Agenda Item D.1.a
Attachment 1
June 2010

Filed electronically: June ____, 2010

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First St. NE
Washington, D.C. 20426

Re: Reedsport OPT Wave Park Project, FERC No. 12713

Dear Secretary Bose:

The Pacific Fishery Management Council (Council) offers the following comments in response to "Reedsport OPT Wave Park Project, FERC No. 12713" (Project) Ready for Environmental Analysis notice. The Council asks that its earlier comments on this project (submitted to the Federal Energy Regulatory Commission (FERC) on November 21, 2007 and attached here again for convenience) also be made a part of this record. Those comments provide background to our Federal responsibilities, interests and concerns about the Project's potential impacts to Council-managed fisheries and the ecosystem.

We appreciate the efforts of FERC and others to work through the Settlement Agreement process. Some of the concerns mentioned in our November 2007 letter are being addressed through that process. However, we remain concerned about some issues. Given the lack of information about the environmental impacts of this new technology, this project must use adequate precaution, consider existing information on resource impacts, and consider the cumulative effects of multiple wave projects in the California current system.

Our primary concerns related to this project are:

- electromagnetic field (EMF) impacts on California Current species, including cumulative effects and the characterization of the scientific literature
- impacts of sound generated by the project
- environmental baseline and monitoring studies
- the proposed adaptive management process

EMF impacts

A comprehensive literature review on EMF for U.K. offshore wind energy (which has similar projected EMF emissions to wave energy) provided in the COWRIE 1.5 Report (Gill et al, 2005) concluded that there are many EMF-sensing species and that many are likely to experience cellular and/or behavioral responses to the EMF field generated by wind farm cables (Gill et al. 2005). This report also noted that EMFs of a magnitude within detectable ranges of EMF-sensing animals would be produced by industry

standard power cabling, even if buried to several meters, unless specific cabling configurations are capable of reducing EMF fields.

More specific findings from the only *in situ* experiment (COWRIE 2 report) (Gill, 2009) concluded that elasmobranchs exhibited noticeable behavioral responses to the electric (E)-field associated with energy cables, and could potentially detect the E-field for several hundred meters from the source (Gill et al. 2009). The UK studies indicate that cable shielding for EMF emissions is project-specific and requires *in situ* studies to test shielding effectiveness and species-specific responses. However, with respect to cable burial depth, COWRIE 2 updates the previous report's findings that EMF emissions are stronger than previously believed, and that there is no burial depth that will reduce the EMF below threshold levels for certain EMF-sensing species. These findings underscore concerns for potential impacts of EMF effects on EMF-sensing species.

There is little or no knowledge of EMF sensitivity thresholds for most EMF-sensing species likely to be found in the project area. Many of these are Council-managed species. OPT proposes to rely on known EMF ranges and the limited literature available on behavioral responses of "surrogate" species, rather than determining threshold values and responses for species likely to occur in the project area. In order to establish triggers for the adaptive management process proposed by the applicants, and to develop tangible mitigation measures, threshold values need to be established for project-area species at various life stages. *In situ* monitoring and experimental studies of behavioral responses are needed to determine the nature of any observed effect. (Any sensitivity studies and monitoring activities should include EMF strengths at least as great as those generated at periods of higher sea states, when EMF strengths will be higher.)

Salmon, green sturgeon and leatherback sea turtles listed under the Endangered Species Act are all EMF-sensing species that are likely to migrate through the project area. The Council's fisheries are impacted by the status of such listed species, and special consideration should be given to studying EMF effects on these and any other listed species.

As the COWRIE reports are the most comprehensive reports on EMF emissions and impacts for offshore energy, they should be considered as guidelines for studying and monitoring the impacts of this project. Additionally, as the COWRIE 2 Report was published several months prior to the release of this notice, its findings should be incorporated into the project's environmental assessment (EA).

Cumulative Effects of EMF

The COWRIE Report (Gill et. al, 2005) identified a number of information gaps regarding other sources of EMF emissions in the marine environment (such as telecommunications cables, power cables, pipelines, submarine power cables, etc.). This information is important to understanding the extent of anthropogenic EMF fields, including the cumulative impacts of other proposed offshore energy development. This information should be gathered and analyzed and effects should be mitigated.

Characterization of the Scientific Literature

The review of scientific studies on EMF and EMF-sensing species cited by OPT in the EA revealed several instances where the results and/or conclusions were inaccurately characterized (see Appendix A) or not utilized effectively to forecast possible impacts of EMF. These lead the reader to conclude that EMF represents no significant concern, which is not the case. Although all studies cited were not reviewed, the inaccurate representation of the reviewed literature raises the question of whether other cited literature was inaccurately represented. This is important because settlement negotiations and study plans were based in large part on the findings of the literature review. The Council suggests a verification of the literature by an independent peer review process.

Impacts of Sound on Fish

Some Council-managed fishes rely on sound to navigate, feed or avoid predation. Pacific herring, an important prey species for some Council-managed fish, is one species known for having highly developed hearing.

The EA addresses acoustic emissions as a potential impact on cetaceans, but does not appear to address acoustic impacts on fish species. The EA references only one scientific study for acoustic impacts to fish (Hastings and Popper 2005). However, in a subsequent scientific review, the study's authors note that the metrics they had employed to characterize sound impacts on fish were not necessarily appropriate (Popper and Hastings, 2009). Additionally, Popper and Hastings (2009) note that most of the studies they reviewed had significant problems in their methodologies and interpretation of results, and many lacked peer review. Despite advances in the current state of knowledge about acoustic emissions from anthropogenic sources, there is little data on species-specific responses, such as hearing loss, tissue damage, feeding behavior, mating behavior, predator avoidance and migration. Popper and Hastings (2009) conclude that the lack of available data makes it very hard to extrapolate data from one sound type or species to another, and note that "the only useful studies on the effects of sound on fish behavior must be done with field observations where the movement of fish can be observed and quantified before, during and for an extended period after exposure to sounds."

There is little evidence then to allay the Council's concerns regarding the impacts of acoustic emissions from the OPT wave energy project on fishes found in the project area. The Council suggests the need to characterize acoustic emissions, determine species-specific sound thresholds, and evaluate responses for species of concern in the project area. Additionally, techniques to dampen sound impacts should be employed where possible. Monitoring the acoustic emissions and species responses, and developing mitigation measures, should be included the adaptive management process where species responses are deemed significant.

Environmental Baseline and Monitoring Studies

We are concerned that the methodology used for OPT's baseline sampling does not provide adequate time to develop accurate baseline data.

Specifically, OPT proposes to conduct surveys of selected fish and invertebrate species in the project area prior to installation of the 10-PowerBuoy Array. The data from these surveys are intended to serve as baseline data for evaluating potential effects of the project. OPT proposes to use BBACI (Beyond Before-After-Control- Impact) statistical analyses to add reliability to the detection of environmental disturbance. These analyses require that the area not be disturbed prior to completion of baseline sampling.

However, given that wave energy buoy installation is planned for 2010 (one buoy and associated mooring infrastructure) and 2011 (nine-buoy array), and given the high natural variability of many marine fish and invertebrate populations, this schedule does not provide adequate time to develop accurate baseline data. Without such a baseline, meaningful estimates of pre-installation interannual variability or "average" abundance for many species cannot be determined. This lack of adequate baseline data will likely make it difficult to detect changes in abundance due to wave park development. In fact, no estimate of natural variability will be possible with only one year of pre-installation baseline data, therefore the BBACI analyses will not provide meaningful results to determine if any changes are due to wave energy impacts or other variables. This is not adequate. Additionally, control sites should be established beyond the boundary of the proposed Phase III build-out to support long-term monitoring of Phase II.

Adaptive Management Process

OPT proposes an adaptive management strategy to address unforeseen project impacts, but the only document describing this strategy is the Adaptive Management Process Overview, which does not provide specific threshold values (e.g. percent decrease in species abundance) for biological studies that would trigger additional impact studies or project modifications. The Council believes it is necessary to establish these triggers before the project begins to ensure that there are no unacceptable impacts.

Relevant Literature

In addition to the salmon fishery management plan that is referenced in the Reedsport project materials, the Council also has comprehensive fishery management plans for groundfish, highly migratory species and coastal pelagic species that should be taken under consideration as part of this project. All of the Council's fishery management plans are accessible from the Council website at http://www.pcouncil.org.

Other references to relevant literature are included in Appendix A.

In closing, we appreciate the opportunity to comment. We hope the Council's comments are useful for the EA analysis.

Sincerely,

D.O. McIsaac, PhD
Executive Director

Attachments:

Council letter to FERC, November 21, 2007
Appendix A

APPENDIX A:
Studies Reviewed in FERC Project License Application No. 12713, Volume II: Issues Assessment; Issue No. 2 – EMF; Appendix C (December 15 2009)

Mann et al. (1988) and Walker et al. (1988)

OPT cited Mann et al. (1988) and Walker et al. (1988) as having found magnetic sensing material in four species of salmon and finding no such material in sockeye salmon. In fact, both study's sole objectives were to study magnetite crystals in sockeye salmon, and both studies found magnetic-sensing crystals in sockeye, concluding that sockeye are capable of detecting changes in the geomagnetic field.

Quinn and Brannon (1982)

OPT accurately cited Yano et al. (1997) that: "no observable effect [was noted] on the horizontal and vertical movements of chum salmon when the magnetic field was altered," but then followed this with a misleading citation of Quinn and Brannon (1982) that they "*further concluded* [that] while salmon can apparently detect B [magnetic] fields, their behavior is likely governed by multiple stimuli as demonstrated by the *ineffectiveness* of artificial B field stimuli." Quinn and Brannon (1982) did not conclude that artificial B field stimuli were 'ineffective'. They did indeed note other environmental cues, such as celestial features and polarization patterns as mechanisms for influencing orientation, however, their experimental results demonstrated that when the magnetic field was altered, salmon smolts actually changed their orientation 56 degrees from the unaltered orientation.

World Health Organization (2005)

OPT cited the World Health Organization (WHO) (2005) that effects of EMF from subsea cables "does not appear to be significant on electro-sensitive species." There was no mention of marine fauna in the WHO report. The report discussed EMF impacts from transmission lines on human health.

Scottish Executive (2007)

OPT cited the *Scottish Executive* (2007) for its citing of CMACS Report (2005) (which cites the COWRIE 1.5 Report): "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." The COWRIE Report 1.5 (Gill et al. 2005) included a summary of industry reports which generally did not show there would be negative impacts to salmon. However, COWRIE authors include Atlantic salmon as a priority species, warranting further investigation of EMF impacts because of their utilization of nearshore waters. They note that an impact on magnetic sensing species

could be trivial (change in swimming direction) or serious (delay in migration), depending on the magnitude and persistence of the magnetic field. They also discuss possible encounters with E fields during critical periods or life stages when they are dependent on electric cues to detect benthic prey and mates, predators, or migratory routes.

Literature cited in this letter not included in the EA

Gill, A.B., Huang, Y., Gloyne-Philips, I., Metcalfe, J., Quayle, V., Spencer, J. & Wearmouth, V. (2009). COWRIE 2.0 Electromagnetic Fields (EMF) Phase 2:EMF-sensitive fish response to EM emissions from sub-sea electricity cables of the type used by the offshore renewable energy industry.Commissioned by COWRIE Ltd (project reference COWRIE-EMF-1-06). www.offshorewind.co.uk

Popper, A.N. and Hastings, M.C. (2009). The effects of human-generated sound on fish. Integrative Zoology; 4: 43-52.

Pacific Fishery Management Council

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Donald K. Hansen, Chairman — Donald O. McIsaac, Executive Director

November 21, 2007

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, D.C. 20426

Michael Murphy
Director of Renewable Energy - Alternative Technologies
Devine Tarbell & Associates, Inc.
970 Baxter Blvd.
Portland, ME 04103

Re: Reedsport OPT Wave Energy Park (FERC No. 12713)

Dear Secretary Bose and Mr. Murphy:

The Pacific Fishery Management Council (Council) is one of eight regional fishery management councils established by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) of 1976, 16 USC 1801et seq. The Council manages fisheries in the Exclusive Economic Zone off the States of California, Oregon, and Washington, working closely with relevant state and tribal governments to coordinate sound fisheries and habitat management practices. Off the Pacific Coast, the Council has prepared federal fishery management plans for salmon (five species); groundfish (more than 80 species), coastal pelagic species (eight species); and highly migratory species (12 species). These fishery management plans have been implemented through federal regulations issued by the National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), and U.S. Department of Commerce.

The Council is aware that several preliminary permit applications to install wave energy facilities off Oregon have been filed with the Federal Energy Regulatory Commission (FERC). While the Council recognizes the need to conserve existing energy resources and find innovative solutions for renewable energy, it is concerned that this new technology be developed appropriately with regard to fishery resources. The Council is not opposed to hydrokinetic energy projects or other energy development *per se*, but as fishery resource managers, we wish to ensure that any development proposal that might impact fish, their habitat, or fisheries is assessed appropriately to minimize adverse impacts. In this regard, the Council wishes to engage early in FERC's development of a wave energy licensing program to help ensure a thorough review process and realistic timeline for addressing adverse impacts to Council-managed species and marine habitats.

The Reedsport Ocean Power Technologies (OPT) Wave Energy Project (FERC Preliminary Application Document No. 12713) is one of the first long-term license application processes for a wave energy project in the United States, and is likely to set a precedent for wave energy projects elsewhere in the U.S. Therefore, it is particularly important that this project be carefully planned and executed. The comments provided below are directed to the Reedsport project, but are applicable to any wave energy project proposed off the West Coast.

The Council has a responsibility to comment on such projects when there may be impacts to fish habitat. Under the MSA, each fishery management plan prepared by the Council must describe and identify essential fish habitat (EFH), minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat. "Essential fish habitat" is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." Furthermore, the MSA *requires* the Council to comment on and make recommendations to FERC concerning any activity that, in the Council's view, is likely to substantially affect the habitat, including the EFH, of an anadromous fishery resource under its authority. The Pacific Council *may* comment and make recommendations to FERC on actions that may affect the habitat, including EFH, of any non-anadromous fishery resource under its authority.

Additionally, the Council is moving towards ecosystem-based fishery management planning, as per the newly reauthorized MSA. Through such an approach, management decisions will include relationships of fish stocks with predators, prey and competitors; the effects of oceanographic and climate conditions on populations and communities; and the effects of fishing and other anthropogenic activities on habitats.

In accordance with these responsibilities, we offer the following comments on the Reedsport wave energy project.

1) Precautionary Approach: The Council recommends that FERC take a precautionary approach with the development of this new technology. Location and design criteria should avoid unnecessary risks until more is known about the impacts of this technology and which wave energy design will yield the least environmental risk. We request that FERC seek to site this project, and other wave energy projects, in less biologically rich or sensitive areas.

2) Scale of Projects and Cumulative Effects: The scale at which wave energy projects are being considered in the Pacific Northwest, with essentially no knowledge of their effects on marine species and the environment, is of great concern to the Council. Not enough testing of wave energy technology has occurred to allow us to understand the impacts of even a single project; yet several entities have submitted preliminary permit applications encompassing a large percentage of the nearshore marine environment. Multiple wave projects distributed along the coast could disturb species whose migration through or within these areas is a key biological requirement. Additionally, the cumulative effects of multiple projects on marine animals and habitats are unknown. A large number of projects could compromise healthy ecosystems, and should be evaluated at a regional ecosystem scale before projects are installed.

3) *Impacts to Fisheries and Species:* Access to wave energy parks will likely be limited for reasons of safety and liability, and as a consequence, fishing is likely to be prohibited in these areas. Fisheries in the Reedsport area include commercial nearshore hook and line, recreational salmon, recreational bottom fish, and commercial Dungeness crab. These fisheries involve both state- and federally-managed species. Spatial data for most of these fisheries is lacking, making it difficult to estimate the economic impact that this stage of the Reedsport project, and expanded or subsequent wave energy projects, will have on the local fishing industry. Potential impacts include reduction in total fishing effort, lost productivity (economic impact), and displacement of fishing effort to areas outside the closure area. Displaced fishers will likely concentrate their efforts on areas immediately outside the wave park boundary, resulting in increased pressure on fish, crab and habitat in those areas. These indirect yet profound changes should be included in the project's assessed impacts.

To address economic impacts on the fishing community, the Council encourages wave energy developers to work with fishery sectors to identify important fishing areas and to minimize the placement of wave energy facilities in these areas. In addition, potential economic losses should be estimated as part of this and future applications.

The specific location of wave energy facilities will have the potential to differentially impact commercial and recreational fishing fleets that target fishing grounds at variable distance from safe harbors and from shore (e.g., day boats vs. trip boats). It is essential that the social and economic effects of these aspects of the fisheries be considered and that stakeholders within the fishing industry participate in the process.

It is not clear if the Reedsport project intends to consider all marine species in its studies of environmental effects. While species or stocks protected under the Endangered Species Act (ESA) or Marine Mammal Protection Act require special consideration, the project should also examine impacts to overfished stocks as well as species with specialized or unique ecological requirements (e.g., green sturgeon).

4) Essential Fish Habitat Information is Inadequate as Baseline Data: The Preliminary Application Document (PAD) for the Reedsport project suggests that EFH designations could be used as the basis for assessing impacts from wave energy projects on fish species and their habitat. While EFH does define the environmental parameters (depth, temperature, latitude, substrate type, etc.) that support the various life stages of a species, EFH does not define where a species actually exists or the relative value of one area over another. EFH alone cannot be used to determine impacts on fish species. It will be necessary for the applicant to conduct *in situ* baseline studies within the proposed project area to characterize the species community and determine relative importance of local habitats. Baseline studies should be conducted prior to a final decision on site location to minimize unnecessary impacts, and prior to project construction.

5) Overall Footprint of the Reedsport Project: The Council is concerned about the size and location of the proposed Reedsport project and the effect this will have on area fisheries. According to the PAD, the Phase II site is proposed to occupy an area of 0.26 sq. mi. within the longer-term, Phase III project area of three miles by one mile. The Council recommends that the

Phase II site (0.26 sq. mi.) be located so as to minimize environmental and fisheries impacts. If this project results in a navigational closure, the smallest area possible should be used. Additionally, in order to minimize the size of the area needed, standards for high energy-efficient turbine design should be implemented, and license conditions should require upgrading facilities within the license period as technology improves. Although not proposed at this time, the Phase III proposal of 200 buoys occupying up to three square miles is of greater concern to the Council and will require a more in-depth review process.

Additional comments on project management and environmental concerns are summarized below and provided with more detail in Appendix A.

The Council recommends specific project development and management requirements related to:

- Baseline studies on biological and physical characteristics
- A site-specific monitoring plan
- Addressing cumulative impacts from multiple projects
- Efforts to minimize emissions from electro-magnetic, acoustic and light sources
- Adaptive management conditions
- A decommissioning plan

The Council provides comments on concerns related to:

- Alteration in species composition and abundance in and around the project area, including trophic level impacts
- Electromagnetic fields
- Acoustical effects
- Collision, entanglement and entrapment
- Seafloor scouring
- Project site location
- Habitat alterations
- Effects on spawning habitat
- Areas of concentrated prey species
- Changes to habitat quality
- Physical dynamics of habitat displacement
- Release of toxins and chemicals

Knowledge of potential impacts of this technology is rapidly developing. Oregon State University's Hatfield Marine Science Center recently hosted a scientific forum of 50 scientists to consider the range of potential environmental impacts of wave energy (http://hmsc.oregonstate.edu/waveenergy/index.html). We hope the Council's comments are helpful to FERC in developing this new licensing program and that a wave energy program takes advantage of the collective wisdom of the scientists and resource managers.

Sincerely,

D. O. McIsaac, Ph.D.
Executive Director

JDG:kam

cc: Council Members
Habitat Committee
Mr. John DeVore
Mr. Chuck Tracy
Ms. Heather Brandon
Mr. Jim Seger
Dr. Kit Dahl
Mr. Merrick Burden
Ms. Jennifer Gilden
FERC Service List for Docket P-12713

APPENDIX

Project Development and Management

a. Baseline biological and physical data

In the context of living marine organisms and dynamic environments, "baseline" is not a static point in time, but rather a "trend analysis" that takes into account natural variability, both temporal and spatial. Baseline information on the biological and habitat resources at the project site allows for a) characterization of species community, diversity, and abundance and habitat; and b) a benchmark on which to monitor and measure short- and long-term effects of wave energy structures on natural resources. Additionally, features such as current convergence zones, migration corridors, spawning and settlement aggregations, and other essential habitat factors that are unique or specific to the project area should be identified. Baseline information for reference or control areas is also needed. To account for changing climatic conditions, El Nino/La Nina weather patterns, hypoxia events, and other annual environmental variables, baseline data are needed over a five-year period.

Baseline information of particular interest to the Council includes:

1) Characterization of the substrate
2) Characterization of the benthic and epibenthic invertebrate communities on which several Council-managed species prey
3) Characterization of the entire fish community, including forage species during spring, summer and winter to account for seasonal migration patterns

b. Site-Specific Monitoring Plan to monitor changes to the biological and physical environment

As there are no other full-scale wave energy projects in the U.S. on which to gauge environmental impacts, a comprehensive monitoring plan is needed for the Reedsport project. This plan could serve as a template for subsequent project as well. The monitoring plan should be developed in coordination with state and federal regulatory agencies. The monitoring plan should also include a requirement for monitoring following decommissioning, should that occur.

c. Determine and manage for cumulative impacts of multiple projects

The cumulative impacts of multiple wave energy projects along the coast are unknown. Factors such as size, spacing, spatial relationship to littoral drift, currents, etc. may have unforeseen impacts on the overall dynamics of the nearshore environment. Cumulative impact studies should be developed as part of a larger, regional wave energy program, incorporating expertise in the fields of physical and biological oceanography, marine geology, marine ecology and fisheries.

d. Establish industry standards for construction of wave energy devises to minimize emissions from electro-magnetic, acoustic and light sources

Standards should be established for construction of all wave energy devices to minimize electromagnetic, acoustic and light emissions in order to reduce exposure of susceptible marine species to such impacts. Such a standard protocol could minimize or eliminate the need to evaluate their utility with each new wave energy proposal.

e. License condition requiring adaptive management

As wave energy technology is relatively new and will continue to evolve with studies and advances in technology, environmental impacts remain unpredictable. To best manage wave energy projects for unforeseen impacts, a management and monitoring plan should be responsive, flexible, and adaptive to ensure that necessary safeguards for the marine environment are put in place as needed. In practice, this could include modifying existing equipment where demonstrated impacts are unacceptable or may be reduced. Adaptive management could also mean minimizing the size of the project footprint, if results can be achieved operationally in a smaller area.

f. License condition requiring project curtailment and/or decommissioning

If adaptation is unsuccessful, if ESA-listed species or sensitive species are taken, or if habitat impacts are beyond those anticipated, the project should be curtailed or decommissioned. Thresholds for such impacts should be set up front, before project implementation. Given the lack of knowledge about impacts of wave energy projects, a condition of impact review and mandatory consultation and response on at least a five-year basis during the license period should be included.

Impacts to Species and Habitat:

Species Concerns

a. Alteration in species composition and abundance in and around the project area

The installation of buoys, anchors and associated structures will add hard substrate to an otherwise uniform sandy environment, and could attract an entire community of rocky reef fishes and invertebrate species not normally present. The ecological consequences of such installations are unknown, but could include displacement of resident fishes. Another consideration is the potential increase in seabird and marine mammal activity in response to concentrations of prey organisms, and increased risk for collisions with structures while diving and swimming. As stated previously, it is necessary to establish the natural, baseline population to determine the relative habitat value of the area and to monitor changes throughout the permit period.

One particular concern is the survivability of salmonid smolts as they leave the Umpqua river estuary. Would wave energy devices alter current patterns such that prey species are affected? Another concern is for green sturgeon spawning in Rogue River and Klamath Rivers as they migrate along a narrow mid-shelf bathymetric corridor.

b. Electromagnetic fields

Electromagnetic fields (EMF) may impact organisms such as elasmobranchs, sea turtles, and marine mammals that use electric and/or magnetic senses in detecting predators and prey, orientating to ocean currents, and sensing their magnetic compass headings. Information on EMF emanating from wave buoys is lacking. Studies would be needed to evaluate the impacts of EMF on these species and evaluate the effectiveness of any device installed to minimize impacts.

c. Acoustics:

Fish and seabirds are highly sensitive to sound, and marine mammals use sound for communication and detection of prey. Sounds and vibrations created by movements of the structure above and below the water surface, along with acoustic guidance devices that may be deployed to direct marine mammals around the array, could disturb or displace fish, diving seabirds and mammals. Studies are needed to determine specific acoustic signatures of OPT's devices and site-specific ambient transmissions.

d. Collision, entanglement and entrapment:

All mobile marine animals are susceptible to collision, entanglement and entrapment. Assessment of these impacts would be necessary during and after construction, and modifications to the structural design may be necessary to reduce observed impacts.

Habitat Concerns

a. Project site location:

Wave projects should not be sited in or near areas that are known to be important ecological habitats (e.g., rare, sensitive, vulnerable).

b. Habitat alterations:

Artificial structure (i.e., fish aggregating devices) in what appears to be an otherwise uniform sand environment. Effects on species are noted above under Species Concerns (a).

c. Effects on spawning habitat:

It is unknown if the proposed area is located in fish spawning habitat. Changes in habitat dynamics, including current dynamics and sand movement, could have negative impacts on spawning success.

d. Areas with high concentrations of prey:

The nearshore area off Oregon is known is a highly productive area supporting high primary (plant) and secondary (zooplankton) production, as well as forage species (e.g., smelts and sandlance). Any loss of or disruption to this important forage area could have significant impacts on ecosystem productivity.

e. Changes to habitat quality:

Grain size, homogeneity, and amount of organic material in the sediment contribute to defining a habitat. These characteristics are likely to change as energy is removed from the wave train and finer sediments are deposited.

f. Physical dynamics of habitat displacement:

Wave energy facilities placed in the dynamic, nearshore environment may affect ocean currents, littoral drift, and beach accretion and erosion. ESA-listed Snowy plovers nest on beaches adjacent to the proposed project area. This critical habitat could be affected by changes in accretion or erosion. A model of the physical effects would help to identify potential impacts to species and to design impact avoidance measures or, if warranted, to develop species impact studies.

g. Toxins and chemicals:

The release of anti-fouling agents, chemical byproducts from the manufacture of project components, and chemicals associated with operation could contaminate habitat and impact species.