys of seabirds, conducted during the month of August of 1989 for the Oregon and Washington Marine Mammal and Seabird Survey, included coverage of offshore areas in the vicinity of the Project area (Bruggeman et al. 1992). Surveyors searched in transects along the coastline and logged species sightings over the course of the survey. During the four days of transect surveys that occurred in the Project vicinity, a total of 834 birds was identified, composing 16 total species. These seabirds are summarized in Table 1 and plotted spatially in Figure 1. Seasonal patterns of abundance of seabird species in Douglas County have not been described; however, Contreras (1998) summarized the seasonal abundance of species, including those documented within the 1989 survey, for neighboring Coos County. Table 2 summarizes findings from this work for notable species recorded near the Project area.

Threatened and Endangered Species

Federally listed threatened or endangered bird species that may occur in the Project vicinity are marbled murrelet (*Brachyramphus marmoratus*), brown pelican (*Pelecanus occidentalis californicus*), and short-tailed albatross (*Phoebastria albatrus*). Habitat for western snowy plovers (*Charadrius alexandrinus nivosus*) and northern spotted owls (*Strix occidentalis caurina*) exists within a few miles of proposed transmission corridors onshore, but these species do not occur in the wave park itself.

Marbled Murrelet

The marbled murrelet is a small seabird distributed along the Pacific coast from Alaska to central California (Nelson et al. 2006). The majority of the population resides in British Columbia and Alaska but low numbers of these seabirds are found in Washington, Oregon, and California (Huff et al. 2006; Piatt et al. 2006). The marbled murrelet nests in inland areas of old-growth forests as far as 50 miles inland from the coast. Ripple et al. (2003) found nesting sites in Douglas County extended miles inland beyond the Umpqua River (see Figure 2 for critical habitat). Further, Cooper and Augenfeld (2001) used radar to survey murrelets at 14 inland sites (each site was a ~1.5-kilometers-radius circle) in the Elliot State Forest, located southeast of Reedsport, and observed 2 to 56 murrelet targets per morning headed into nesting areas from the ocean. Murrelets spend most of their time in near-shore marine waters, foraging, loafing, molting, preening, and exhibiting courtship behavior (McShane et al. 2007). In the southern portion of their range, they generally remain near nesting areas throughout the year (McShane et al. 2007).

TABLE 2

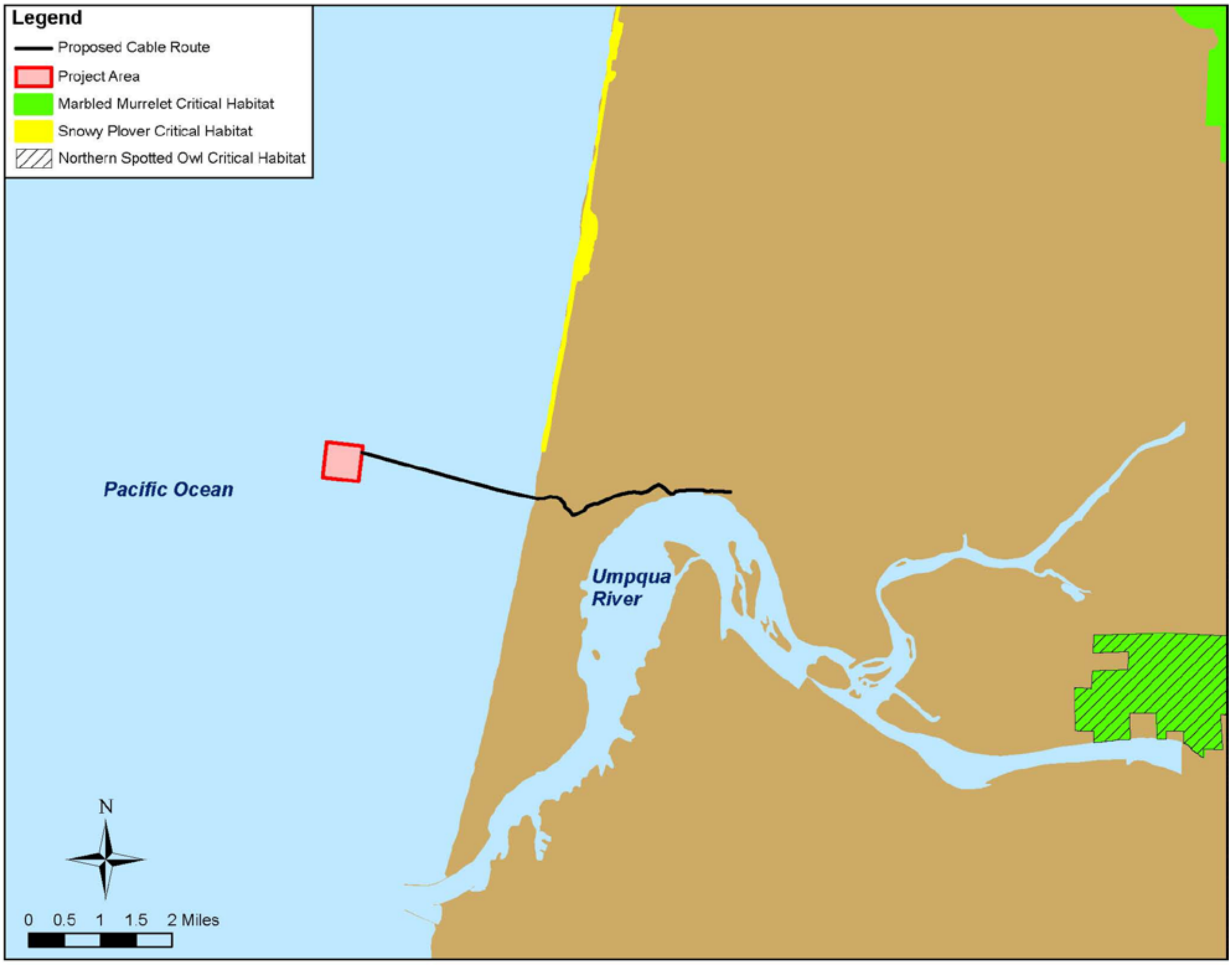
EXPECTED ABUNDANCE AND TIMING OF SELECT SPECIES FOUND ALONG THE COAST OF COOS COUNTY, OREGON

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Albatross	Rare	Rare	Rare	Common	Common	Abundant	Abundant	Abundant	Abundant	Common	Rare	Rare
Ancient Murrelet	Common	Common	Rare	Rare	Absent	Absent	Absent	Absent	Rare	Rare	Common	Common
Black-legged kittiwake	Rare	Rare	Common	Common	Rare	Absent	Rare	Rare	Common	Common	Rare	Rare
Bonaparte's Gull	Rare	Rare	Rare	Abundant	Common	Rare	Rare	Common	Common	Abundant	Common	Rare
Brandt's Cormorant	Rare	Common	Common	Common	Common	Common	Common	Common	Common	Common	Common	Rare
Brant	Common	Common	Abundant	Abundant	Rare	Absent	Absent	Absent	Rare	Common	Common	Common
Brown Pelican	Rare	Rare	Rare	Rare	Rare	Abundant	Abundant	Abundant	Common	Common	Common	Rare
California Gull	Rare	Rare	Common	Common	Rare	Rare	Common	Common	Common	Common	Rare	Rare
Cassin's Auklet	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Common	Common	Common	Rare
Common Loon	Common	Common	Common	Common	Common	Common	Rare	Common	Common	Common	Common	Common
Common Murre	Rare	Rare	Common	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Common	Rare	Rare
Common Tern	Absent	Absent	Rare	Common	Common	Rare	Rare	Common	Common	Rare	Rare	Absent
Fork-tailed Storm-Petrel	Rare	Rare	Rare	Common	Common	Common	Common	Common	Common	Rare	Rare	Rare
Glaucous-winged Gull	Abundant	Abundant	Abundant	Abundant	Rare	Rare	Common	Common	Abundant	Abundant	Abundant	Abundant
Herring Gull	Rare	Rare	Rare	Rare	Rare	Absent	Rare	Rare	Rare	Rare	Rare	Rare
Marbled Murrelet	Rare	Rare	Rare	Rare	Rare	Rare	Common	Common	Common	Common	Rare	Rare
Mew Gull	Abundant	Abundant	Abundant	Common	Rare	Absent	Rare	Rare	Common	Abundant	Abundant	Abundant
Northern Fulmar	Common	Common	Common	Rare	Rare	Absent	Absent	Absent	Rare	Common	Common	Common
Pacific Loon	Common	Common	Common	Common	Abundant	Abundant	Common	Common	Abundant	Abundant	Common	Common
Pomarine Jaeger	Absent	Absent	Absent	Rare	Rare	Absent	Rare	Rare	Rare	Rare	Rare	Rare
Red Phalarope	Rare	Rare	Rare	Common	Common	Absent	Absent	Absent	Rare	Rare	Common	Common
Red-legged kittiwake	Rare	Rare	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Rare	Rare
Red-necked Phalarope	Absent	Absent	Absent	Common	Common	Absent	Rare	Common	Common	Rare	Rare	Absent
Red-throated Loon	Common	Common	Common	Common	Common	Rare	Rare	Rare	Common	Common	Common	Common
Ring-billed Gull	Abundant	Abundant	Abundant	Abundant	Common	Absent	Rare	Rare	Common	Common	Common	Common
Scoters	Abundant	Abundant	Abundant	Abundant	Abundant	Rare	Rare	Rare	Rare	Common	Common	Common
Short-tailed Shearwater	Common	Rare	Rare	Rare	Absent	Absent	Absent	Absent	Rare	Common	Abundant	Common
Snowy Plover	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Rare
Sooty Shearwater	Rare	Rare	Rare	Common	Common	Common	Abundant	Abundant	Abundant	Abundant	Common	Rare
Thayer's Gull	Rare	Rare	Rare	Rare	Rare	Absent	Absent	Absent	Rare	Rare	Rare	Rare
Tufted Puffin	Absent	Absent	Rare	Common	Common	Common	Common	Common	Common	Absent	Absent	Rare

Legend:
- Absent or extremely rare
- Rare
- Common
- Abundant

Table adapted from Contreras 1998; Pers. comm. Jon Plissner, ABR, March 11, 2008.

FIGURE 2
CRITICAL AVIAN HABITAT



Data obtained from USFWS 2005*b*, 2007*b*, 2007*c*.

Marbled murrelets forage in near-shore marine areas, primarily within 1 to 2 kilometers from shore (USFWS 1997). Strong (1995) found that murrelet sightings off the Oregon coast declined after a distance of a little over one-half mile offshore (Table 3). Marbled murrelets feed on small fish such as surf smelt and sandlance, as well as invertebrates (USFWS 1997). Diving depth appears to vary and may depend on where the prey species is located (McShane et al. 2007). Although murrelets are likely capable of dives up to 47 meters deep (Mathews and Burger 1998), captures in gill net sets have recorded a maximal depth of 27 m, and most were caught between 3 and 5 meters of the surface (Carter and Erickson 1992). While foraging is an important contributor to sustaining murrelet populations, no distinct foraging zones have been identified. Researchers at Sea Engineering, Inc. (SEI) found that these seabirds would forage near-shore during the day and move several kilometers offshore at night (SEI 2007).

TABLE 3

NUMBER OF MARBLED MURRELET BIRDS PER MILE SURVEYED BY DISTANCE FROM SHORE NEAR NEWPORT IN 1992

Date	**Time**	**Distance Offshore**				
		<.3 mi	**3 - .6 mi**	**.6 - .9 mi**	**.9 - 1.2 mi**	**>1.2 mi**
		# of birds per mile, transects lateral to shoreline				
15-Jun	1130-1230	22.2	14.7	0.0	n/a	n/a
28-Jun	0840-1000	12.9	12.0	1.9	n/a	n/a
28-Jun	1200-1240	7.1	8.4	0.0	n/a	n/a
12-Jun	0710-1040	33.8	12.1	3.4	1.	n/a
16-Jul	0730-0800	11.9	1.3	0.0	n/a	n/a
1-Aug	1020-1150	14.4	20.2	6.8	5.4	1.7
7-Aug	0900-1050	3.3	2.9	0.0	n/a	n/a
10-Aug	0900-1050	13.5	13.7	3.0	1.3	0.0
Average		12.3	10.3	1.9	2.5	0.8

Table adapted from Strong (1995).

Strong (2003) reported declines in numbers of marbled murrelets in Oregon in the 1990s, but there is currently insufficient data to evaluate more recent population trends in the Washington, Oregon, and California population (McShane et al. 2007; Miller et al. 2006). Notably, researchers have cited the challenge of counting and estimating murrelets as the cause for the variability with their counts (Miller et al. 2006; Piatt et al. 2007). In addition, differences in census methodologies have impeded comparisons of survey results (Miller et al. 2006). Murrelets do not forage or nest in large groups but instead are spread along the coast and within old growth tree stands, thereby making counting difficult. Regardless, statistically significant declines have been identified in British Columbia (Piatt et al. 2007) and are suspected to occur throughout its west coast range (McShane et al. 2007). Huff et al. (2006) estimated the current Washington, Oregon, and California population as consisting of 22,000 birds. Of these, an estimated 5,100 were between along the Oregon coast (Miller et al. 2006), with a density of 14.08 ± 2.49 murrelets/mile^2 in Conservation Zone 3, Stratum 2 (i.e., the area that the proposed wave park is located within). Based upon surveys conducted along the Oregon coast in 1992 and 1993 (Strong et al.1995), marbled murrelets were abundant in central Oregon from Newport to Coos Bay but variable in numbers south of Coos Bay. As seen in Table 3, the highest density of birds occurs in a narrow band close to shore, with a dramatic decrease at greater than 0.6 miles from the shore.

Data on marbled murrelet population densities in Oregon outside the breeding season are very limited. Following the grounding of the *New Carissa* and subsequent oil spill near Coos Bay in early February 1999, a series of boat-based transect surveys of murrelets and other seabirds were conducted on February 14 and 15, up to 25 kilometers south and 80 kilometers north of the wreck (Strong 2000). Transect lines were run parallel to the coast at distances from 500 to 2,000 meters from the shore. The mean density of marbled murrelets during these surveys (0.48 birds/$km^{2)}$ was 0.3 to 3 percent of densities observed during breeding season surveys (Strong 2000). The low densities observed, however, may have resulted from effects of the oil spill and may not reflect typical winter densities in the area.

Historically, population declines of marbled murrelet populations have been attributed to loss and degradation of nesting habitat. Adult mortalities related to gill netting activities have been severe as well in some areas, although it is not known to have occurred in Oregon (USFWS 1997). Continuing threats to recovery primarily include disturbance to nesting areas which affect nesting success, nest predation, and the decline in nesting habitat (old growth forest stands). Additional threats include commercial and recreational fishing; ocean pollution, oil spills, changes in forage species distribution and abundance, and ocean conditions (USFWS 1997; McShane et al. 2007; SEI 2007). Although collisions with transmission lines and vehicles have been reported for the species, no cases of murrelets colliding with structures at-sea have been documented (McShane et al. 2007).

Brown Pelican

The brown pelican is a large seabird that nests in southern U.S. and Mexico coastal regions along small islands and estuaries. Pacific populations of the brown pelican nest in colonies in southern California and Baja California but regularly range northward post-breeding as far as British Columbia. Numbers along the Oregon coast peak from late summer through the fall, although some individuals may be present throughout the year (Nehls 2003*a*). In Oregon and Washington, they are found at greatest concentrations in large estuaries (USFWS 2007*a*). During an on-site investigation in July 2007, a Devine Tarbell & Associates, Inc. (DTA) scientist observed brown pelicans flying over the Project area.

Pelicans generally feed in coastal and estuarine waters with birds seldom venturing more than 20 miles out to sea (Shields 2002); however, migrations up to 40 miles have been seen when good fishing conditions are present (USFWS 2007*a*). They feed on various species of fish such as sardines, mackerels and anchovies, typically diving headfirst from heights up to 20 meters but only catching prey within 1 to 2 meters of the ocean surface (Shields 2002).

The status of the brown pelican has greatly improved in recent years. The primary factor in the species decline was the use of DDT, a harmful pesticide that reduced eggshell thickness. Additional factors included reduced prey abundance and disturbance to nesting areas. Subsequent banning of DDT and additional conservation measures to protect key nesting areas has resulted in population growth throughout the range of the species. Based on the latest status review conducted in 2006, the California brown pelican total population is currently estimated at 142,400 breeding birds (USFWS 2008). In February 2008, the USFWS concluded that the brown pelican has recovered and formally proposed de-listing the species (USFWS 2008).

Short-tailed Albatross

Thought to be extinct in the mid-20th century, short-tailed albatross numbers are currently estimated to be less than 2,000 birds (USFWS 2005*c*). The species' breeding grounds are limited to Torishima Island, south of Japan, and the Senkaku Islands, northeast of Taiwan; although in recent years, non-breeding individuals and pairs have been observed during breeding seasons further south on Minami-Kojima Island in the Ryukyu chain as well as on Midway Island (USFWS 2005*c*). Birds spend most of their lives over the northern Pacific Ocean and the Bering Sea. Short-tailed albatrosses typically occur 20 to 30 miles or more offshore (Pers. comm. Thompson, in NOAA 2001), and there are fewer than 10 reported observations of the species off the Oregon coast, with none closer than 20 miles offshore (Nehls 2003*b*).

3.0 Project Effects

The height of the PowerBuoys above-water structure is necessary to accommodate the float's stroke length required to capture the energy from the wave oscillation. The USFWS has noted that migratory and resident seabirds are habituated to flying through unobstructed habitats, when away from nesting and roost areas. Because the Company's PowerBuoys rise 29.5 feet above the water surface, stakeholders have raised concerns the Project may result in bird injury or mortality via collision or attraction, particularly during inclement weather (Pers. comm. Kathy Roberts, USFWS, October 5, 2007; pers. comm. Maura Naughton, Fish and Wildlife Service, Regional Office, Portland, Oregon 2007; PRBO Conservation Science 2003; Dick and Davidson 1978; Wiese et al. 2001; USFWS 2005*a*).

The Aquatic Species Subgroup identified the need to assess whether Project lighting will cause seabirds to collide with the PowerBuoys. To address U.S. Coast Guard (USCG) regulations, which include NVICO2-07 and to aid navigation, the Company will light the PowerBuoy array at night. As requested by the USFWS, the lights will be shielded, to direct light only towards approaching watercraft, and not directly upwards. As requested by the USFWS, the flash intensity has been selected to meet the minimum USCG requirement for navigational safety.

The Company will light the eight perimeter PowerBuoys in the array with Carmanah 702-GPS as described in the table below. The inside two PowerBuoys will also have a flashing light of less intensity, as requested by the USCG.

The lighting flash pattern will be developed in consultation with stakeholders and the light manufacturer. The final flash pattern will aid in depth perception, visibility in a variety of sea states, and the ability to distinguish individual PowerBuoys. With respect to concerns regarding attraction of seabirds to the lit PowerBuoys, USFWS recommends a brief flash, then at least 4 seconds off, for each individual light, and the Company will adhere to this request. The Company anticipates that the light flash duration (time on) will be between 1/4 second and 1/2 second.

The Carmanah (www.solarmarinelights.com) Model 702-GPS is a fully-integrated, solar LED three-nautical-mile (3.4 miles) marine light with Global Positioning Satellite (GPS) synchronization. The integrated GPS receiver will allow the lights to synchronize flash pattern timing.

The following are the typical specifications of the Carmanah 702-GPS.

- Lens Color .... Yellow
- Effective Intensity .... 18 Candela
- Nominal Night Range .... 3.2 nautical miles
- Horizontal Output .... 360 degrees
- Minimum Autonomy .... 300 hours
- On/Off Level .... 70/100 lux

- Illumination Technology .... 24 LEDs
- Synchronization Technology..Global Positioning System

4.0 Need for Additional Information

Listed bird species are protected under the U.S. Endangered Species Act (16 USC 1531), and, although the other migratory species in the Project area are not in danger of extinction, they are protected under the U.S. Migratory Bird Treaty Act (16 USC 703). Hence, there is a need to estimate possible levels of collisions and potential fatality of members of the bird community found in the location of the Project.

Collision-related mortality of seabirds has been well documented, particularly in relation to larger lighted structures (reviewed in Rich and Longcore 2006) and more recently at offshore wind farms (Drewitt and Langston 2006). Currently, however, no data are available to address directly the risks incurred by seabirds at wave parks. Furthermore, few avian data from the area of the proposed wave park are available to help assess the potential effects of this Project on birds that reside in or traverse through the area. Exceptions include some limited boat-survey data collected as part of regional monitoring activities for marbled murrelets and aerial- and boat-survey data conducted as part of the response to the *New Carissa* oil spill. In addition, general information on seasonal patterns in bird species composition in Oregon coastal waters is available from records of intensive, though anecdotal, observational data ("seawatches" and pelagic birding trips) provided by local birders. Currently, all known data are being compiled to help with a preconstruction assessment of general avian collision risk at the proposed wave park.

Information necessary for accurate predictions of the risk of collision between birds and WEC include: (1) the abundance of avian species within and near the proposed wave park throughout the year; (2) flight characteristics (altitude, temporal patterns, etc.) of individuals within the proposed development area; and (3) direct or indirect determination of birds' abilities to detect and avoid potential collisions with PowerBuoys under various environmental conditions. These data then can be used as inputs for models that predict numbers of birds that will collide with PowerBuoys at the site. Because no comprehensive data are available for birds at the proposed development area, either assumptions must be made about appropriate input values or data should be collected to provide these values.

5.0 Study Plan

5.1 Introduction and Overview

The Offshore Avian Use Study will consist of a series of studies to collect the field data necessary to assess the collision-related effects of this proposed wave park on birds and will follow an adaptive course of action as indicated in Figure 3. The Offshore Avian Use Study will consist of the following components: (1) studies of avian presence to collect information on use of the wave park by the bird community as a whole; (2) risk-assessment modeling to estimate the annual fatality of seabirds at the proposed wave park; and (3) studies of behavioral-avoidance/collision rates to collect information on avian avoidance behavior and fatality at the wave park. At several points during the process, results of studies will be reviewed by the Aquatic Resources and Water Quality Implementation Committee, which will then determine if collision risk is sufficiently low that additional studies are unwarranted, or if there is need to continue with additional monitoring studies and/or alternative mitigation measures.

The data collection for the avian presence portion of the study (Figure 3, blue) will focus on ship-based survey data, supplemented by radar studies that provide information on nocturnal bird activity. The key data to be collected for this study will include seasonal information on movement rates through the wave park (birds/km/h), bird species-composition, distance offshore, flock sizes (number of birds/flock), flight altitudes (in meters above sea level [asl]), and flight directions. These data will provide input values for the risk-assessment modeling study (Figure 3, yellow), for which existing models for estimating seabird fatalities at wind farms and other tower structures will be adapted for application to the Project. Because the probability of birds avoiding collisions with WEC is unknown, a range of fatality estimates will be provided, representing minimal and maximal avoidance rates. If the maximal estimated fatality rate is deemed to be sufficiently high (by the Aquatic Resources and Water Quality Implementation Committee), we will initiate a behavioral-avoidance/fatality study to determine collision and/or avoidance rates of birds during initial deployment of the PowerBuoys (Figure 3, green Option 1b), in order to assess more precise estimates of risk and impact. The observed avoidance rates would then be applied to the models to derive precise fatality estimates for all species. If warranted, by the Aquatic Resources and Water Quality Implementation Committee, additional fatality studies will be undertaken to confirm predictions of low rates of collisions/fatalities following deployment (Figure 3, green Option 2b). Alternatively, high fatality estimates may trigger additional measures to mitigate or reduce fatality rates (Figure 3, gray Option 2c).

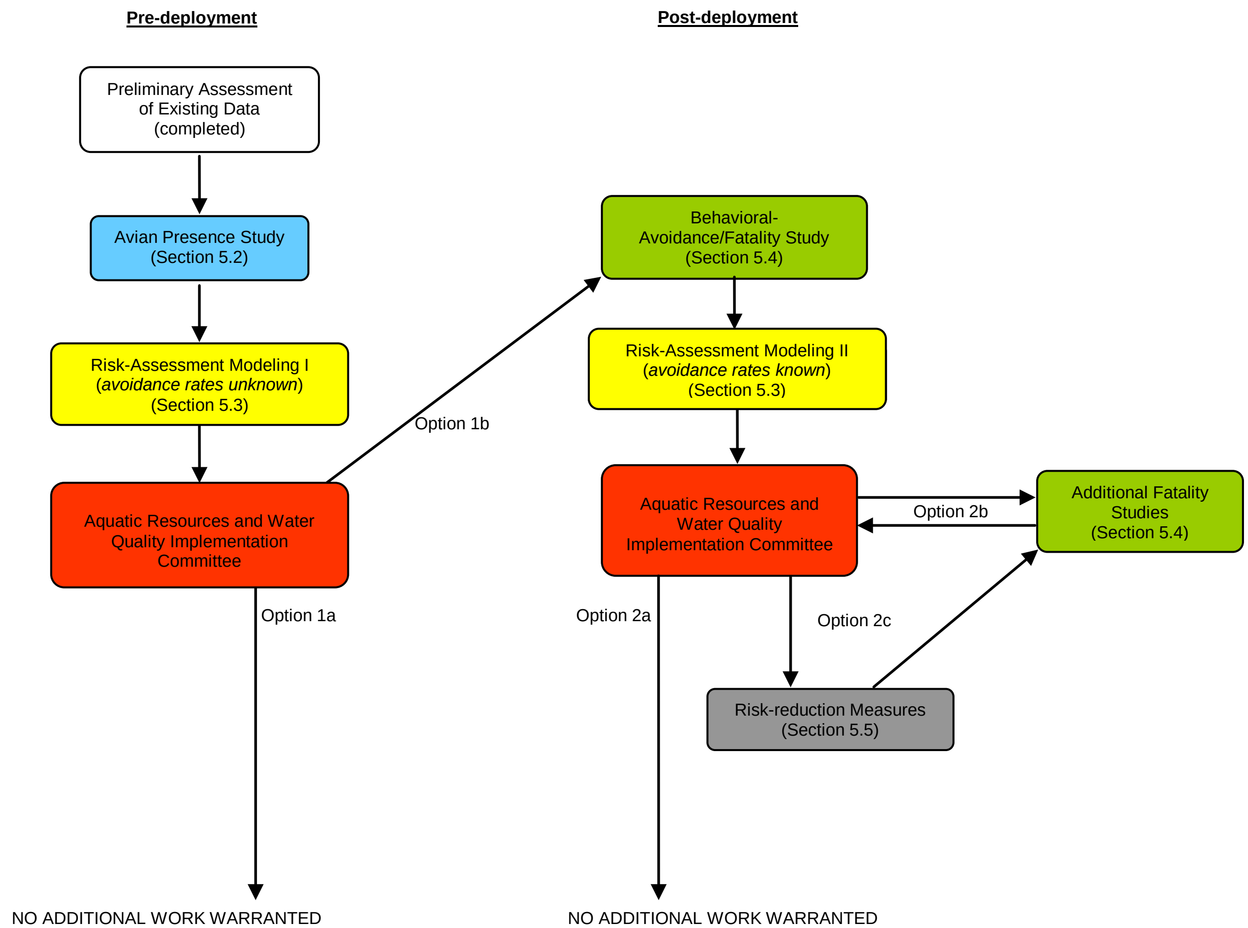
5.2 Avian Presence Study

5.2.1 Boat-Based Sampling

Monthly boat-based seabird surveys will be conducted in and around the proposed Project area prior to deployment of PowerBuoy array to increase our understanding of the at-sea distribution, seasonal occurrence, and behavior of species throughout the annual cycle. The surveys will be conducted after the deployment of the single PowerBuoy but before the deployment of the PowerBuoy array. Avian surveys are anticipated to be coordinated with Fish & Invertebrate and other studies. The at-sea sampling also will enable us to collect high-resolution data on the distribution and abundance of marbled murrelets in this area, so that the risk-assessment modeling discussed below (Section 5.3) can be improved.

Figure 3

Adaptive management plan for offshore avian use study at the proposed Project near Reedsport, Oregon



The boat-based surveys will use standardized strip-transect sampling for birds at sea (Gould and Forsell 1989) and will be conducted during two 2-3 day periods of sampling/month for 1 year. Surveys would be conducted systematically along a series of 7.5-kilometers-long east-west transect lines, extending westward from near-shore (~350 meters from shore), and spaced 1.2 kilometers apart. The overall sampling area would include the proposed Project area, as well as areas up to 8 kilometers to the south and north. During each survey, a standardized north-south trackline through the proposed Project area will be sampled to obtain additional information (especially for marbled murrelets). In addition, sea conditions permitting, site-specific data on flux rates (flights), and flight altitudes will be collected each day during a 1-hour fixed-point survey within the 800 by 800 meters Project area. It is expected that each complete run of the transect routes would require 2+ days of effort. Conducting the surveys twice each month, approximately two weeks apart, allows for measurement of within-month variation in numbers of individuals moving through the study area.

During these boat-based surveys, data will be recorded on species (or lowest possible taxon), flock size, behavior, distance from transect line, flight direction, and flight altitude whenever possible. During survey efforts, boat speed will be maintained at ~10 knots to maximize probability of detecting many species of diving birds (Miller et al. 2007). Observers will record data on all birds observed ≤300 meters horizontal distance from the observer and within an arc from directly in front of the bow 90° to the side. Two observers will be used to generate the best possible estimates of densities (Spear et al. 2004), with one individual conducting observation on each side of the vessel. The "snapshot method" will be used to compensate for biases introduced by flying birds (Tasker et al. 1984). Locations of transects will be recorded at a scale small enough that the data can be stratified geographically (i.e., within the wave park vs. outside of it, and by bins of distance from shore). Counts of birds will be converted to density estimates based on the area sampled during each transect.

The sampling protocol for boat-based portion of the avian presence study provides sufficient sample sizes to achieve our objective of obtaining avian presence data for the Project area. There will be multiple survey efforts within each season and within each month to obtain some measures of variance. We will not be able to assess effects of yearly variation in numbers, but with multi-year cycles of seabird abundance among several species, accounting for such variation for all birds present would require effort outside the scope of this study.

5.2.2 Radar Sampling

A shore-based surveillance radar system will be used to obtain data on relative numbers of seabirds active during diurnal and nocturnal hours, which then can be applied to the pre-installation boat-based survey results in order to estimate numbers of birds present in the proposed development area at night. A mobile radar lab is anticipated to consist of an X-band marine radar, transmitting at 9,410 MHz with peak power output of 12 kW (Cooper et al. 1991). Sampling will include four hours of diurnal sampling and four nocturnal hours. Sampling efforts will be spread throughout the year to account for seasonal differences in daily activity patterns and will occur the year after the boat-based sampling (Section 5.2.1). Additional boat-based surveys may be performed periodically during the radar sampling year to identify species present during sampling, and confirm the accuracy of the seasonal species composition collected during the first year.

Radar sampling will be used to measure the movement rates (targets/km/h), flight directions, and flight behaviors of radar targets through the area. A “screen-shift” function on the radar will be used to enable us to sample to ~2.5 to 2.7 kilometers offshore (depending on where the system can be set up and how far low-flying birds can be detected); the Company can then quantify movement rates in 500-m-wide distance zones. Because the Company will not be able to measure movement rates through the wave park itself, movement rates from zones just inshore of it will be used, assuming that movement rates and relative numbers in the development area and just inshore will be comparable.

5.2.3 Avian Presence Study Metrics and Analyses

Survey Results

Data from boat-based survey efforts will be used to calculate species-specific density estimates for the general area of the proposed wave park as well as movement rates for birds flying within the Project boundary at altitudes where they could potentially encounter PowerBuoys. Densities will be calculated using both fixed-width transect strips (50 meters wide for marbled murrelets and smaller species; up to 300 meters wide for larger species) and by applying observed distances from the transect line to program DISTANCE (Thomas et al. 2006). These two estimators will allow flexibility in comparing results to other studies that use either of the two methods for determining densities. Density estimates will be generated for all species observed for each month and across seasons. Mean densities will be determined in relation to distance from shore; using categories of **nearshore** (≤1.5 kilometers from shore, corresponding with Strong’s [2003] designation as well as the maximal marine radar sampling distance), **offshore** (1.5 to 5.0 kilometers from shore, corresponding with Strong’s [2003] designation and encompassing the zone of the proposed wave park), and **far offshore** (5.0 to 7.5 kilometers from shore, beyond the seaward boundary of the PowerBuoy array). Relative densities of birds observed nearshore and offshore from the boat-based sampling will be applied to results of radar sampling to estimate numbers of individuals flying through the proposed Project area at night. Identification of birds beyond the proposed Project area will help to identify species that may on occasion or under certain weather or ocean conditions move closer to shore and into the area of interest.

5.3 Risk-Assessment Modeling Study

An estimate of annual fatality rates of seabirds at the Project, will be calculated based on information that is collected during the avian presence study plus any additional information that is gleaned from pertinent published and unpublished literature. Whenever possible, this risk metric (bird fatalities/WEC/year) will be estimated for the bird species-groups of interest (i.e., loons and grebes, albatrosses, petrels, shearwaters and fulmars, pelicans, cormorants, murres, marbled murrelets, other alcids, shorebirds, and sea ducks); however, the level of taxonomic resolution ultimately will depend on the data collected and the sample sizes that are available to us. The model will be run after on-site survey data have been collected from the avian presence study before installation of the PowerBuoys to obtain a range of risk values and again following the behavioral-avoidance/fatality study, if initial risk-assessment model results warrant such behavioral studies to produce more precise estimates of risk (Figure 3, Option 1b; see Section 5.4 below).

Risk assessment models require data on movement rates of birds flying below the maximal above-water height of the PowerBuoys. Movement rates will be calculated from the number of birds flying across the transect line less than 300 meters in front of the observer (or that would have crossed the transect line if they had not reacted to the vessel). Birds crossing the transect because of obvious attraction to the boat will be excluded. Rates will be calculated separately for each category of distance from shore. To account for birds flying toward or away from the shore, movement rates also will be measured during transit between primary transect lines and during sampling of the north-south trackline through the proposed Project area. Minimum flight altitudes of all birds flying within the 300 meters sampling zone will be recorded. For each species, relative numbers of individuals flying above and below the maximal height of the PowerBuoys will be calculated and applied to the overall movement rates to obtain appropriate movement rates for the models. Rates and altitudes will also be calculated from observations during stationary sampling within the wave park boundary. Such measures may be biased somewhat by birds responding to the presence of the vessel, but such biases will be examined by comparison of rates with results from nearby transects and will nevertheless provide information on seasonal differences.

5.3.1 Risk-Assessment Model Study Metrics and Analysis

Following methods developed for using radar and visual data for modeling seabird fatality at wind farms (e.g., Cooper and Day 2004, Cooper and Sanzenbacher 2006) and tall towers (e.g., Day and Cooper 2003, 2004*a*, 2004*b*, 2004*c*), the boat-based observational data will be used on numbers, flight altitudes, and movement patterns of different species of seabirds as the basis for the risk-assessment modeling at the proposed wave park. The proportion of radar targets observed during nocturnal hours to our boat survey numbers will be applied to also account for birds flying through the proposed development area at night. These **movement rates** through the proposed wave park form the first component of the risk-assessment modeling (Figure 4).

A second component of the fatality modeling involves the **horizontal-interaction probability**, which is the probability that a seabird flying over the wave park will cross the airspace occupied by a PowerBuoy. To estimate this probability, we will use the cumulative area (i.e., side profile) of the above-water superstructure of all PowerBuoys and the total dimensions of the proposed wave park to estimate the probability of encountering a PowerBuoy.

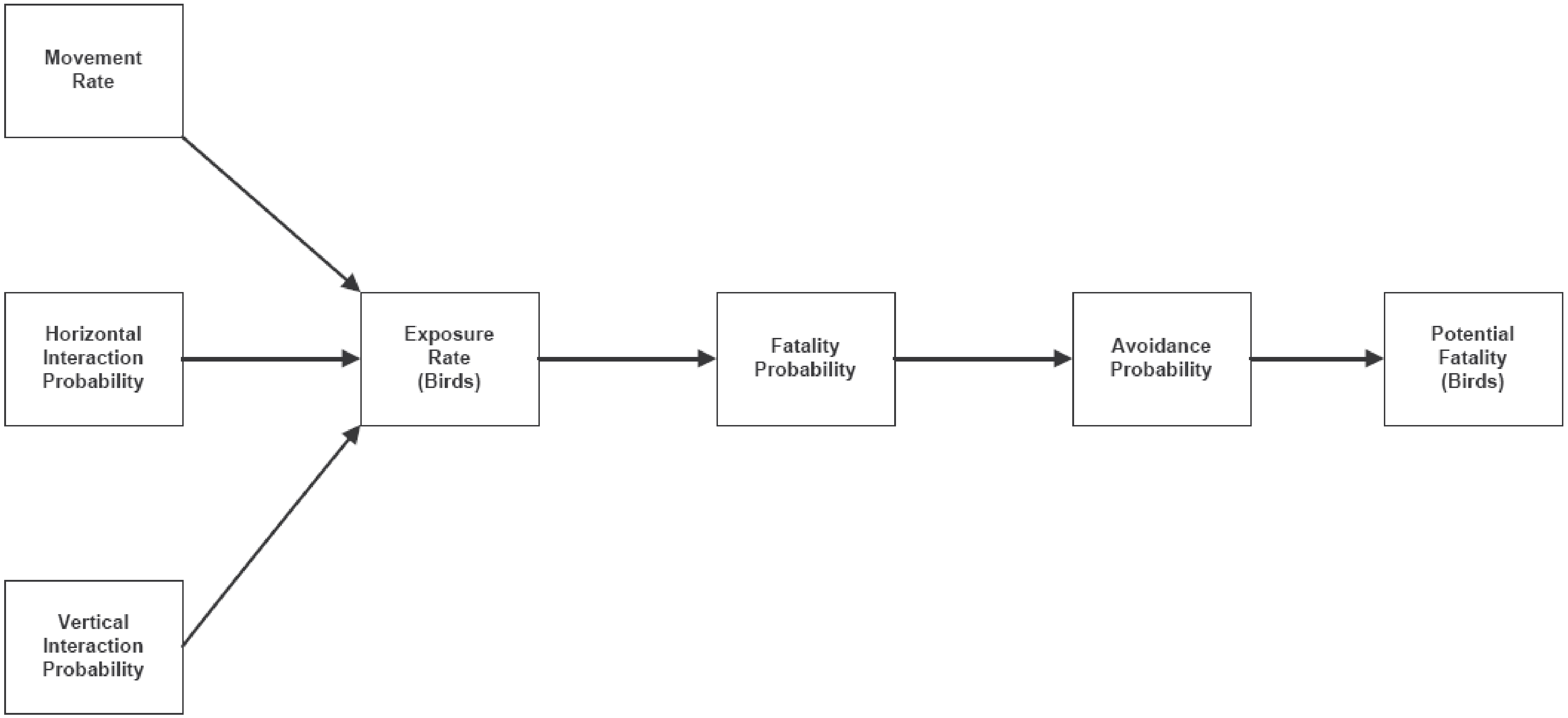
A third component of the fatality modeling involves flight altitudes, in that collision risk (**vertical-interaction probability** based on flight altitudes) drops dramatically if all birds fly far above the ocean; conversely, vertical-interaction probabilities are high for bird groups that fly near the ocean surface. This component is equal to the proportion of seabirds (for each or species-group of interest) that we observe flying at or below PowerBuoy height in the avian presence study.

A fourth component of the fatality modeling involves the **fatality probability** if there is exposure to a PowerBuoy, which is the probability of dying if a bird flies within the airspace occupied by the superstructure of a PowerBuoy. Because the above-water portion of the PowerBuoy is a rigid structure, we will estimate the fatality probability to be 99 percent (i.e., 1 percent of birds colliding with the PowerBuoy will only graze the superstructure and, hence, will survive). Initially, we will use a range of estimates for **behavioral-avoidance rates** (0, 50, 95, and 99 percent) to apply to the model. If warranted, behavioral studies of collision/avoidance described in section 5.4 below will be used to estimate avoidance rates. Avoidance rates will be assumed to be higher during the daytime than at night and lower during inclement weather conditions (fog and heavy surf) than calmer and clearer conditions.

A second component of the fatality modeling involves the **horizontal-interaction probability**, which is the probability that a seabird flying over the wave park will cross the airspace occupied by a PowerBuoy. To estimate this probability, we will use the cumulative area (i.e., side profile) of the above-water

Figure 4

Schematic diagram of the primary steps in calculating possible fatality rates of birds at the proposed Project near Reedsport, Oregon



superstructure of all PowerBuoys and the total dimensions of the proposed Project to estimate the probability of encountering a PowerBuoy.

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A fourth component of the fatality modeling involves the **fatality probability** if there is exposure to a PowerBuoy, which is the probability of dying if a bird flies within the airspace occupied by the superstructure of a PowerBuoy. Because the above-water portion of the PowerBuoy is a rigid structure, we will estimate the fatality probability to be 99 percent (i.e., 1 percent of birds colliding with the PowerBuoy will only graze the superstructure and, hence, will survive). Initially, we will use a range of estimates for **behavioral-avoidance rates** (0, 50, 95, and 99 percent) to apply to the model. If warranted, behavioral studies of collision/avoidance described in section 5.4 below will be used to estimate avoidance rates. Avoidance rates will be assumed to be higher during the daytime than at night and lower during inclement weather conditions (fog and heavy surf) than calmer and clearer conditions.

The main components of this fatality model are shown in Figure 4. In essence, the **movement rates** (i.e., flux rates), the **horizontal-interaction probability** (i.e., the probability of flying through airspace occupied by a PowerBuoy if the bird crosses the wave park), and the **vertical-interaction probability** (i.e., the probability of hitting a PowerBuoys superstructure if flying through the airspace occupied by a PowerBuoy) are used to estimate the number of birds that might hit the superstructure (i.e., **exposure rate**). The **fatality probability** then is used to estimate the probability of dying if the bird hits the structure to estimate possible fatality. Finally, the various **behavioral-avoidance rates** are used to estimate potential levels of fatality (i.e., number of fatalities/WEC/year) for each scenario and species-group.

5.4 Behavioral-Avoidance/Fatality Study

This portion of the study is the most difficult logistically, as no tested methods currently exist for monitoring avian fatalities at ocean buoys or WEC of any kind. Approaches to answering the question of how many, if any, birds are killed at this wave park will be assessed in consultation with resource agencies.

The most promising approach involves development of a camera system for measuring the actual avoidance and/or fatality rates at one or more deployed PowerBuoys. Currently, the most promising technology for such studies is an infrared (thermal imaging) camera system that has been developed for use on offshore wind turbines (Desholm et al. 2006). The costs and limitations of using such technology on constantly-moving structures may be problematic, and significant advances in the design and reliability of such devices are needed before they could successfully be applied to these studies. Other technologies for monitoring bird collisions, such as acoustic/vibration detectors (e.g., Pandey et al. 2007), are similarly in a developmental stage and face additional challenges for adaptation to the environment of an oceanic buoy.

Results of these studies would be used to produce specific avoidance rates that then could be applied to the risk-assessment model described above (Section 5.3). The methodology might also be adopted for further studies to confirm model predictions (Figure 3, Option 2b) and/or assess results of risk-reduction measures that might be implemented (Figure 3, Option 2c; see Section 5.5 below).

5.5 Risk-reduction Measures

Results of various studies described in Sections 5.2, 5.3 and 5.4 will be reviewed by the Aquatic Resources and Water Quality Implementation Committee, which may determine that additional studies are unnecessary (Figure 3, Option 2a); that additional monitoring is warranted (Figure 3, Option 2b); or that measures should be taken to reduce collision/fatality risk at PowerBuoys (Figure 3, Option 2c).

5.6 Constraints, Limitations, and Feasibility

The paucity of existing data that could be useful in assessing avian risk at the proposed Project is indicative of the difficulties in obtaining such information and also highlights the value of gaining any additional knowledge of patterns of seabird behavior and use of these waters. Each aspect of the proposed work has different constraints and challenges. Boat-based survey efforts may be hampered by sea conditions, although we would attempt to schedule sampling times accordingly. Nevertheless, bird activity might be expected to be radically different during conditions when surveys cannot be conducted, which might also be when avoidance behaviors might be hampered. Radar sampling is also weather-dependent; and correction factors may need to be applied for low-flying individuals under some conditions. Studies of avoidance/collisions at wave parks are highly constrained currently by the lack of a proven technique for gathering such information. Although it is likely that suitable technologies will be developed to provide such desirable information, it is uncertain how much time and trial efforts will be needed to produce a reliable monitoring system. These limitations lead to the possibility that either assumed values or a plausible range of values (of avoidance rates) will be needed for fatality modeling efforts. It may be possible to derive reasonable approximations from surrogate studies. Nevertheless, any additional data derived from survey efforts in the area of the proposed development will greatly improve the assessment of risk not only for the immediate Project but also for some applications to other sites.

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Reedsport OPT Wave Park, LLC.
Reedsport OPT Wave Park
FERC No. 12713

Issue Assessment
Wave, Current, and Sediment Transport
May 6, 2010

1.0 Description of Issue

The Company has filed with FERC a License Application for a 35-year license to develop and operate the Project. The Project would consist of deployment and operation of 10 PowerBuoy® wave energy converters (WEC) having a total capacity of 1.5 megawatts (MW), to be located approximately 2.5 miles (4 kilometers) off the coast of Gardiner in Douglas County, Oregon (Figure 1). The ½-mile-by-½-mile (0.25 square miles) Project area represents the area within which the 10-PowerBuoy array would be deployed. The actual footprint of the constructed array is expected to be only about 1,000 feet by 1,300 feet (300 meters by 400 meters) or approximately 30 acres (0.05 square miles), excluding the navigation safety zone. The PowerBuoys will be deployed in an array of three rows, approximately in a northeast-southwest orientation and in an oblique orientation to the beach. Two rows will consist of three PowerBuoys, and one row will consist of four PowerBuoys (Figures 2 and 3). The Company plans to deploy the 10-PowerBuoy array during the summer of 2011. Prior to that, the Company also plans to install a single PowerBuoy in 2010, which will not be grid connected.

Large floating objects such as WEC will potentially reflect and scatter wave energy in addition to the wave energy they absorb. Stakeholders have expressed concerns about the potential impacts of wave farms to the physical environments and ecosystems. The elements of this work plan are based on criteria set forth in the Oregon Territorial Sea Plan, Part Two (Oregon Ocean Policy Advisory Council [OPAC] 1994).

2.0 Relevant Existing Information

The PowerBuoy generates power by taking the up-and-down motion of the surface waves and using it to cycle hydraulic cylinders. The hydraulic fluid is then pumped through a hydraulic motor, which is made to spin. In this way, the reciprocating motion is converted into rotational motion. In the PowerBuoy, the hydraulic motor is coupled to a generator which generates AC current that is smoothed into DC current, and then is converted back to 60 Hz synchronous three-phase power. This AC to DC to AC electrical conversion occurs in each PowerBuoy before exiting and being transmitted to the Underwater Substation Pod (USP) . The USP houses switching gear and a transformer, which is used to increase the voltage before the power is transmitted to shore (Figure 2). The USP is about 6 feet in diameter and about 15 feet in length. It rests on the seabed below the PowerBuoys and is held down with pre-cured concrete ballast blocks. The power produced by the PowerBuoys is routed into the USP through watertight penetrators. The 10 PowerBuoys will share the USP.

The generated power will be transmitted to shore for interconnection to the electrical grid via an armored subsea cable. The cable will be connected to the PowerBuoy array and will follow an easterly course about two miles to the underwater outlet of an existing effluent discharge pipe, which is located about 0.5 miles from shore. This portion of the cable, seaward of the effluent

FIGURE 1
PROJECT LOCATION MAP

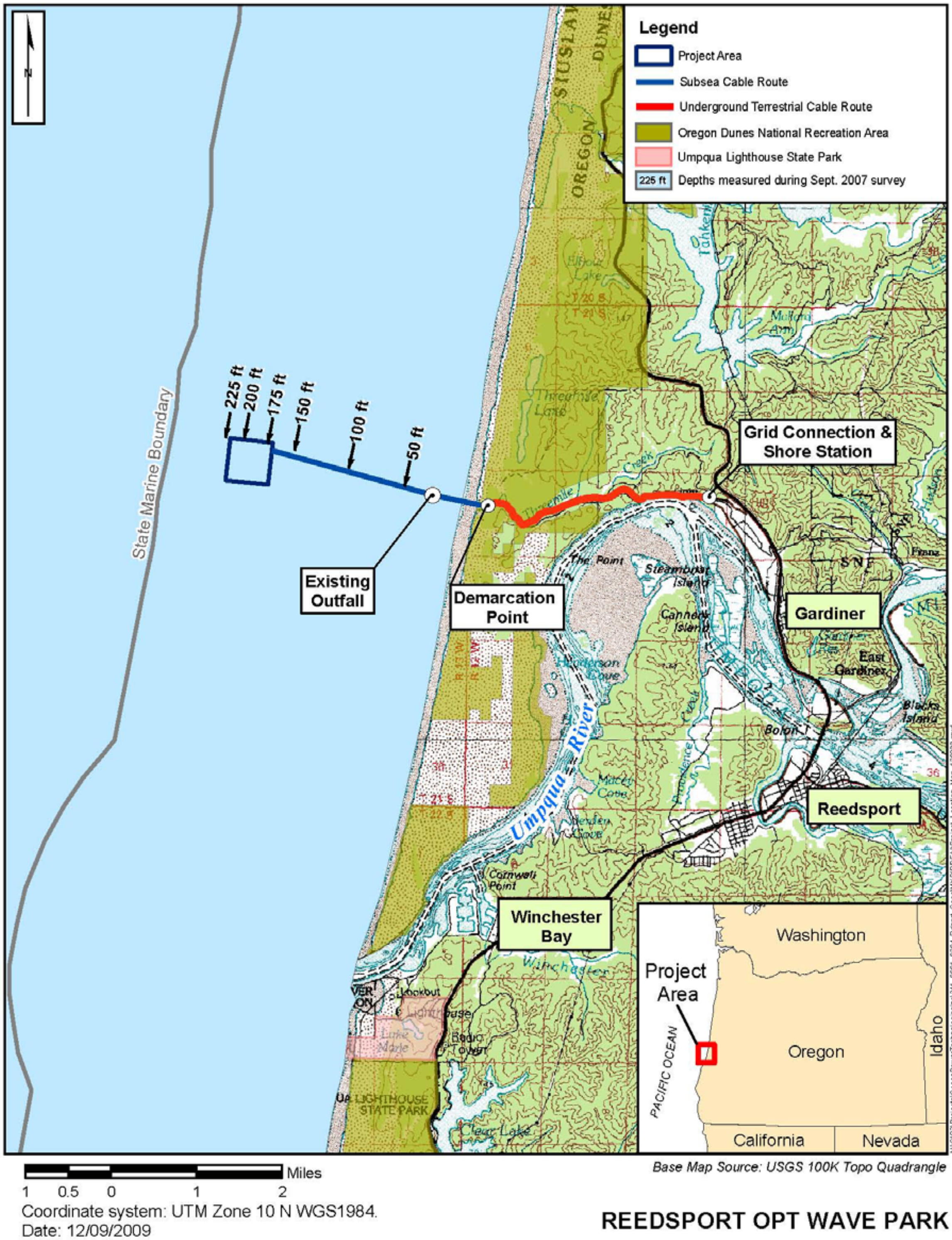
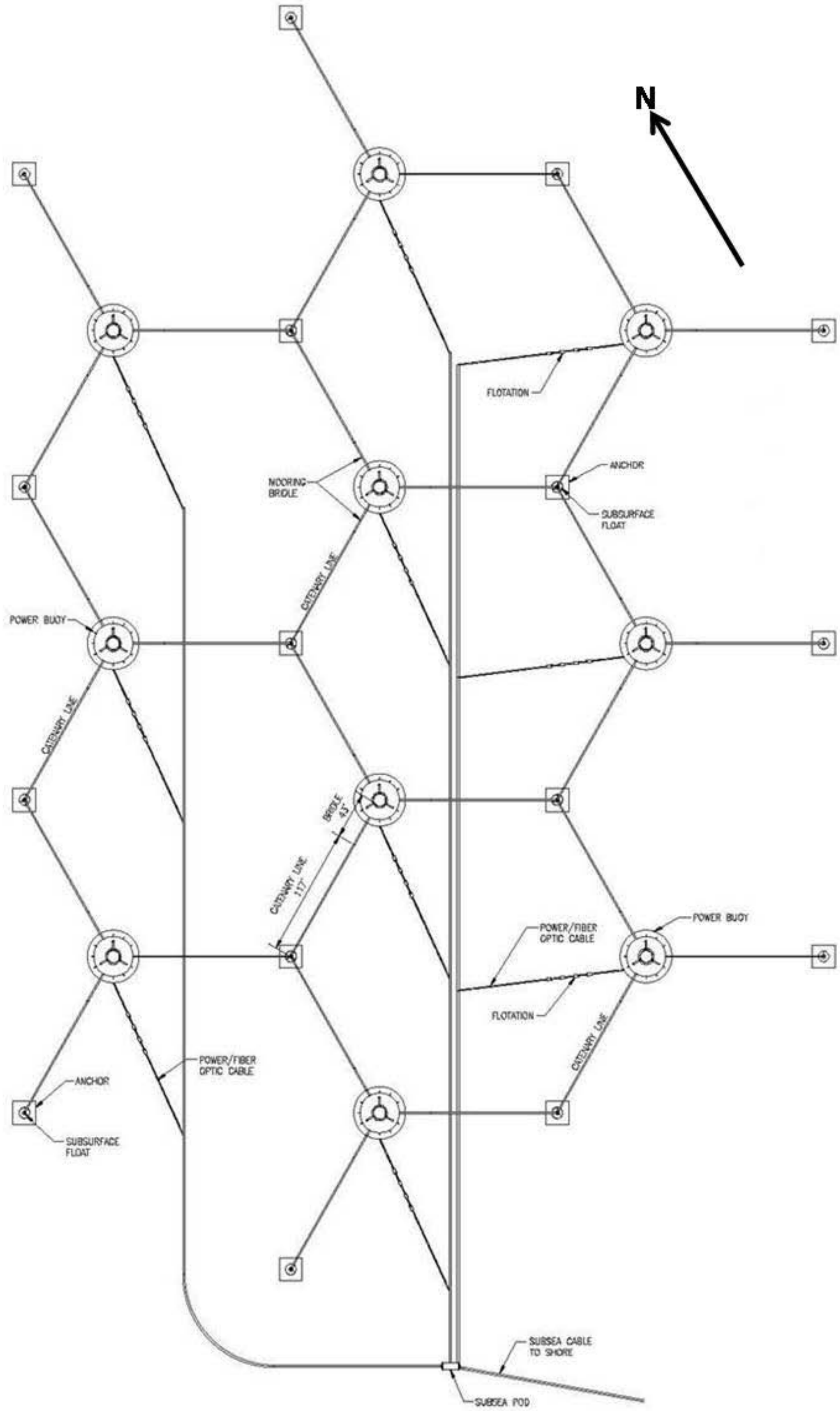


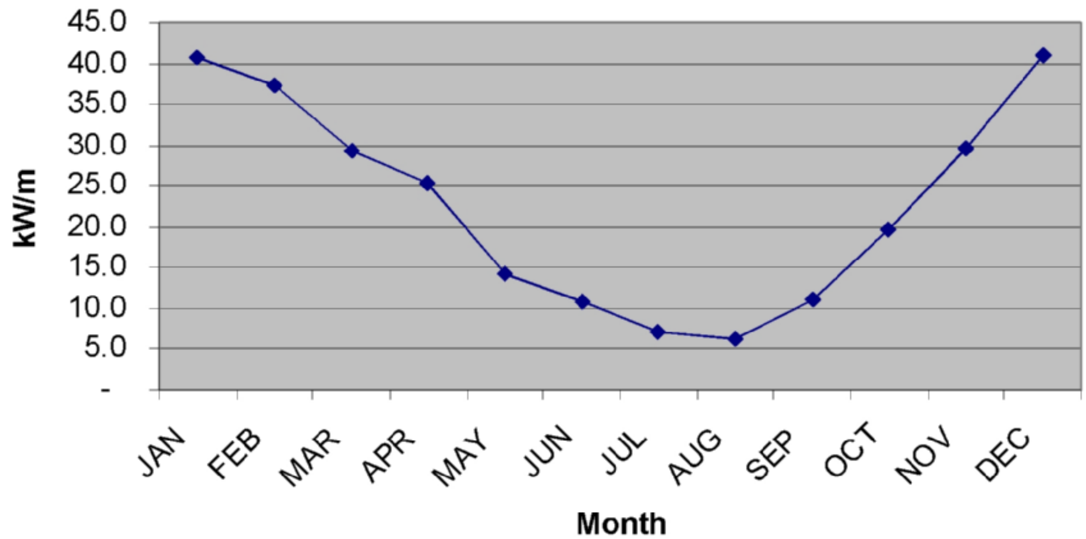
FIGURE 2
REEDSPORT PROJECT POWERBUOY ARRAY



pipe outfall, will be buried in the seabed to a minimum depth of about 3 to 6 feet (about 1 to 2 meters).

The Electric Power Research Institute (EPRI) conducted a wave energy feasibility definition study for a number of sites in Oregon in 2004 (EPRI 2005), including the proposed Project area. EPRI concluded that Oregon has very powerful waves and that the total wave energy resource potential off the coast of Oregon has the potential to supply about 20 percent of the state's total electrical demand. EPRI reported that the nearest wave data buoy to the Project site is the Coquille River Station (CDIP 0037) data buoy, located at a depth of 210 feet (64 m) about 70 miles (110 kilometers) southwest of the Project site. From results of the 12 years of available data (1984 to 1996), the average annual wave power at the data buoy is 21.2 kW/m, ranging from about 6 kW/m to 41 kW/m (Figure 3; EPRI 2005). This range represents seasonal variation in average wave power with the highest energy occurring during the winter and lowest energy occurring during the summer (EPRI 2005). The largest single-wave event was estimated to be 49.2 feet[14], and the median height (trough to crest) of the one-third highest waves for a 12-hour period averaged over the 12-year dataset was 25.6 feet (EPRI 2004).

FIGURE 3
MONTHLY AVERAGE WAVE POWER GENERATED AT COQUILLE RIVER STATION (CDIP 0037) DATA BUOY, LOCATED ABOUT 70 MILES (110 KILOMETERS) SOUTHWEST OF THE PROJECT SITE



Source: EPRI 2004

A recent report analyzed the potential impact of a number of wave energy device types, including the PowerBuoy, off the southwest coast of England ("Wave Hub Development and Design Phase Coastal Processes Study Report" by Halcrow Group Limited). In that case, the wave energy park is located more than 20 kilometers offshore, and potential wave height modifications were inferred using a simple numerical model that assumes the wave buoys behave like solid pilings. Their results suggested that the wave heights near the shoreline could be altered by a few percent. However, where the devices are located closer to the shore the reduction in wave energy is suggested to be higher. Despite these results there remains

14 This statistic should not to be confused with the 100-year wave condition, which is the design criterion for the mooring and PowerBuoy structures.

uncertainty about the effects of wave energy devices altering the wave field. As a result, a fundamental objective of this sediment transport study is to quantitatively document the degree of wave energy losses shoreward of the Powerbuoy array in order to both calibrate the numerical model used to understand wave focusing and defocusing effects around the Powerbuoys and shoreward of them and to quantitatively determine the degree of energy losses and any potential effects at the shore.

3.0 Project Effects

Due to its small size and distance from shore, the Company does not expect the 10-PowerBuoy array to significantly attenuate wave energy at the beach. The PowerBuoys to be installed at the Reedsport Project have a float diameter of 36 feet and will be placed approximately 330 feet apart. Based on a Fresnel analysis (a numerical model) of the PowerBuoy array at these dimensions, the Company estimates attenuation of about 12 percent behind the PowerBuoys and a worst-case instantaneous attenuation of wave amplitude at the beach of 2.1 percent. This estimate assumes monochromatic waves, which would be worst case, and a directional wave spreading factor of 0.95. Surfrider provided an independent analysis of a preliminary array design at a February 5, 2007 Oregon Solutions Recreation and Public Safety Subgroup meeting that confirmed an attenuation of less than 15 percent, given the current level of wave energy conversion technology and the density and placement of the proposed PowerBuoys.

An analysis by the Office of Naval Research in an environmental assessment for the installation of up to six 40 kW PowerBuoys offshore of a Marine Corps base in Kaneohe Bay, Hawaii concluded that the PowerBuoys would have only a very localized effect on currents, wave direction, and shoreline physiography. Currents would only be affected within an area that would not extend more than a few PowerBuoy diameters (Department of the Navy 2003). While the Hawaii site differs physically from the Project site, and the Project itself is larger, the Company believes these findings suggest that a project the size of the proposed Project would only have a negligible effect on ocean currents, wave attenuation, and related erosion and/or accretion patterns in the Coos littoral cell.

However, due to the lack of empirical data and uncertainty inherent in the above analyses, the Aquatic Resources and Water Quality Subgroup has expressed concerns about the potential impacts of the Project to the physical environments and ecosystems (e.g., affect on currents and erosion/accretion at the beach). Depending on local sea state, and the size and other characteristics (e.g., porosity), of the array of PowerBuoys, they could cause changes in wave height and direction in its lee, at length scales similar to the spacing between the devices (330 feet). Changes in wave height can alter nearshore circulation patterns and potentially cause shoreline change. Careful monitoring of the physical impacts of the Project is necessary, particularly due to its proximity to shore.

4.0 Need for Additional Information

To address stakeholder concerns, the Company proposes to conduct a Wave, Current, and Transport Study to assess changes to the wave field and water column characteristics due to the placement of the PowerBuoy array.

5.0 Study Plan

The Company's proposed Wave, Current, and Sediment Transport Study will provide an effective means to obtain site-specific data and evaluate, through associated modeling of acquired data, potential effects of the Project on waves and currents. Results of the modeling can be used to predict Project effects, if any, on sediment transport. In the event that substantial effects on waves, currents, or both waves and currents are observed, additional evaluation of effects on shoreline processes may be warranted.

The Company has consulted with a group, led by Tuba Özkan-Haller of the College of Oceanic & Atmospheric Sciences, Oregon State University, to develop the Wave, Current, and Sediment Transport Plan presented in this section.

The authors anticipate that the Wave, Current and Sediment Transport Plan will either provide reassuring data that suggests that effect of the Project is minimal, or show that significant effects (*e.g.*, shoreline change, change in local wave climate) are present and therefore trigger the need to evaluate appropriate measures within the Agreement's adaptive management process (AMP). Although such measures will be part of the AMP, an example may include conducting all, or a portion of the original study proposed by Özkan-Haller et. al. in 2007.

This proposed study focuses on:

1. Identifying the near-field effects of the PowerBuoys; and
2. Monitoring the bathymetry, shoreline contour, and water column properties to capture any anomalous nearshore effects.

5.1 Sampling Methods and Rationale

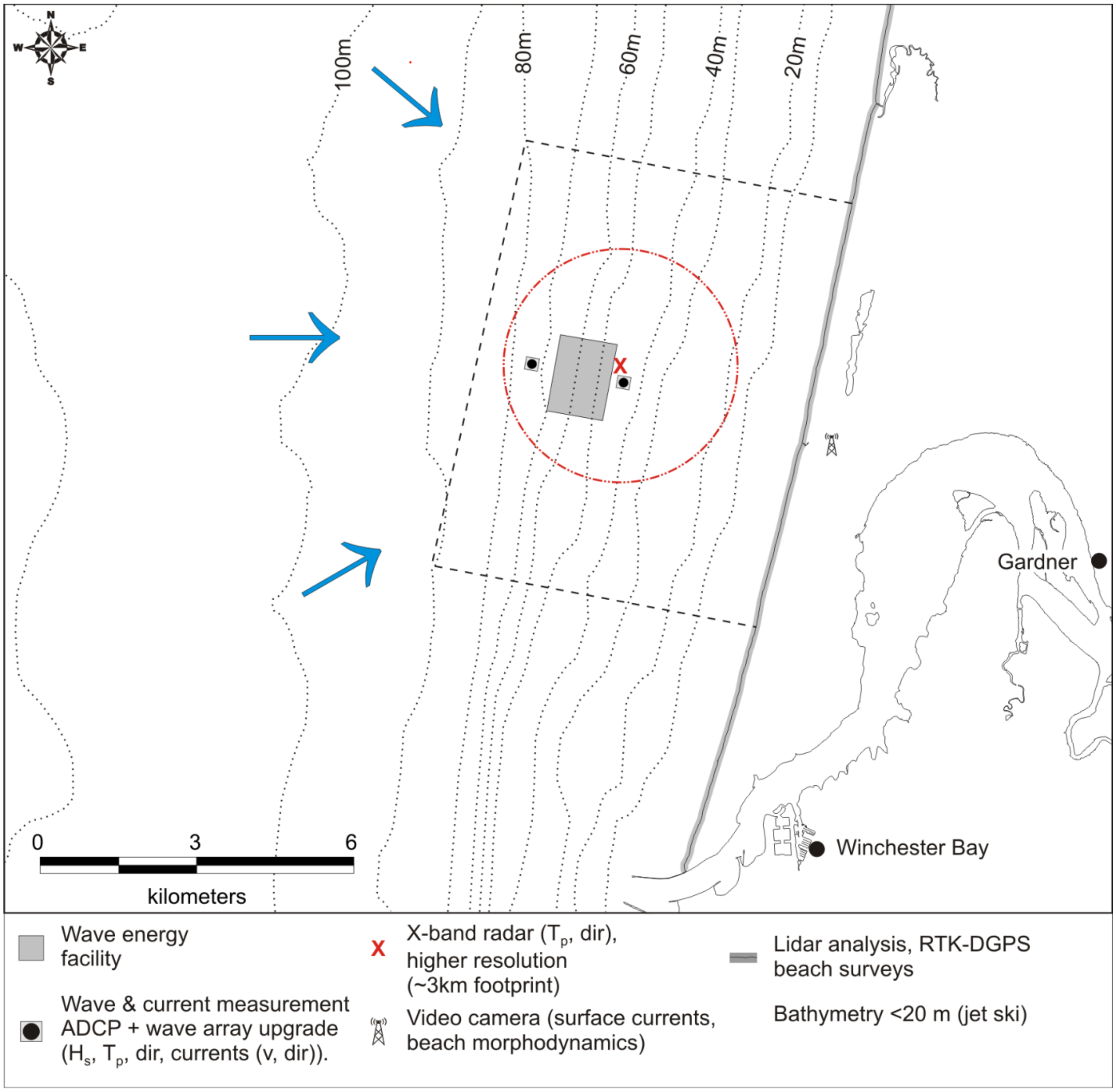
The proposed monitoring plan is depicted schematically in Figure 4 and includes *in-situ* observations of the wave field, vertical structure of horizontal currents and water-column properties, and synoptic observations of the wave field near the PowerBuoys with an X-band radar system. Changes to the topography and bathymetry are monitored using regular beach surveys as well as a video-based monitoring system. A numerical model of the effects of the PowerBuoys on the wave field utilizes these measurements either as input (e.g., bathymetry) or for calibration and validation purposes. Each component is discussed briefly below.

- ***In-situ* Observations:** Wave observations near the PowerBuoy array will consist of *in-situ* observations of the directional waves using two acoustic Doppler current profilers (ADCPs), one seaward and one shoreward of the Project. These observations sample the scattering pattern induced by the PowerBuoy array and will serve as ground-truth for remote sensing observations (described next) and as input to and verification of a numerical model (described below). The *in-situ* observations will also document changes in the vertical structure of horizontal currents, and the temperature and salinity fields. *In-situ* instruments will be deployed over several months during late summer/early winter, shortly after the installation of the 10-PowerBuoy array scheduled for late summer 2011. Additional in-situ sampling will be undertaken during late winter/spring/early summer (early 2012) after the 10 PowerBuoy array has been installed. In addition to the ADCPs, several bottom-mounted pressure sensors will also be deployed to further quantify the amount of wave energy losses that may occur shoreward of the PowerBuoys.

- **X-Band Radar Observations:** This system is capable of imaging nearshore waves at the high spatial and temporal resolution necessary for nearshore applications with an image footprint radius of about 2 to 3 kilometers. The system can be deployed onboard a ship and will provide a unique synoptic view of the wave scattering from individual PowerBuoys. *In-situ* ADCP data collected near the PowerBuoys and within the footprint of the radar images will be used to calibrate the wave radar data in order to estimate wave height variations across the imaged area. Such calibrated radar image sequences will provide a unique and powerful data set for wave model comparisons. Six (6) one (1) day deployments are planned; two (2) of the deployments will occur just prior to the installation of the 10 PowerBuoys, while the remaining four (4) deployments will occur after their installation (in all cases the x-band radar observations will coincide with the time the *in-situ* instruments are in place). At least two deployments will be during moderately large wave conditions.

- **Video Observations:** Observations will be accomplished using Argus-like optical remote sensing approaches. Sampling will be variable (at monthly intervals for 12 months prior to installation of the 10 PowerBuoys, increasing to biweekly following installation of the PowerBuoys), carried out manually, and will be based on a single digital camera that has been modified to collect time exposure images. The camera will be mounted in a fixed survey spot and will collect imagery from a suite of views that will be merged and geo-rectified later in the lab. Features such as the shoreline and sand bar locations will be mapped over a substantial (~4 kilometers) length of beach. A baseline will be established prior to any device installations, and then over time, potential anomalies associated with PowerBuoy installations can be detected.

FIGURE 4
MONITORING PROGRAM FOR THE REEDSPORT WAVE ENERGY PARK



Note: Sensor locations are subject to change based on array orientation. Figure provided for illustrative purposes only.

- **Beach Monitoring:** This component has two key objectives: first, document the baseline conditions at the Project site. These data are important for establishing baseline conditions that will be used in the initial development of numerical models. Second, initiate a field-based observation program to document changes to the beach and nearshore, and compare those measured changes with the natural envelope of variability determined for the Reedsport site. Data collected during the observation phase of the study will be utilized by the numerical modeling. Monitoring of the beach profile network and topography (contours) will be initially carried out every 3 months (i.e. seasonally) for a period of 12 months prior to installation of the 10 PowerBuoys, increasing to bimonthly (every 2 months) following installation of the PowerBuoys. Jet ski surveys of the nearshore will be conducted twice (scheduled for summer 2011 and 2012) to provide the necessary data for the wave modeling effort.

- **Numerical Modeling:** This component of the study is geared towards modifying existing wave propagation models by approximating the PowerBuoys as stationary devices with associated empirical "transmission" coefficients. Numerical models that can predict the transformation of waves from deep water (where they are observed by NDBC/CDIP buoys) to the nearshore already exist. As part of this work, we will augment these models to represent the presence of individual or an array of PowerBuoys and validate the predictions with observations. The observation program above is geared towards learning more about the nature of this scattering effect and will be used to calibrate empirical coefficients in the modeling framework. Model results that consider the presence of the PowerBuoys can then be compared to model results for the area in the absence of them to quantify the effect of the Project.

For the purposes of this sediment transport study, "bimonthly" denotes measurements undertaken every two months and "biweekly" indicates measurements carried out every two weeks.

5.2 Sampling Frequency Needs to Meet Specific Objectives

The proposed monitoring plan includes the following frequency:

- **Video Observations:** Sampling, which will be carried out manually and will be based on a single digital camera that has been modified to collect time exposure images, will initially occur at monthly intervals for a period of 12 months prior to installation of the 10 PowerBuoys, increasing to biweekly following installation of the PowerBuoys. The proposed monitoring schedule is:

    - July 2010 - July 2011 (Monthly video imaging)
    - July 2011 (post 10-device installation) - July 2012 (Biweekly video imaging)

- **Beach Monitoring:** Monitoring of the beach profile network and topography (contours) will be initially carried out every 3 months (i.e. seasonally) for a period of 12 months prior to installation of the 10 PowerBuoys, increasing to bimonthly (every 2 months) following installation of the PowerBuoys. Jet ski surveys of the nearshore will be conducted twice (scheduled for summer 2011 and 2012) to provide the necessary data for the wave modeling effort. The proposed monitoring schedule is:

    - Beaches

        - July 2010-July 2011 (Quarterly beach surveys)
        - July 2011 (post 10-device installation) - July 2012 (Bimonthly beach surveys)

    - Bathymetry
        - July 2010-July 2011 (Single survey in summer 2011)
        - July 2011 (post 10-device installation) - July 2012 (Single survey in summer 2012)

- ***In-situ* Observations:** A one to two month deployment will occur prior to the installation of the 10-PowerBuoy array, and will be part of a five (5) month deployment period approximately centered on the deployment of the 10-PowerBuoy array. The proposed monitoring schedule is:

    - A total of approximately 5 months *in-situ* deployment that brackets the 10-device installation. Deployment of the ADCPs would initially occur in late summer/fall 2011, with additional deployments occurring again in late winter/spring 2012. These deployments will capture the array installation, the transition to the fall storm season and late winter to spring period.
    - Utilize pressure sensor observations in the lee of the array. The deployment of these sensors is anticipated to be relevant in validating model result and improving predictive capabilities of the numerical model and would be deployed at the same time as the ADCPs are being deployed.

- **X-Band Radar Observations:** Six (6) 1-day deployments are planned. Two (2) of the six (6) observations will be done prior to the deployment of the 10 PowerBuoys. A few observations will coincide with the *in-situ* observations while some of the observations may bracket moderately large wave conditions. The proposed monitoring schedule is:

    - Two (2) deployments prior to installation of the 10-PowerBuoy array in late summer 2011.
    - Four (4) deployments following installation of the 10-PowerBuoy array.

- **Numerical Modeling:** Modeling predictions will be carried out for any period of time *in-situ* or radar observations are being collected. Predictive model runs will also be carried out for normal as well as extreme wave conditions. The Aquatic Resources and Water Quality Implementation Committee will be notified when the modeling efforts commence.

The outline below for the time line of monitoring is presented as three phases: those that begin prior to any installation ("baseline" monitoring), those that occur while the single buoy is in place, and those undertaken following the placement of the 10 PowerBuoys, at which time the monitoring program will be fully underway.

- **Design and Baseline Studies** - The objective of this stage is directed toward analyses and measurements that provide a documentation of the environment at the site in the absence of PowerBuoys (the "baseline"). This will include:
    - Analyses of the NDBC and CDIP buoy data to document the deep-water wave climates along the Oregon coast, including the development of a deep-water wave climate to the water depth at the Project site;

- Development and initial runs of the numerical models, applied both to examine the wave transformations for the undeveloped condition of the site and to produce initial predictions of the effect of the PowerBuoys;
- Pre-development surveys of the beach and jet ski survey of the site;
- Historical shoreline change analysis; and
- Establish the ARGUS camera video site and begin observations of the beach and nearshore bars.

■ **Additional Beach, Shoreline and Bathymetry Monitoring –** This phase will extend the baseline data collection period by an additional 12 months and will bracket the period when the single PowerBuoy is installed.

■ **Monitoring of an Array of Energy Extraction Units** - This phase will document the modified wave conditions of the PowerBuoys array, and its effect on the environment. Monitoring shall occur as outlined in this Section 5.2 to document potential changes (if any) that may occur as a result of the Project. Beyond that time-frame, the length of study will be agreed upon by the Aquatic Resources and Water Quality Implementation Committee through the AMP.
  - Deployment of ADCP's and X-band radar to measure the waves and currents;
  - Numerical model analyses of the wave reduction and diffraction corresponding to the period of wave and current measurements, comparison between the models and data; and
  - Continue the periodic beach surveys and video observations to assess beach response to the Project.

Should installation of the single buoy and hence the 9 additional PowerBuoys be delayed, then the entire sediment transport study would be shifted in time (e.g., by 12 months should the single buoy deployment be delayed until summer 2011) to reflect the new time line for PowerBuoy installation.

5.3 Metrics and Analyses

The analysis that will be conducted for this study is discussed above in Section 5.1. Metrics for each study component are discussed below.

■ ***In-situ* Observations:** Metrics will include wave height, wave direction, and vertical structure of mean currents, temperature, and salinity both seaward and shoreward of the PowerBuoys.

■ **X-Band Radar Observations:** Observations will be processed with state-of-the-art methods to produce estimates of wave speed and wave direction over an area of radius 2 to 3 kilometers. Using *in-situ* estimates to calibrate the radar image may lead to estimates of wave height over the entire region.

■ **Video Observations:** Products will include time-exposure images of the submerged topography. Variance images will give indication of the presence of any rip currents before and after buoy installation.

■ **Beach Monitoring:** Metrics will be based on shoreline position as a function of time. Development of potential rip embayments can be monitored.

- **Numerical Modeling:** Metrics will be wave height and direction in the lee of the wave park, percent-change in the wave height at the outer edge of the surf zone due to the presence of the wave park, resulting surf zone circulation.

5.4 Constraints, Limitations, and Feasibility

This study provides an initial monitoring and modeling strategy for the Project based on preliminary information obtained from the initial wave, current, and sediment studies conducted to date at the Project site. The study outlined above does not include all necessary observations to assess if any observed shoreline changes can be linked to the presence of the Project or if, instead, they were results of the natural variability of the coastal zone. Therefore, if significant shoreline changes are observed, appropriate additional steps or monitoring (*e.g.*, a more in-depth study) will be evaluated through the AMP. More study may also be necessary to make reliable predictions about potential wave height modification if the size, configuration, number or placement of the buoys were significantly altered.

6.0 Literature Cited

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Electric Power Research Institute. 2005. Oregon Offshore Wave Power Demonstration Project. Bridging the Gap Between the Completed Phase 1 Project Definition Study and the Next Phase - Phase 2 Detailed Design and Permitting. Douglas County Oregon Offshore Wave Power Plant Site. Report No. EPRI-WP-010 OR; Prepared by Roger Bedard. 75 pgs. December 13, 2005.

——. 2004. System Level Design Performance and Costs - Oregon State Offshore Wave Power Plant. Report No. E2I EPRI Global - WP 006 - OR Rev 1. Principal Investigator: Mirko Previsic. 63 pgs. November 30, 2004.

Oregon Ocean Policy Advisory Council. 1994. Oregon Territorial Sea Plan. 250 pgs. [Online] Available at: http://www.oregon.gov/LCD/OCMP/Ocean_TSP.shtml.

Appendix B - Recreation and Public Safety Plan

During consultation in support of development of the License Application, submitted February 1, 2010, local stakeholders and state agencies raised concerns about the effects of deploying and operating the Project on recreational fishing, navigation safety, and other recreational resources. The potential effects of the Project on recreational resources and safety issues were identified and discussed throughout late 2006 and early 2007 at Oregon Solutions meetings and subsequent resource and subgroup meetings in support of development of a Declaration of Cooperation, the Preliminary Application Document, the Agreement, and the License Application. Under normal operation, the Project will have no effects on beach access, recreational facilities or any other known terrestrial use. In terms of ocean effects, stakeholders have expressed particular concern about navigation safety and to a lesser extent the effect on marine recreation including whale watching and sport fishing.

As a result of these consultations, the Company will undertake the following actions:

- Light PowerBuoys in accordance with U.S. Coast Guard (USCG) regulations with consideration for protection for offshore birds and recreational and commercial fishing vessels. Also, have the PowerBuoy array clearly marked on navigational charts.
- Locate subsurface floats (underwater mooring floats) at depth of 30 to 50 feet to avoid potential vessel strike.
- Install the terrestrial portion of transmission cable within the existing effluent pipe easement which is within the bed of the access road to minimize potential visual environmental effects.
- Implement an Emergency Response and Recovery Plan (ERRP). A copy of the ERRP was included as Appendix I to the License Application. The ERRP may be amended through the Agreement's AMP in consultation with the Recreation and Public Safety Implementation Committee. Amendments to the ERRP shall be consistent with any applicable regulatory requirements and shall give primary consideration to the safety of mariners and emergency response and recovery personnel.
- Implement a Spill Prevention Control and Countermeasure Plan (SPCCP). A copy of the SPCCP was included as Appendix F to the License Application. The SPCCP may be amended through the Agreement's AMP in consultation with the Recreation and Public Safety Implementation Committee. Amendments to the SPCCP shall be consistent with applicable regulatory requirements.

- Join Oregon Fishermen's Cable Committee (OFCC) and follow relevant procedures for the buried cable.
- Implement a Marine Use/Public Information Plan, in consultation with the Recreation and Public Safety Implementation Committee, which will include:
    - Plans and procedures for designation of the PowerBuoy array by USCG as a Restricted Navigation Area and by ODFW as a No Fishing Area. Pursue similar designations with the DSL. Establish and distribute the appropriate navigation chart modifications through the USCG.
    - Plans for lighting the PowerBuoys to minimize the opportunity for vessel collisions. In addition, manage lighting through the Agreement's AMP in consultation with the appropriate Implementation Committees in full consideration of USCG requirements and the results of avian and/or cetaceans studies.
    - Plans for a public information campaign to inform commercial and recreational users of the changes in designation and provide information about location, hazards, and how to manage a vessel that inadvertently enters the PowerBuoy array area.
- Implement an Interpretive and Education Plan (including design and installation of interpretive displays on shore) in cooperation with interested Parties to the Agreement.
- Conduct a Visual Assessment Review from the beach, nearby dunes, and the Umpqua Lighthouse with interested members of the Recreation and Public Safety Implementation Committee following installation of the single PowerBuoy. The Visual Assessment Review may be amended through the Agreement's AMP in consultation with the Recreation and Public Safety Implementation Committee.
- Consider results of the Cetacean Study on recreational whale watching in consultation with the Aquatics Resources and Water Quality Implementation Committee and the Recreation and Public Safety Implementation Committee.
- Consider results of the EMF Study on recreational issues in consultation with the Aquatic Resources and Water Quality Implementation Committee and the Recreation and Public Safety Implementation Committee.
- Conduct a meeting of the Recreation and Public Safety Implementation Committee under the AMP at least annually and more often as necessary to assess Project effects on recreational fishing, navigation safety, aesthetics, and other recreational resources.

Appendix C - Crabbing and Fishing Plan

During consultation in support of development of the License Application, local stakeholders and state and federal agencies raised concerns about the effects of deploying and operating the Project on commercial crabbing and fishing. The potential effects of the Project on commercial crabbing and fishing were identified and discussed throughout late 2006 and early 2007 at Oregon Solutions meetings and subsequent meetings with commercial fishermen and SOORC. These meetings further clarified the potential impacts of the Project.

As a result of these consultations, the Company will implement the following actions:

- Locate the PowerBuoy array in the deepest possible area within the FERC Project boundary to minimize the risk of entanglement of crab gear with the PowerBuoy mooring lines.
- Work with ODFW, SOORC, and the Crabbing and Fishing Implementation Committee to:

  (1) identify ways to minimize the potential for loss of gear; and

  (2) develop a protocol to recover or provide compensation, other than from ODFW, for gear that becomes entangled in the PowerBuoy array.

- Implement a Crabbing and Fishing Protection Plan in consultation with the Crabbing and Fishing Implementation Committee and other interested stakeholders and agencies, to include the following measures:
  (1) plan and procedures for initiating a transport moratorium during the first eight weeks of every Dungeness crab season (which starts in December) to minimize damages to crab pot buoys;
  (2) establishment of a predetermined transit lane from the port to the PowerBuoy array for Project-related vessels during construction and normal maintenance; and
  (3) plans to provide two weeks notice of PowerBuoy transport associated with scheduled maintenance throughout the term of the License or until the Crabbing and Fishing Implementation Committee determines such notice is no longer needed (unscheduled maintenance, emergencies, and weather may not allow OPT to provide this advanced notice).

- Join Oregon Fishermen's Cable Committee (OFCC) and follow relevant procedures for the buried cable.
- Implement the studies as described in Appendix A (Aquatic Resources and Water Quality Plan), which include studies related to crab and fish.
- Locate subsurface floats (underwater mooring floats) at a depth of 30 to 50 feet to avoid potential vessel strikes.
- Implement a Marine Use/Public Information Plan, which will include:
    - Plans and procedures for designation of the Project by the U.S. Coast Guard (USCG) as a Restricted Navigation Area and by the Oregon Fish and Wildlife Commission as a No Fishing Area. Pursue similar designations with DSL. Establish and distribute the appropriate navigation chart modifications through the USCG.
    - Plans for lighting the PowerBuoys to minimize the opportunity for vessel collisions.
    - Plans for a public information campaign to inform commercial and recreational users of the changes in designation and provide information about location, hazards, and how to manage a vessel that inadvertently enters the PowerBuoy array area.
- Conduct a meeting of the Crabbing and Fishing Implementation Committee under the AMP at least annually and more often as necessary to assess Project effects on commercial crabbing and fishing.

Appendix D - Terrestrial and Cultural Resources Plan

The Company formally requested information from both the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians (CTCLUSI) and the State Historic Preservation Officer (SHPO) on the presence of known archaeological properties within the Project area in a letter dated August 30, 2007. The Company subsequently consulted with the SHPO and conducted an assessment at the SHPO's request on potential Project impacts to cultural/historic resources located within the Project boundary in the ocean which concluded the Project is unlikely to have effects on known submerged archaeological resources. In addition, the Company initiated informal consultation with the CTCLUSI through the Oregon Solutions process in October 2006, which resulted in the Company and CTCLUSI signing a Memorandum of Understanding (MOU) in 2007 pursuant to which the Company will implement a Cultural Resources Survey, Monitoring, and Contingency Mitigation Plan. The Company will place the terrestrial portion of the transmission cable entirely within the existing effluent pipe to minimize potential effects to cultural, environmental, and visual resources.

As a result of these consultations, the Company will undertake the following measures regarding cultural resources:

- Implement a Cultural Resources Survey, Monitoring, and Contingency Mitigation Plan consistent with the MOU signed with CTCLUSI and in consultation with the CTCLUSI and SHPO.

- Install the terrestrial portion of transmission cable within the existing effluent pipe easement which is within the bed of the access road to minimize potential visual, cultural, and environmental effects.

- Contract an archaeologist to evaluate any as yet unidentified undisturbed areas if required for use as staging areas for Project construction in order to investigate the presence of cultural resources or historic properties. At this time, no staging areas or ground disturbance is proposed for the Project. Given the presence of several known cultural sites, a professional archaeologist will be on site to monitor any ground disturbing activities in the area of the proposed shore station. If cultural resources are identified during any phase of construction, all work will stop immediately and an assessment of the discovery completed by the archaeologist. SHPO will be contacted with regards to any assessment that may be needed.

Because the transmission cable will be located within the effluent pipeline which is within the bed of the access road, there are no anticipated terrestrial wildlife or plant impacts from the Project along the transmission cable route. In addition, the shore station will be located on industrial property. Nevertheless, the Terrestrial and Cultural Resources Implementation Committee may consider new information and propose new measures pursuant to the AMP.

EXHIBIT A - AUTHORIZED REPRESENTATIVES

Party	Authorized Representatives	Contact Information
Oregon Department of Energy	Kathy Stuttaford	(503) 373-2127 kathy.d.stuttaford@state.or.us 625 Marion St NE Salem, OR 97301-3737
Oregon State Marine Board	Randy Henry	(503) 378-2611 Randy.H.Henry@state.or.us 435 Commercial St NE #400 Salem 97309-5065
Oregon Water Resources Department	Mary S. Grainey	(503) 986-0833 Mary.S.GRAINEY@state.or.us 725 Summer St. NE Suite A Salem, OR 97301
Oregon Department of Environmental Quality	Marilyn Fonseca	(503) 229-6804 marilyn.fonseca@state.or.us 811 SW 6th Avenue Portland, OR 97204
Oregon Department of Fish and Wildlife	Ken Homolka With copy to: Caren Braby	(503) 947-6090 Ken.Homolka@state.or.us 3406 Cherry Ave Salem, Oregon 97303 (541) 867-0300 x226 Caren.E.Braby@state.or.us 40 SE Marine Science Drive Newport, Oregon 97365
Oregon Parks and Recreation Department	Jim Morgan	(503) 986-0738 jim.morgan@state.or.us 725 Summer St NE Suite C Salem, OR 97301
Oregon Department of Land Conservation and Development	Paul Klarin	(503) 373-0050 x249 Cell (503) 363-4912 Paul.klarin@state.or.us 635 Capitol St. NE, Suite 150 Salem, OR 97301-2540

Oregon Department of State Lands	Jeff Kroft	(503) 986-5280 Jeff.kroft@state.or.us 775 Summer St. NE Suite 100 Salem, OR 97301-1279
National Marine Fisheries Service	Cathy Tortorici	(503) 231-6268 Cathy.Tortorici@noaa.gov 1201 NE Lloyd Blvd Suite 1100 Portland, OR 97232
US Fish & Wildlife Service	Ann Gray	503-231-6179 Ann_E_Gray@fws.gov 2600 S.E. 98TH Ave., Suite 100 Portland, OR 97266
US Forest Service	Mike Harvey	(541) 750-7046 mharvey@fs.fed.us 4077 SW Research Way Corvallis, OR 97333
Southern Oregon Ocean Resource Coalition	Nick Furman	(541) 267-5810 nick@oregondungeness.org 964 Central Avenue Coos Bay, OR 97420
Oregon Shores Conservation Coalition	Robin Hartmann	(541) 672-3694 robinhartmann@msn.com 1721 S.E. Main Street Roseburg, OR 97470
Surfrider	Peter Stauffer With copy to: Gus Gates	(503) 887-0514 PStauffer@surfrider.org 4001 S.E. Ivon Portland, OR 97202 (541)997-1316 ggates@surfrider.org 3225 31st Street Florence, OR 97439
Reedsport OPT Wave Park, LLC	George Wolff	(609) 730-0400 ext. 238 GWolff@oceanpowertech.com 1590 Reed Road Pennington, NJ 08534

EXHIBIT B – ADAPTIVE MANAGEMENT PROCESS OVERVIEW

The parties to the Reedsport OPT Wave Park Settlement Agreement ("Parties" and "Agreement," respectively) have agreed to participate in an adaptive management process (AMP or "Process") designed to manage construction and operation of Reedsport OPT Wave Park LLC's (the "Company") multiple-buoy Reedsport OPT Wave Park ("Project") in a collective and adaptive manner to avoid or minimize impacts to aquatic resources, water quality, recreation, public safety, crabbing and fishing, terrestrial resources, and cultural resources. The Parties intend that the Company's implementation of the AMP be a condition of its Federal Energy Regulatory Commission (FERC) license. The AMP does not prevent any Party from acting quickly in the event of an emergency. An ancillary but important benefit of generating and analyzing data and information in this group is that it can be used to gain a more comprehensive ecological understanding of the effects of wave energy on the marine ecosystem more generally. To that end, public data and information generated through the AMP will be able to be utilized by developers and stakeholders in evaluating other wave energy projects to the extent such data and information are applicable.

The purpose of this overview is to comprehensively describe the various components of the Agreement's AMP in one document. For purposes of this document, the AMP includes the Company's implementation of study and monitoring plans and any synthesis or analysis of data or information generated; analysis of and agreement on study and monitoring results; recommendations and decisions regarding the need for changes in study designs, methods and duration, or changes in construction methods or operations; implementation of those changes; and, in the case of disagreements among Parties, mediation to attempt to resolve disputes and reach consensus. This document should be used as a reference tool in implementing the AMP; however, in the event of a conflict between the language in this document and the Agreement (including plans attached as Appendices A through D of the Agreement), the Agreement's language shall control.

This document begins by generally defining adaptive management. It then provides an overview of the organizational structure of the AMP, and then describes in detail each step of the AMP.

1.0 Adaptive Management

Adaptive management can be defined as "evaluating the performance of new management approaches and changing practices over time as experience is gained." (West Coast Environmental Law, Urban Growth and Development, Smart Bylaws Guide – Glossary, http://www.bcwatersheds.org/issues/urban/sbg/glossary/ (last visited April 22, 2010)). Adaptive management prescribes an iterative process wherein activities can be changed or managed in relation to their efficacy in restoring and/or maintaining an ecological or other system in some desired range of conditions. A key component is in the establishment of a feedback mechanism whereby monitoring or studies can be used in combination with an understanding of the ecosystem to alter behavior, if necessary, to obtain future system conditions compatible with the desired conditions and/or to avoid or minimize undesired effects.

2.0 Organizational Structure

The AMP's organizational structure consists of a Coordinating Committee, four Implementation Committees, and a Licensing Compliance Coordinator (each described below). The Coordinating Committee will serve as an umbrella organization that addresses all issues raised under the Agreement. Implementation Committees for each of the substantive appendices (Aquatics Resources and Water Quality, Recreation and Public Safety, Crabbing and Fishing, and Terrestrial and Cultural Resources) will oversee the Company's implementation of Appendices A through D, particularly study and monitoring implementation, and provide recommendations and technical support to the Coordinating Committee. A Licensing Compliance Coordinator designated by the Company will coordinate among the various committees and oversee the Company's implementation of its FERC license and the Agreement.

2.1 Coordinating Committee (Settlement Agreement (SA) at ' 4.2)

The Licensing Compliance Coordinator (Section 2.3 below) will convene the Coordinating Committee within 120 days after FERC issues a license for the Project. The Coordinating Committee will be composed of a representative from each Party to the Agreement. No one Party or representative will lead the substantive discussion within the Committee; all representatives will work together and strive to act by consensus. For purposes of the Agreement and the AMP, "consensus" means that any decision must be acceptable to all members of a Committee who have expressed an interest in the issue (*i.e.*, something those members can at least "live with").

Committee members will receive all communications related to the AMP, including monitoring and study results, and quarterly and annual reports. The Coordinating Committee has broad authority under the Agreement to address any issues related to implementation of the Agreement by consensus of the Committee's representatives, and therefore will be able to intervene in any part of the Process should it so choose. In addition, the Coordinating Committee may set direction for the Implementation Committees on their operation and focus, and may change Implementation Committee membership. In the context of the AMP, however, the Coordinating Committee's only specified role will be to attempt to resolve any disputes that may arise within an Implementation Committee or between two or more Implementation Committees as the Implementation Committees work to oversee study and monitoring plan implementation and respond to results, and to consult with the Company regarding the content of Annual Reports. The dispute resolution process is described in detail in Section 3.5, below.

2.2 Implementation Committees (SA ' 4.2)

The Licensing Compliance Coordinator (Section 2.3 below) will convene four Implementation Committees within 120 days after FERC issues a license for the Project: the Aquatic Resources and Water Quality Committee, Recreation and Public Safety

Committee, Crabbing and Fishing Committee, and Terrestrial and Cultural Resources Committee (each also referred to as an "Implementation Committee").

The Implementation Committees are charged with overseeing the Company's implementation of the Agreement's appendices, which include agreed-upon study and monitoring plans, and participating in the adaptive management process. At its execution, the Agreement includes detailed studies related to aquatic resources and water quality issues only (Appendix A). The AMP allows Implementation Committees to address issues outside of those initially studied, including issues related to recreation, public safety, crabbing and fishing, terrestrial resources, and cultural resources, as well as aquatic resources and water quality issues not addressed in initial studies.

Parties may designate a representative to an Implementation Committee as indicated in Table 1. In addition, to accommodate the likely variety of discussions within an Implementation Committee and the potential need for Parties to send staff with particular experience or expertise, a Party may have a person or persons other than, or in addition to, its designated representative attend and participate in Committee meetings or discussions. No one Party or representative will lead the substantive discussion within the Implementation Committee; all representatives will work together and strive to act by consensus. For purposes of the Agreement and the AMP, "consensus" means that any decision must be acceptable to all members of a Committee who have expressed an interest in the issue (*i.e.*, something those members can at least "live with").

Table 1. Implementation Committee membership.

Aquatic Resources and Water Quality Committee	Recreation and Public Safety Committee	Crabbing and Fishing Committee	Terrestrial and Cultural Resources Committee
-The Company -NOAA Fisheries Service -USFWS -USDA-FS -ODFW -PRD -WRD -DEQ -DLCD -Oregon Shores Conservation Coalition -Surfrider -SOORC	-The Company -USDA-FS -PRD -WRD -DLCD -Surfrider -SOORC	-The Company -ODFW -SOORC	-The Company -USFWS -USDA-FS -PRD -ODFW -Oregon Shores Conservation Coalition

The AMP is set forth in detail in Section 3.0, below. However, key functions of the Implementation Committees include:

- reviewing Quarterly Reports containing status reports on ongoing monitoring and studies, as well as study plans for the coming quarter;

- reviewing and evaluating study and monitoring results to determine whether results are properly characterized and whether any relevant screening criteria have been met;

- determining resource management objectives and formulating new screening criteria for resources that do not yet have them, and modifying screening criteria where warranted;

- determining whether a change in the Project (see Section 3.3 below) is required as a result of meeting a screening criterion, or whether existing management practices continue to be appropriate;

- evaluating Response Plans proposed by the Company where the Implementation Committee has determined that a change in the Project is required, and determining whether to adopt, modify or propose an alternative to the Company's Response Plan;

- where critical adverse effects require immediate response, agreeing on actions that the Company can take to address those effects;
- providing input on the Company's Annual Report to FERC that summarizes any monitoring or study results and any Implementation Committee decisions, and describes study plans for the coming year; and
- participating in dispute resolution procedures (described in Section 3.5 below) when unable to reach consensus on any of the issues before an Implementation Committee.

Representatives should have sufficient familiarity with the issues addressed by an Implementation Committee to be able to actively participate in Committee discussions. Representatives will serve as a primary source of technical support for the adaptive management process, but Implementation Committees may also request that the Company fund a mutually agreed-upon third party technical expert to assist their members in reaching decisions.

The Company shall provide a facilitator at the first of each Implementation Committee meetings, and thereafter on request of an Implementation Committee for the first year after the Effective Date.

2.3 Licensing Compliance Coordinator (SA ' 4.2.3)

The Company will designate a Licensing Compliance Coordinator tasked with overseeing implementation of the FERC license and the Agreement, including the AMP. The Coordinator's primary job in the context of adaptive management will be to work closely with the Company and both the Coordinating Committee and the Implementation Committees to ensure that the AMP is implemented in accordance with the terms of the Agreement. The Parties intend that the Coordinator will provide support to the Coordinating Committee and Implementation Committees, including helping set meetings, ensuring that reports are prepared and completed in a timely manner, and maintaining important documents, meeting minutes, and data to be made available to

Implementation Committee members. At the Coordinating Committee or an Implementation Committee's direction, the Licensing Compliance Coordinator will also share appropriate information with the public on a Web site or by other method.

3.0 Reedsport Adaptive Management Process

As indicated above, the AMP includes the Company's implementation of Appendices A through D to the Agreement, including study and monitoring plans and any synthesis or analysis of data or information generated; analysis of and agreement on study and monitoring results; recommendations and decisions regarding the need for changes in study designs, methods and duration, or changes in construction methods or operations; implementation of those changes; and, in the case of disagreements among Parties, mediation to attempt to resolve disputes and reach consensus. Each of these steps is described in detail below and is illustrated in Figure 1.

3.1 Implementation of Study and Monitoring Plans (SA ' 3.3.2, 3.3.9)

As part of the settlement process, an Aquatic Resources and Water Quality Subgroup (which is distinct from the Aquatic Resources and Water Quality Implementation Committee created by the Agreement) met over the course of a year to develop the study and monitoring plans contained in the Agreement's Appendix A. Those are the cetacean study plan, electro-magnetic field study plan, pinniped study plan, fish and invertebrate study plan (focused on alteration of habitat and effects of Project installation), offshore avian study plan, and the wave, current and sediment transport study plan.

Each plan was specifically designed by the Aquatic Resources and Water Quality Subgroup to evaluate the Project's effects, if any, on various resources, and to inform management of the Project through this AMP. These plans form the basis for monitoring potential impacts to aquatic resources and water quality. The plans serve two purposes. First, monitoring is used to collect data and information on the Project's effects on the surrounding ocean ecosystem. Second, monitoring will be used to develop, assess, and utilize screening criteria implemented to adaptively manage the Project.

The Company will implement these plans and provide the resulting data or information in the form specified in the applicable study plan. For example, observations of pinnipeds will be tabulated and provided to the Aquatic Resources and Water Quality Implementation Committee as is, whereas results of field efforts such as benthic infauna will be analyzed consistent with the methodology within the study plan and a report prepared to be distributed. The resulting data or information will be provided to the Parties' representatives (as described in Section 3.2 below) for consideration.

3.2 Analysis of Study and Monitoring Results, Other Relevant Information (SA ' ' 3.3.3, 3.3.4)

Implementation Committees will meet between 30 and 60 days after the Company releases the results of studies or monitoring in accordance with the plans described above, or sooner than 30 days with agreement of the Implementation Committee members. In the case of critical adverse effects on a resource, any Implementation Committee member may direct the Licensing Compliance Coordinator to schedule a meeting as soon as practicable.

Meetings will be in person or by conference call as determined by those Implementation Committee members who express an interest in the issue. Any Committee member can elect to participate in any meeting by phone. For example, when the Company has completed the final report for the benthic infauna analysis, it will provide those results to each Party's designated representative (Exhibit A to the Agreement), to each Party's Coordinating Committee representative, and to each Party's representative to the Aquatic Resources and Water Quality Committee. The Company or the Licensing Compliance Coordinator will then schedule a meeting of the Aquatic Resources and Water Quality Committee within 60 days after providing the results.

At the meeting, Implementation Committee members will discuss whether monitoring and study results have been properly characterized and, if so, determine whether any screening criteria have been met. Comparisons of pre-project, construction, and post-construction monitoring data will be used along with relevant screening criteria to evaluate the Project's effects. If a screening criterion has been met, the Implementation Committee will then determine whether a change in the Project is required to address the issue or whether, based on the members' best professional judgment, existing management practices continue to be appropriate. Continued implementation of existing management practices might be appropriate, for example, if a screening criteria is met but the Implementation Committee determines that current management practices already sufficiently minimize adverse impacts, that there are no additional minimization or avoidance measures that could be implemented and ongoing adverse impacts are not critical, or that identified measures would not provide sufficient benefits given their cost. The process for requesting changes in the Project is described in Section 3.3, below.

In the case of resources for which screening criteria have not yet been defined, Implementation Committees are obligated to consider on an ongoing basis whether study or monitoring results provide sufficient basis to formulate screening criteria. Screening criteria need not be numerical, but should be based on best professional judgment and the best available science. Similarly, Implementation Committees will consider whether modifications to existing screening criteria are warranted. If new or modified criteria are warranted, the Implementation Committee will meet as necessary to do so within 3 months. The Implementation Committee may also determine that a new study is needed. As noted in Section 2.2 above, the Implementation Committee may retain the assistance of a technical expert.

In addition to meeting after study or monitoring results are completed, Implementation Committees can also meet at the request of any Implementation Committee member to discuss information contained in a Quarterly Report or Annual Report (*see* Section 3.4 regarding reports), or new information (which includes a new scientific understanding of existing information) obtained from other sources (*i.e.*, sources other than the Company's studies or monitoring) that is relevant to the Project's potential resource effects. At these meetings, the Implementation Committee will address the same questions set forth above, namely whether screening criteria have been met, whether to formulate new screening criteria or modify existing screening criteria, and whether a change in Project management is required as a result of meeting a screening criterion.

Throughout this Process, the Implementation Committees will strive to conduct their business by consensus. Any disagreements over whether results are properly characterized, whether screening criteria have been met, whether to formulate new screening criteria or modify existing screening criteria, whether additional monitoring or study is required, whether a change in Project management is required as a result of meeting a screening criterion, or any other disagreements, will be addressed through the Agreement's dispute resolution process (described in Section 3.5).

At any time, the Company may propose Project changes in the form of a Response Plan by e-mail or similar communication to the Implementation Committee members. Upon written approval (by e-mail or other form) from Implementation Committee members, the Company will implement the Response Plan subject to any required FERC or other agency approvals. If any Implementation Committee member objects, the Company will convene the Implementation Committee to initiate the AMP.

3.3 Change in the Project (SA ' ' 3.3.5 - 3.3.7)

If, as a result of meeting a screening criterion, an Implementation Committee determines that a change in the Project is required, the Company will prepare a proposed avoidance, minimization or mitigation plan ("Response Plan"). The Response Plan may include design changes, operational changes, structural changes, changes in maintenance or other management, changes in monitoring or studies, new monitoring or studies, temporary suspension of construction or operations, or removal of one or more structures. The Response Plan will also include any additional monitoring necessary to judge the Response Plan's success at addressing the issue raised, the results of which will also be provided to the Implementation Committee. The Company will invite input from appropriate members of the Implementation Committee during this time, and while the Company will not be obligated to include specific recommendations in its proposed Response Plan, it will respond to any input received. The Company will provide a proposed Response Plan to the Implementation Committee within 60 days of the Committee's request, and the Committee will meet within 30 days of receiving a proposed Response Plan from the Company.

At its meeting, the Implementation Committee will determine whether to adopt the proposed Response Plan, modify the proposed Response Plan, or choose an alternative Response Plan. The Implementation Committee will make best efforts to reach consensus. Additional meetings may be scheduled as necessary; however, if consensus is not reached on a final Response Plan within 60 days of the Implementation Committee's first meeting to review the proposed Response Plan, any Party may submit the disagreement for dispute resolution (described in Section 3.5). This does not mean that discussion will end at 60 days, or that dispute resolution will always be triggered at that time; however, allowing Parties to trigger dispute resolution at any time after the initial 60-day period ensures that difficult problems can be dealt with in a timely manner. If any member of the Implementation Committee, after making best efforts to reach consensus, believes that additional discussion would not be fruitful, the member need not wait for the expiration of the 60-day period, but may trigger dispute resolution at that time.

In some cases, the Implementation Committee may believe immediate action is required to address critical adverse effects of the Project. In that case, the Committee will either (1) make best efforts to agree on a Response Plan that the Company can implement immediately to address the effect, or (2) direct the Company to develop a proposed Response Plan within a specified time period (*i.e.*, shorter than the 60 days normally prescribed for plan development).

Once an Implementation Committee has agreed to a final Response Plan, or upon successful conclusion of dispute resolution resulting in a final Response Plan to which the Parties agree, the Company will submit the final Response Plan to FERC. This filing will include the appropriate request for FERC approval or license amendment, depending on the type of changes or additional license requirements included in the Response Plan.

3.4. Communication, Updates and Reports (SA '' 3.3.8, 3.3.9)

The Company will prepare Quarterly Updates and Annual Reports. The Company will distribute the Quarterly Update by e-mail or other appropriate method as soon as practicable but not later than 30 days following the end of each quarter. The Quarterly Update will contain a brief update on the status of any ongoing monitoring and studies, as well as plans for the next quarter. The Quarterly Updates will be provided to each Party's Implementation Committee representative (*e.g.*, if the Quarterly Update includes aquatic resource monitoring results, it will be provided to the Aquatic Resources and Water Quality Committee members).

The Company will prepare an Annual Report to FERC in consultation with the Coordinating Committee and Implementation Committees. On a calendar year basis, the Annual Report will summarize monitoring and study results, describe any Committee decisions (*e.g.*, regarding the need for changes in management), and describe study and monitoring plans for the coming year. The Company will submit the Annual Report to FERC, and will also provide a final copy to each Party's authorized representative (Exhibit A to the Agreement), each Party's Coordinating Committee representative, and the designated representatives of relevant Implementation Committees. The first Annual Report will be due to FERC on April 1 after License issuance, except that if the License is issued between October 1 and April 1, the first Annual Report will be due to FERC on the second April 1 following issuance of the License. For the first five years after license issuance and thereafter on request of the Coordinating Committee, the Company will convene a meeting to present the Annual Report to the Coordinating Committee after submission to FERC.

All other notices required by the AMP– including monitoring and study results – will be sent to each Party's authorized representative (Exhibit A), each Party's representative to the Coordinating Committee, and applicable Implementation Committee members.

3.5 Dispute Resolution (SA ' 7.5)

As mentioned in Section 3.2, Implementation Committees will strive to conduct their business by consensus. Any disagreements that arise in the AMP, including disputes over whether study or monitoring results are properly characterized, whether screening criteria have been met, whether to formulate new screening criteria or modify existing screening criteria, or whether a change in Project management is required as a result of meeting a screening criterion and, if so, what the resulting Response Plan should contain, will be addressed through the Agreement's dispute resolution process.

Generally, an Implementation Committee member must give notice to all Parties of the dispute within 30 days after learning of the dispute. An exception to that time requirement occurs when an Implementation Committee is working to reach agreement on a final Response Plan, in which case a member may trigger dispute resolution upon learning of a dispute, or may trigger dispute resolution if consensus has not been reached after 60 days have passed since the Committee's first meeting to review the proposed Response Plan. In a dispute regarding adaptive management, notice must be provided in writing by first-class mail or comparable method of distribution (including electronic mail) to each Party's designated representative (Exhibit A to the Agreement), each Party's Coordinating Committee representative, and the members of relevant

Implementation Committees. The Company will convene a meeting of the Implementation Committee, within 20 days after such notice, to attempt to resolve the dispute. Representatives may attend in person or by phone.

If the dispute is not resolved within 15 days after the Implementation Committee meeting, any Party may refer the dispute to the Coordinating Committee, which will act as a dispute resolution body. The Licensing Compliance Coordinator will schedule a meeting or conference call of the Coordinating Committee within 20 days of the referral. If the Coordinating Committee is unable to resolve the dispute within 60 days, the Coordinating Committee may attempt to resolve the dispute using a neutral mediator unanimously selected by the disputing Parties. The mediator will mediate the dispute in accordance with the instructions and schedule provided to it by the Coordinating Committee. If the Company agrees to mediation, the Company will pay the mediator's fees. However, unless otherwise agreed among the Parties, each Party shall bear its costs for its own participation in the dispute resolution.

Any of these time periods may be reasonably extended or shortened by agreement of the Parties, or to conform to the procedure of an agency or court with jurisdiction over the dispute.

In the event of an emergency, nothing in the Agreement's AMP or dispute resolution provisions delays immediate response mechanisms or prevents Parties from taking necessary steps to address such emergency consistent with their statutory and regulatory obligations.

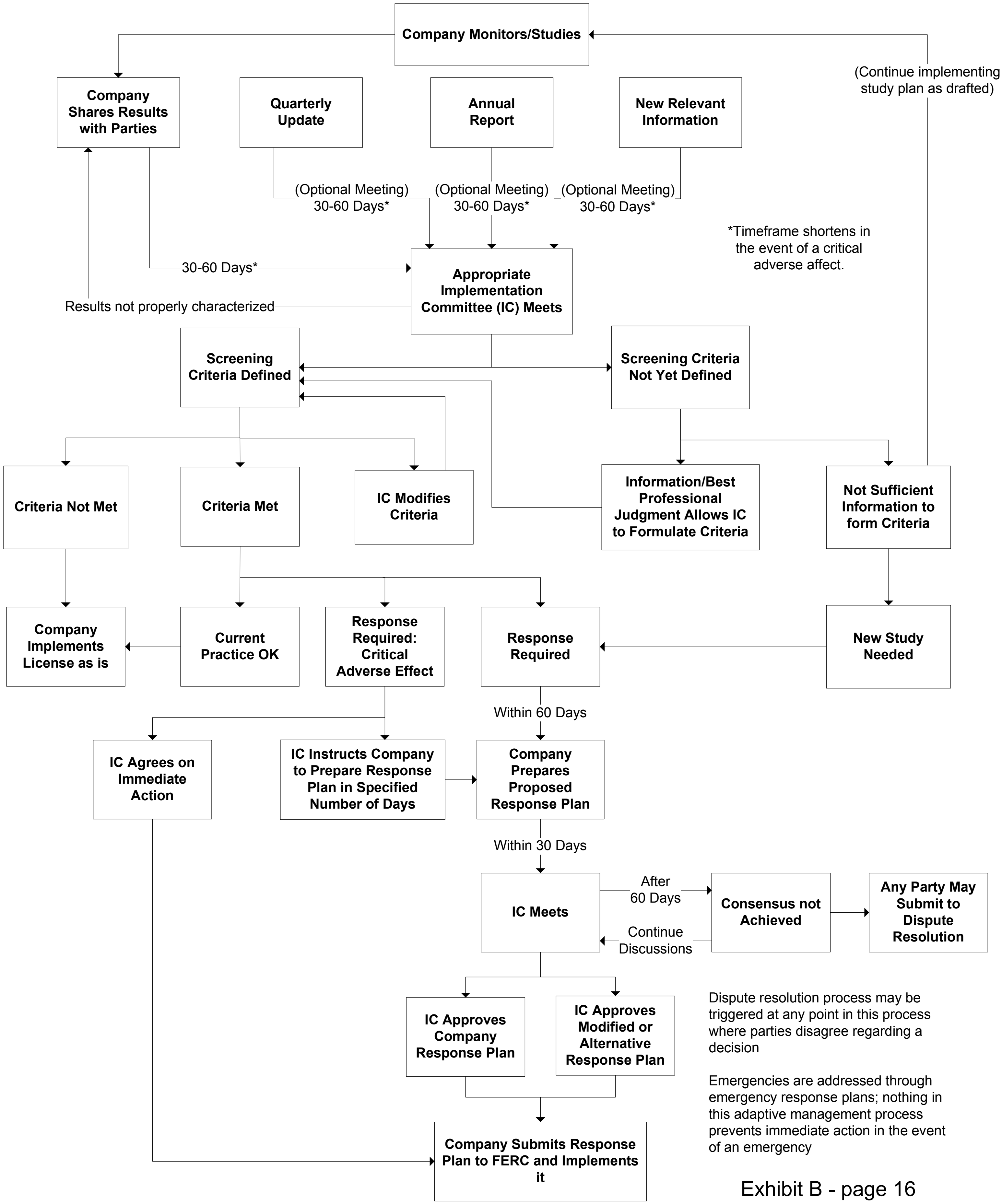
3.6 Failure to Reach Consensus Regarding Response Plan; Seeking Different or Additional Measures (SA ' 3.3.7)

In the event of disagreement among the Parties with regard to the content of a Response Plan, where that disagreement is not resolved by dispute resolution, the Company will submit its proposed Response Plan to FERC, with copies to the Parties' representatives, along with documentation of consultation with the appropriate Implementation Committee members and any consultation with the Coordinating Committee, copies of any comments and recommendations on the Response Plan, and specific descriptions of how those comments were accommodated by the Response Plan or why they were not adopted. In that event, any Party may seek different or additional measures pursuant to state or federal statute or regulation.

3.7 Five Year Evaluations (SA ' 3.3.10)

Every five years, at a minimum, the Parties will meet to discuss whether changes to the AMP are appropriate and to provide an additional forum to discuss new or modified studies that may be warranted. Given the length of time the PowerBuoy array may be deployed, additional studies may be identified. Monitoring time frames longer than the timlines in the proposed study plans may be possible. If a new or modified study is identified for consideration, the appropriate Implementation Committee will evaluate the study through the AMP. Changes to the AMP will require amendment of the Agreement.

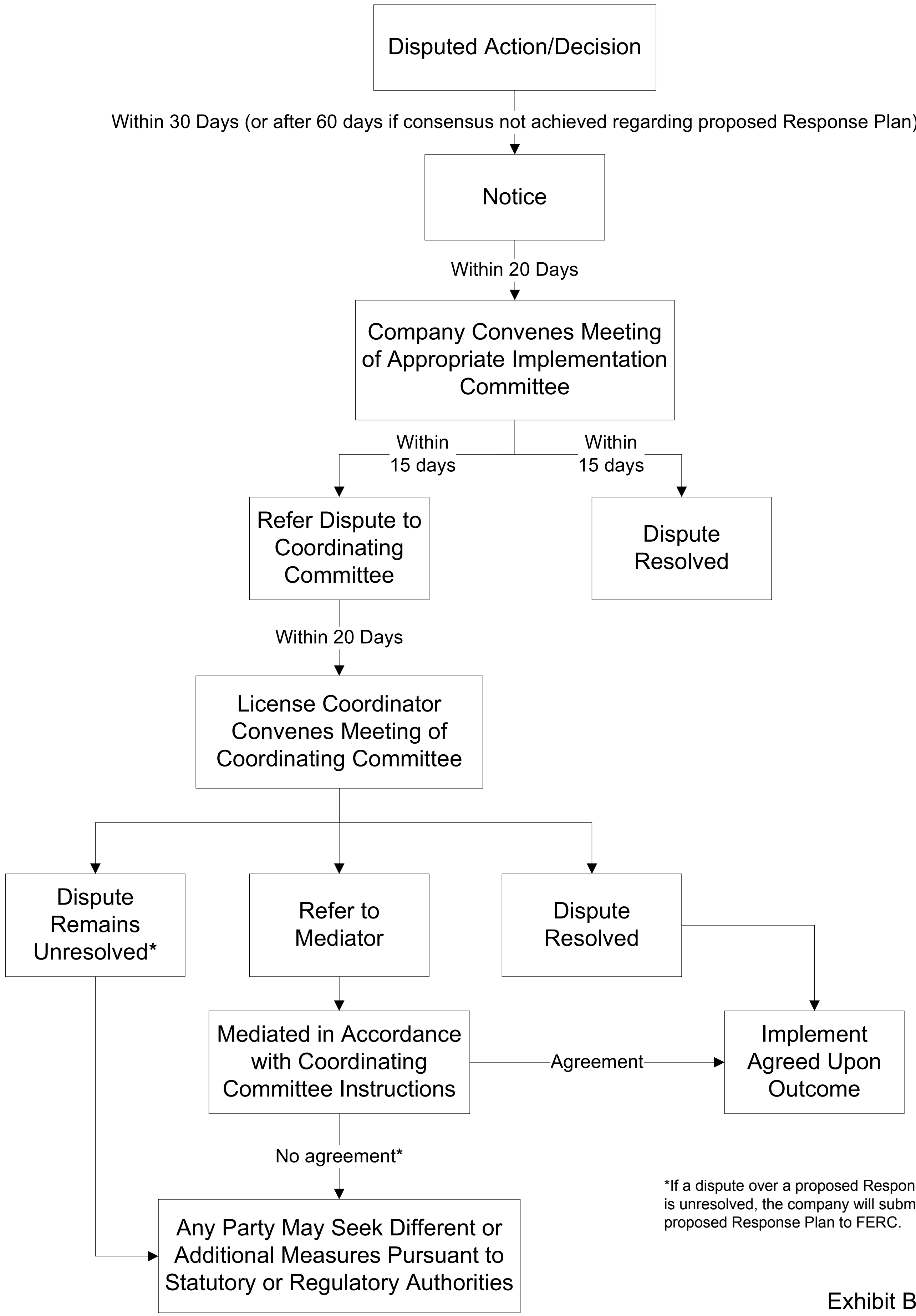
Figure 1
Reedsport OPT Wave Park
Adaptive Management Process



Dispute resolution process may be triggered at any point in this process where parties disagree regarding a decision

Emergencies are addressed through emergency response plans; nothing in this adaptive management process prevents immediate action in the event of an emergency

Figure 2
Reedsport OPT Wave Park
Dispute Resolution



*If a dispute over a proposed Response Plan is unresolved, the company will submit its proposed Response Plan to FERC.

EXHIBIT C - FISH AND WILDLIFE EMERGENCY CONTACTS

Entity	**Contact**	**Phone Number**
Oregon Emergency Response System	24 Hour Duty Officer	(800) 452-0311 (503) 378-6377 oers.staff@state.or.us
Reedsport OPT Wave Park, LLC	Bill Powers	(609) 730-0400 ext. 217 (Work) (609) 865-1159 (Mobile)
Additional Phone Numbers		
Marine Mammals		
National Marine Fisheries Service	Cathy Tortorici	(503) 231-6268
Oregon Department of Environmental Quality	Larry Caton (primary contact) Watershed Assessment Staff Aaron Borisenko (secondary contact) Manager, Watershed Assessment Staff	(503) 693-5726 (503) 693-5723
Oregon State Police Coos Bay Area Command (Make call to dispatcher in order given until dispatcher contacted)	Patrol Center Dispatch Center	(541) 888-2677 (541) 269-5000
Oregon Department of Fish and Wildlife	Susan Riemer	(541) 247-7605 (Gold Beach)
Oregon Department of State Lands	Steve Purchase Assistant Director, Land Management Division	(503) 986-5279

US Forest Service*	Forest Dispatcher	(541) 750-7024
Fish and other Aquatic Species		
National Marine Fisheries Service	Cathy Tortorici	(503) 231-6268
United States Fish and Wildlife Service	Laura Todd Field Supervisor, Newport Field Office	(541) 867-4558
Oregon Department of Environmental Quality	Larry Caton (primary contact) Watershed Assessment Staff Aaron Borisenko (secondary contact) Manager, Watershed Assessment	(503) 693-5726 (503) 693-5723
Oregon State Police Coos Bay Area Command (Make call to dispatcher in order given until dispatcher contacted)	Patrol Center Dispatch Center	(541) 888-2677 (541) 269-5000
Oregon Department of Fish and Wildlife	Mike Donnellan Marine Habitat Project Leader, Marine Resources Program	(541) 867-0300 ext. 279 cell: 541-270-8203 (Newport)
Oregon Department of State Lands	Steve Purchase Assistant Director, Land Management Division	(503) 986-5279
US Forest Service*	Forest Dispatcher	(541) 750-7024

Birds, Terrestrial Wildlife, Beaches		
United States Fish and Wildlife Service	Laura Todd Field Supervisor, Newport Field Office	(541) 867-4558
Oregon State Police Coos Bay Area Command (Make call to dispatcher in order given until dispatcher contacted)	Patrol Center Dispatch Center	(541) 888-2677 (541) 269-5000
Oregon Department of Fish and Wildlife	Andrea Hanson	(503) 947-6320
Oregon Department of State Lands	Steve Purchase Assistant Director, Land Management Division	(503) 986-5279
Oregon Parks and Recreation Department	Jim Morgan	(503) 986-0738
US Forest Service*	Forest Dispatcher	(541) 750-7024

*US Forest Service Emergency Contact Information provided for information. Access to the beach and/or Forest Service response may be required depending on the nature of the emergency and response required, e.g., recovery, remediation, or beach access for other emergencies.