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**Assessing and Addressing Information Needs of Stakeholders Involved in
Wave Energy Development and Marine Spatial Planning**

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1.0 Introduction

1.1 Background

In the United States, there is an increasing demand for the development of alternative sources of energy. Investments at the state and federal level are being made in renewable energy resources such as wind, solar, geothermal, and ocean. In the Pacific Northwest, interest grows in energy harnessed from the tides, currents, and waves as long-term renewable energy sources for coastal populations. Planning for and implementation of this development is multi-faceted and challenging. Understanding the ecological risks and potential impacts associated with development will be critical to make informed marine spatial planning decisions (Bondareff, 2011). These must be weighed with the economic costs and benefits as well as social concerns.

Marine spatial planning is “a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives” (Elher and Douvere, 2009). When successfully used, it addresses all three objectives through dialogue and eventual shared understanding of the risks and potential impacts of development and changing use patterns. The flow of information among those concerned should be robust and relevant.

This project examined the information needs of those interested in the planning for marine renewable energy in Oregon. The objective was to recommend to Oregon State University’s Northwest National Marine Renewable Energy Center (NNMREC) an approach to facilitating sharing of relevant information concerning marine renewable energy in Oregon and Washington. The focus was primarily on Oregon given recent developments at the state level.

1.2 Wave Energy Development in Oregon

Wave energy is a potential marine renewable energy resource for Oregon. In 2006, Oregon Governor Theodore Kulongoski proposed a renewable portfolio standard (RPS) in Oregon, calling for twenty-five percent of the state’s electricity to be generated from renewable energy as part of Oregon’s Action Plan for Energy (2007). Wave energy companies were encouraged as the State committed \$10 million to Oregon Wave Energy Trust for the sustainable development of wave energy (Busch, 2012). The State also commenced the political process to amend the Territorial Sea Plan (TSP), Oregon’s marine spatial plan, to include wave energy as a potential use of the ocean. One major amendment to the TSP includes guidelines for permitting wave energy devices off of the coast (Oregon Coastal Management Program, 2009). As part of the permit process, developers will be required to look at the potential ecological effects of wave energy development (Oregon Coastal Management Program, 2009).

In October 2007, Hatfield Marine Science Center (HMSC) hosted a scientific workshop to look at the potential ecological effects of wave energy development in the Pacific Northwest. One goal of the conference was to identify the potential ecological effects of wave energy development on the coast and ocean and the agents involved (Boehlert et al, 2008). A major component of the workshop included breakout groups to discuss “stressors” and “receptors” of wave energy development. Stressors are the components of wave energy development that may change the environment as devices are installed, operated, or decommissioned (Boehlert et al., 2008). Receptors are elements of ocean and coastal systems that may be altered from wave energy development (Boehlert et al., 2008). One

recommendation of the workshop was to evaluate those potential ecological effects using stressors and receptors as a basis for what to evaluate in order to reduce the uncertainty surrounding development. Ideally, the evaluations would provide information about best practices for the development of standards and monitoring requirements as full-scale device arrays are developed.

1.3 Information needs of stakeholders

As evaluation of the potential ecological effects of marine renewable energy development moves forward, communicating the findings to stakeholders and planners is critical. Stakeholders include the marine renewable energy industry, fishers, other commercial users, researchers, local and state government, federal and local government agencies, NGO staff, educators, and university researchers and students. Communicating relevant information effectively entails understanding the needs of the various stakeholders.

The NNMREC is concerned with broad access to information on potential ecological effects of marine renewable energy research and development in the Pacific Northwest. Ideally, NNMREC will be a hub for this type of information. As part of this effort, we engaged in this project with the following goals:

1. *Create a database of literature*, both scientific and gray, about ecological effects of marine renewable energy development.
2. *Assess stakeholder information needs* with regards to potential ecological effects of wave energy development using social science methods, including interviews and a survey.
3. *Make recommendations for NNMREC on how to effectively communicate information* on potential ecological effects of wave energy development, based on stakeholders information needs.

The project was completed through a combination of a year-long monitoring and search effort for scientific and gray literature related to ecological effects of wave energy development, a series of phone-interviews, and a web-based survey of stakeholders. The two principal investigators for the project were Janet Webster, the Head Librarian of the Guin Library at HMSC, and Sarah Henkel, a Benthic Ecologist at HMSC. Kate Sherman, an Oregon State University graduate research assistant (GRA), was the primary staff person.

The information and literature included in the project focused on wave energy development in Oregon, and where relevant, include information about broader topics related to marine renewable energy development. The geographic extent expanded to include global research.

2.0 Literature search

2.1 Methods

The GRA searched published and professional literature on the topic of ecological effects of marine renewable energy, with a specific focus on wave energy. The searches focused on the stressor receptor relationships discussed in the MRE workshop at HMSC in 2007. Some effort was also spent researching other marine renewable energy forms, such as wind, tidal, and hydrokinetic devices, since they share certain stressor characteristics as wave energy (for example, both wind and wave energy will require underwater cables).

The two principal investigators provided the GRA with their personal, pre-existing literature databases. Each database was mined for relevant published and professional literature that matched the search criteria used in the search portion of the project.

Since there were a variety of sources searched, flexibility with search strategies was used to find new references. Some of the resources searched were publicly accessible, and others were proprietary (i.e. scholarly journals) or commercial products (i.e. conference proceedings). The resources used included:

- Databases:
 - Oregon State University 1Search
 - Aquatic Science and Fisheries Abstracts
 - Environmental Sciences and Pollution Management
 - Web of Knowledge
- Web and Open Repository Resources
 - DOE Green Energy
 - Science.gov
 - FedWorld.gov
- Web Search Engines
 - Google
 - GoogleScholar
 - Bing

Once references were identified, they were entered into a bibliographic database, EndNote, maintained by the GRA. Each record was tagged with keywords featuring the following elements:

- Stressor or receptor
- Geographic area of research
- Type of research (pre-development, post-development, baseline data, synthesis of information). This tag indicated if the literature addressed information about actual ecological effects or development, if it was an estimation of what the effects would be, or if it was baseline ecological information about the specific geographic area in discussion
- Category of marine renewable energy (wave, wind, tidal, hydrokinetic)

Eventually, 182 records were entered, tagged and analyzed. A bibliography of records is listed in Appendix 4. The database is also available at: https://www.zotero.org/groups/osu_wave_energy_-_potential_ecological_impact_literature.

2.2 Characterization of the literature

In general, little information is available on actual environmental effects of marine renewable energy development and even less for wave energy development. However, the literature is growing (Figure 1). Only 15% of the citations address observed environmental effects, and 3% were results from a wave energy device. None of those came from an Oregon wave energy device. Potential effects, such as found in Environmental Impact Statements (EIS) or Environmental Impact Assessments (EIA), made up 36% of all literature included in the database, and literature reviews and literature synthesis made up 35% of the literature (Table 1).

Nearly half (45%) of all of the literature came from research based out of the United States, and 20% of all of the literature was research from the state of Oregon. International research accounted for 37% of all of the collected literature.

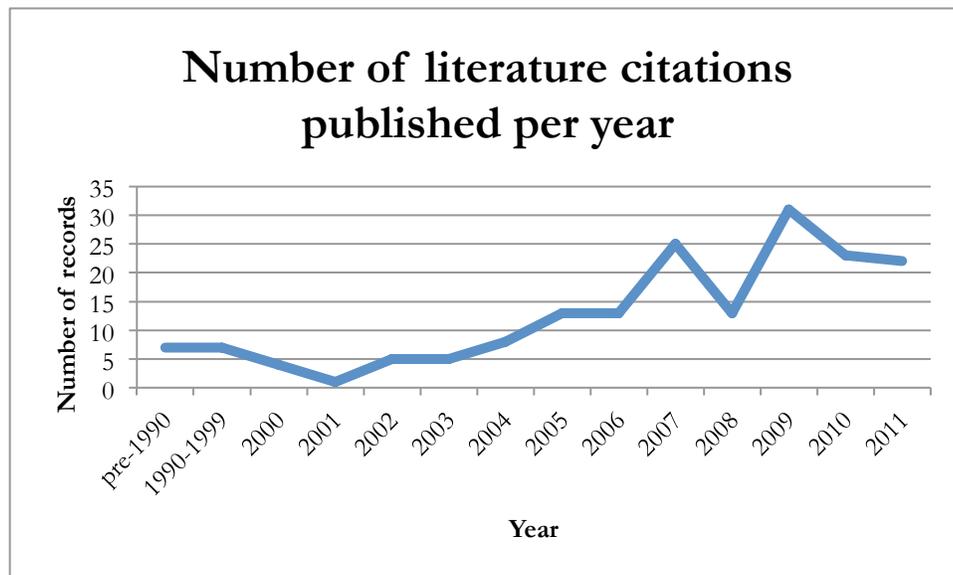


Figure 1: Number of literature citations related to potential ecological effects of marine renewable energy development, published by year.

Records focused on wave energy accounted for 26% of the citations. The rest of the research was either wind energy (19%), tidal energy (10%), or baseline observations that were not related to any particular type of device, but were geographically tied to locations with potential for marine renewable energy development. It is important to note that the literature search was focused on wave energy, so additional records may exist but were not found given the subject restriction.

At this point in wave energy development in Oregon, the literature shows that we are in the stages of modeling and estimating what the potential ecological effects of wave energy will be. There are currently no results on the actual ecological effects of wave energy development in Oregon.

Table 1: EndNote & Zotero Literature Database Composition

	Number of citations	Percentage of Total
Category of Research		
Baseline observation	39	21%
Environmental assessment (pre-development)	66	36%
Ecological effect (post-development)	27	15%
Literature/Synthesis	63	35%
Methods & Models	22	12%
Type of Marine Renewable Energy		
Wave Energy	48	26%
Wind Energy	34	19%
Tidal Energy	19	10%
Geographic Area		
Oregon	37	20%
Washington	23	13%
California	13	7%
United States	82	45%
International	68	37%
Stressor*		
Sound and Acoustics	52	29%
Electromagnetic fields (EMF)	19	10%
Collision (devices with wildlife)	16	9%
Collision (industry ships with wildlife)	1	1%
Visual appearance	22	12%
Changes in wave energy	23	13%
Sediment dynamics	48	26%
Cables, pipelines, transmission lines	27	15%
New structure (artificial habitat)	49	27%
Chemical interactions	19	10%
Receptor*		
Fish and fisheries	117	64%
Marine mammals	56	31%
Sharks and ray	16	9%
Turtles	12	7%
Marine birds	52	29%
Invertebrates	37	20%
Corals	7	4%
Human dimensions and social interactions	29	16%
Physical Environment	35	19%
Pelagic Habitat	30	16%
Benthic Habitat	79	43%

3.0 Stakeholder Interviews and Survey

3.1 Identification of stakeholders

Ethnographic research methods were used to gather information through interviews and surveys on the information needs of stakeholders about the potential ecological effects of marine renewable energy development. A contact list of stakeholders was created based on their association with marine renewable energy development in the United States, with a focus on individuals associated with the state of Oregon. The list was created through a mix of recommendation from the project PI's as well as through web-based searches for individuals involved in marine renewable energy development in Oregon. Additional recommendations for participants were obtained through known marine renewable energy stakeholders who acted as key informants (Marshall, 1996), as well as through state and federal agencies that focus on marine renewable energy issues (e.g. Oregon Department of State Lands and the Bureau of Ocean Energy Management).

Prior to conducting the ethnographic research, the project background and purpose, as well as supporting documents (including the interview guide and survey), were submitted to the Institutional Review Board (IRB) at Oregon State University (OSU). See Appendix 2 for the letter of approval from OSU's IRB office.

3.2 Interview methods

The main purpose of the stakeholder interviews was to gain a better understanding of what information stakeholders desire to know about potential ecological effects of marine renewable energy development. The stakeholder interviews also looked to uncover the communication outlets and strategies for communicating information about ecological effects of marine renewable energy development. The PI's for the project each identified 15-20 key individuals, representing different stakeholder groups, to target for the stakeholder interviews. Each individual was contacted by email and invited to participate in an interview. Each of the recruitment emails included background information and purpose of the project.

Each interview was conducted by the GRA. During the interview, notes were taken and an audio recorder rented from the Oregon State University Libraries was used to record the interview. A consent document was used to gain the stakeholder's permission to audio-record the interview. If after review of the informed consent document, the stakeholder no longer wanted to participate, they were free to withdraw their participation without any repercussions. They were also free to participate in the interview without being audio-recorded.

During the interview, the GRA asked questions from an interview guide designed to guide ethnographic, semi-structured interviews (Robson, 2002) (Appendix 1), developed by the GRA and the PI's. Interviews were designed to take approximately thirty minutes, depending on the stakeholder responses. Participants were able to opt out of answering any question asked during the interview. At the end of the interview, the participant was asked if there were any other individuals who would be good to contact to include in the next step of the project, the stakeholder survey, and those individuals were added to the contact list developed in the beginning of the project.

Seven stakeholders participated in an interview. Participants represented the following stakeholder groups:

- Local Government
- Media
- Commercial Fishing / Local Business
- MRE Industry Consultant
- Federal Agency
- State agency (Oregon)
- Shipping/Port Representative

All the interviews were conducted over the phone from October 2011 to February 2012. Six out of the seven interviews were audio-recorded, and one individual requested not to be recorded. The six interviews that were audio-recorded were transcribed in as much detail as possible from the audio-recording. All seven interviews were analyzed for themes and anecdotal information.

3.3 Results of the Stakeholder Interviews

3.3.1 “Where do you go to search for information about the potential ecological efforts of marine renewable energy development?”

At least three of the interview participants mentioned these information outlets:

- Tethy’s MHK Knowledge Base produced by Pacific Northwest National Lab (PNNL)
- Google
- Academic Institutions (Oregon Institute of Marine Biology, Hatfield Marine Science Center)
- Town Halls and Public Forums

Other information outlets mentioned by one or two participants included:

- Oregon Policy Advisory Council Announcements
- Any of the National Labs, such as PNNL and Oakridge National Lab (ONL)
- Puget Sound Partnership
- Bureau of Ocean Energy Management (BOEM) Oregon forum

Two individuals mentioned that they do not search for information because it is shared with them through email or by word of mouth. Another said that if they had to look for information, they would not know exactly where to look because information is in so many different places.

3.3.2 “What type of information do you need?” and “What format do you prefer for receiving this type of information?”

Responses included:

- Synthesis of scientific literature
- Expert reports, information from universities, agencies, or third-party consulting firms

- Research from Europe

For the most part, they did **not** want the following information:

- Research from the marine renewable energy industry
- Results in the format of journal articles

3.3.3 “Are there any stressors that you are interested in?”

Participants were prompted, if necessary, that “stressors are the components of wave energy development that may change the environment as devices are installed, operated, or decommissioned” (Boehlert et al, 2008). All of the participants expressed a low level of interest in all of the stressors. Three stressors were repeatedly mentioned:

- Collision or physical interactions with the device (both wildlife and ships with the device)
- EMF impacts on fish and other electro-magnetic sensitive species
- Physical presence of the device (sediment dynamics)

3.3.4 “Are there any receptors that you are interested in?”

Only one receptor, fish and fisheries, was repeatedly emphasized as being important by multiple participants. Other receptors, such as marine mammals and birds, were not emphasized during the interview, though they were occasionally discussed.

3.3.5 General observations from the interviews

A theme throughout two of the interviews was the potential wave energy impacts on Oregon fisheries. One participant mentioned their concern over the potential wave energy impacts on benthic organisms, in particular, Dungeness crabs. Another participant reported that commercial fishermen are very aware of the potential impacts that EMF can have on fish and that some have updated their fishing boats to reduce EMF in order to reduce their impact on the resource. This participant suggested that fishermen are a good source of information on the impacts of EMF on fish and fisheries.

Overall, the interviews revealed persistent themes concerning information:

- Actual results of the ecological effects of wave energy are needed;
- Scientific literature is difficult to understand for most people; the members of general public are not experts;
- There is not currently one source of information about potential ecological effects of wave energy development. The information is scattered;
- Sources of information need to be consistently managed. If there is going to be an information source, such as a website, listserv, or blog, someone needs to maintain it over time;
- Blogs, social media, and other media outlets are good ways to catch people’s attention and point to information that is available (e.g. an academic or agency website).

3.4 Survey methods

The survey was based off the interview questions and refined by the GRA and the PI's (Appendix XX). The survey was designed and administered using Qualtrics, an online survey tool. The 236 individuals were sent an email that included background information about the project, a link to the survey (AppendixXX), and contact information for the GRA and the PI's. Using a snowball sampling technique (Robson, 2002), email recipients were requested that stakeholders forward the survey on to people who they think should participate. The survey was designed to take fifteen minutes, and it was voluntary and anonymous.

The survey was started by 20% of the email recipients, and 16% completed the whole survey. Survey respondents identified with the following stakeholder categories:

- Academic institution
- Non-profit / advocacy group
- Non-extractive recreational users (i.e. surfing, scuba diving, sailing)
- Recreational fishing
- Other commercial ocean user
- Port/harbor master or manager
- State agency
- Federal agency
- Local government
- State government
- Federal government
- Consultant
- Interested citizen

There were no respondents from the following stakeholder categories listed within the survey:

- Commercial fishing
- Engineer
- Tribal government

3.4 Results of the Stakeholder Survey

3.4.1 How often are you in need of information about the potential ecological effects of marine renewable energy development?" (Figure 2)

This question addressed need. Twenty percent of the respondents never or rarely use information while 35% need information daily or weekly. While there is variety in the level of need, most respondents (80%) need information at least once a month.

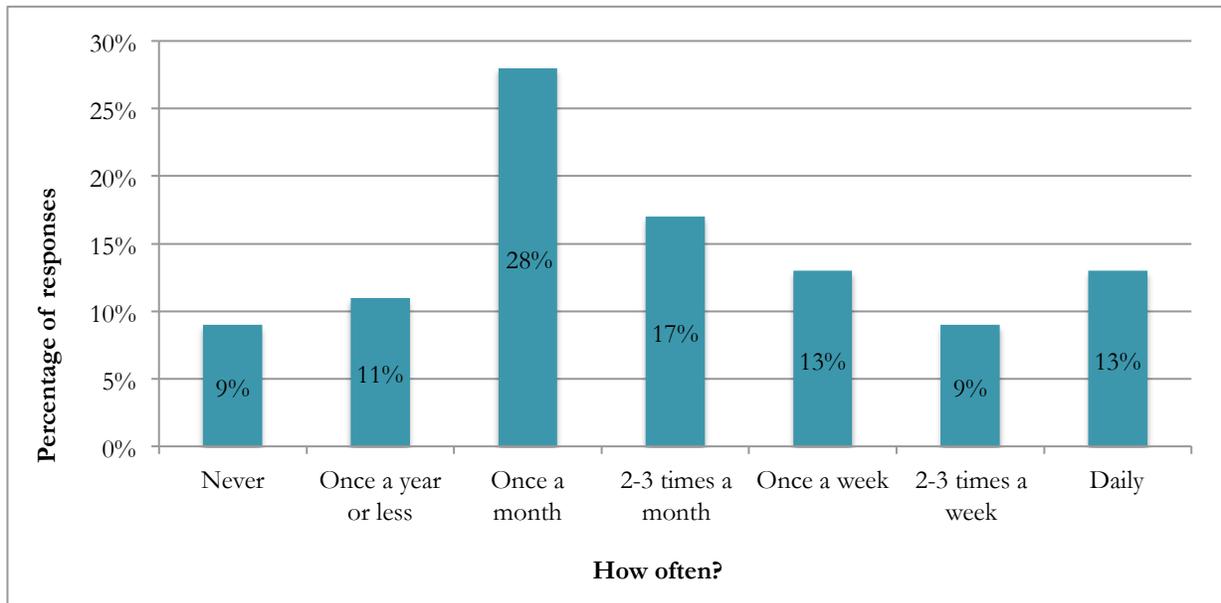


Figure 2: Responses from the survey question, “How often are you in need of information about the potential ecological effects of marine renewable energy development?”

3.4.2 “When looking for information on potential ecological effects of marine renewable energy, how often do you go to the following sources, and is the source trusted?” (Figure 3)

The respondents were given the option to choose “very often,” “sometimes,” or “never.” State and federal agencies, academic institutions, conferences and scholarly journals were used very often or often. Social networking sites and blogs were rarely visited for this type of information.

Academic institutions, scholarly journals, and state and federal agencies are trusted. The few people who regularly visit blogs and social networking sites do not have a high level of trust in them.

There was another category available for respondents to submit what sources they visit. The following information sources were listed in the “Other” response space:

- Scientists
- Call Oregon Department of Fish and Wildlife (ODFW)
- Pacific Energy Ventures new clearinghouse
- Oregon Wave Energy Trust’s support tool
- Project developers
- Commercial fishing industry

Of note, 8% of individuals who responded to this question indicated that they contact scientists directly to find out information.

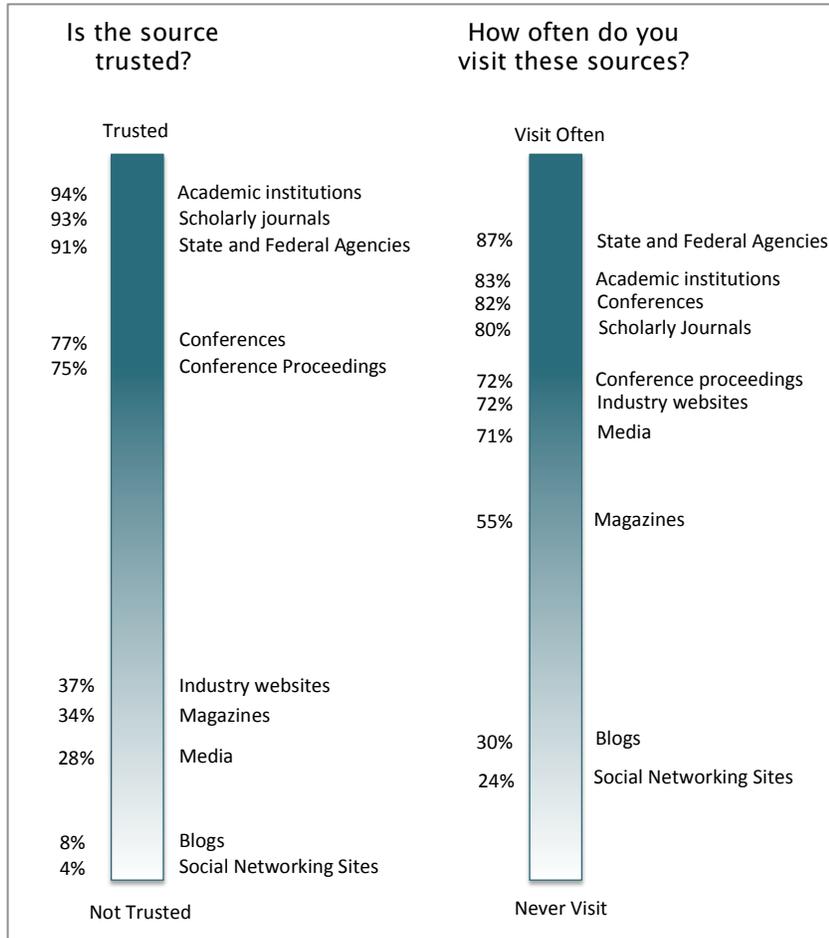


Figure 3: Responses from the following two-part question from the stakeholder survey, “When looking for information on potential ecological effects of marine renewable energy, how often do you go to the following sources, and is the source trusted?”

3.4.3 “Describe your limitations, if any, to accessing information on potential ecological effects of marine renewable energy development?” (Figure 4)

This question was a true or false question about stakeholder’s access to information. Respondents were fairly evenly mixed on whether they felt the information was available and if they had time to search. They overwhelmingly disagreed that they did not have access to available information or that the information was untrustworthy. Other comments included the following:

- “Access to data can be limiting.”
- “A lot of science is dependent on who paid for the research.”
- “All of the information I want is not available, but some information is available.”
- “Industry information is held as proprietary.”

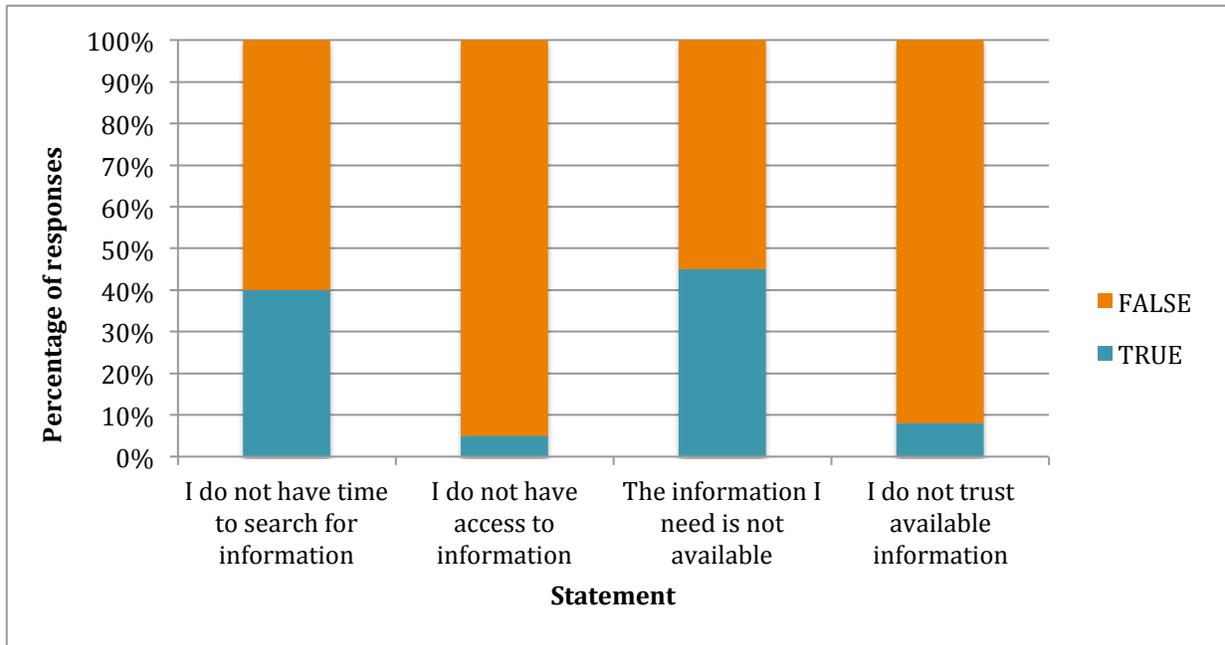


Figure 4: Responses to a true or false question on the survey. The question was, “to what extent do the following statements describe your limitations, if any, to accessing information on potential ecological effects of marine renewable energy development?”

3.4.4 “Which of the following geographic areas are you interested in learning about potential ecological effects of marine renewable energy development?” (Figure 5)

Respondents were most interested geographically in the state of Oregon. Respondents had a similar level of interest in other states on the west coast, including Washington California, and Alaska. When asked to identify a specific location, respondents indicated the following:

- Tillamook County
- Northern California
- Scotland
- Florida
- Maine
- Pacific Ocean
- Oregon Rivers



Figure 5: Geographic areas that stakeholders were, “very interested” in.

3.4.5 “What types of information on potential ecological effects of marine renewable are you interested in?” (Figure 6)?

Respondents had the most interest in ecological effects and had the least interest in industry reports. Respondents were also very interested in baseline observations and case studies. Interest was mixed in literature reviews and models.

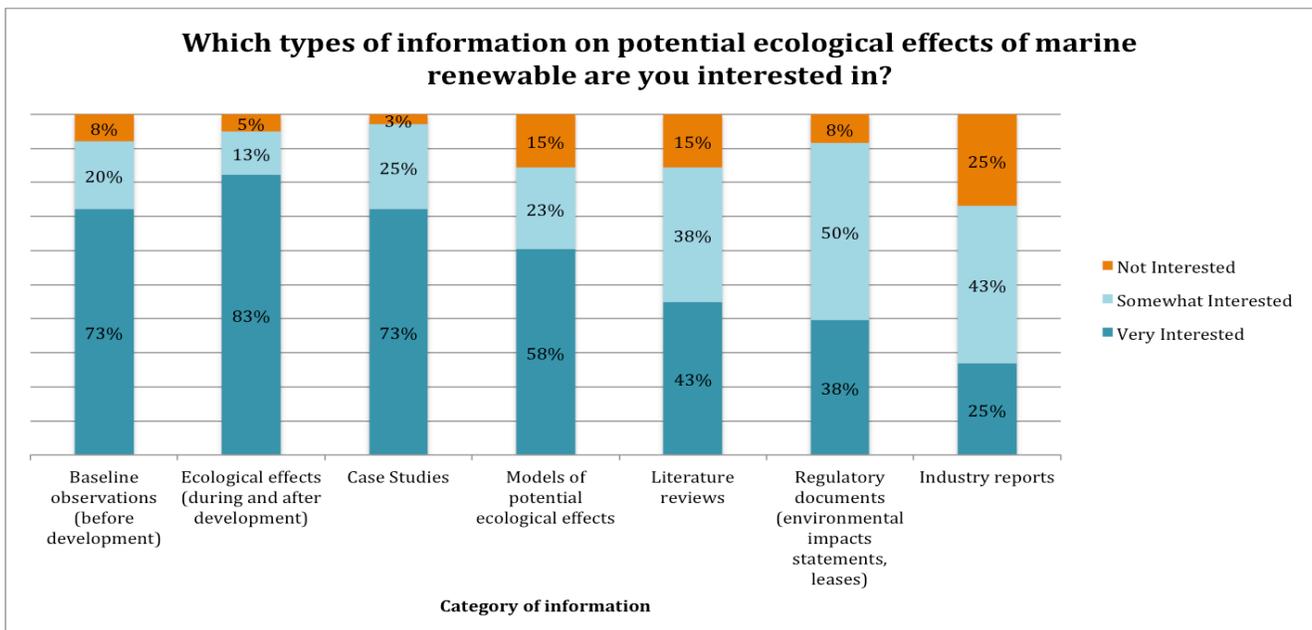


Figure 6: Responses to the survey question, “Which types of information on potential ecological effects of marine renewable are you interested in?” Respondents were asked to select, “very interested,” “somewhat interested,” or “not interested” for each category of information.

3.4.6 Stressors (Figure 7)

The stressors used in the interviews were listed to get an understanding of those of interest. Respondents were very interested in collisions of devices with wildlife, new structure/artificial habitat sound and acoustics and collision of industry ships with wildlife. There was limited interest in “visual appearance,”. All in all, respondents were interested in everything to some degree.

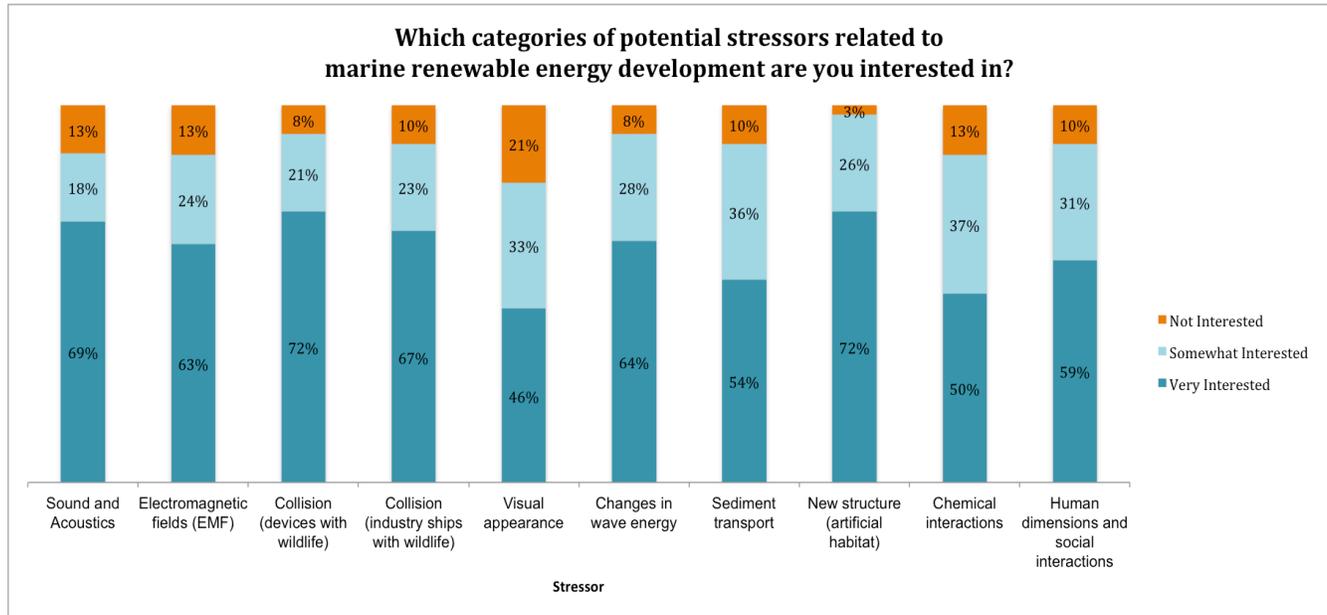


Figure 7: Stressors of Interest

Respondents also indicated additional stressors of interest:

- Lighting (impacts on wildlife)
- Cumulative effects of multiple devices
- Climate change effects

3.4.7 Receptors (Figure 8)

Receptors covered habitats and organisms. Respondents were very interested in fish and fisheries, marine mammals and the pelagic environment. Little interest was expressed for turtles and corals. All of the other categories of receptors were of interest to some degree.

Respondents indicated interest in additional receptors:

- Continental shelf
- Sandy beaches
- Benthic-pelagic coupling
- Green sturgeon
- Krill
- Migrating birds

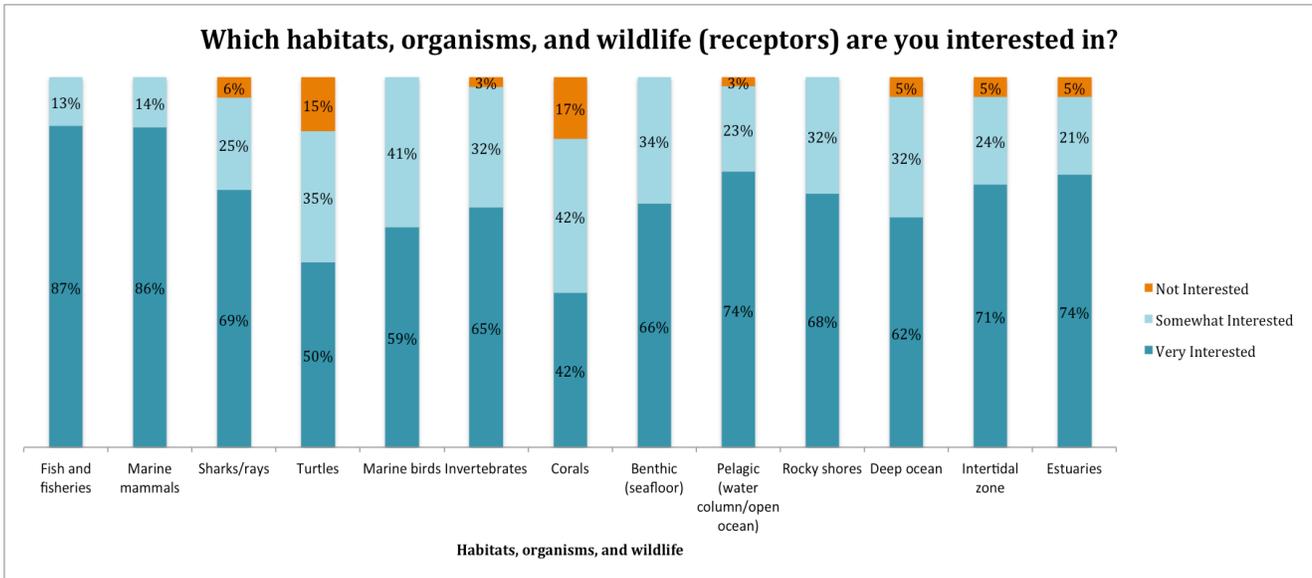


Figure 8: Responses to the survey questions about receptors, “Which habitats are you interested in?” and “Which types of organisms and wildlife are you interested in?” Respondents were asked to select, “very interested,” “somewhat interested,” or “not interested” for each category of information.

4.0 Analysis of the literature, stakeholder interviews, and survey

We can identify information gaps and focus effort through the analysis of the currently available literature coupled with input on stakeholders’ need for and perception of information.

4.1 Literature analysis

4.1.1 Geographic areas of literature

Geographic focus is important to stakeholders and more Oregon-centric information is needed. The international literature accounted for 45% of the publications identified for this project while only 20% had an Oregon component. The stakeholder survey showed that 95% of stakeholders were very interested in information from Oregon, and the smallest demand came for international research (31%). This information implies that stakeholders may not be interested in the international studies, already familiar with that body of work, or just very eager for more local, relevant information. In addition, stakeholders were very interested in information about Washington and California (68% and 61% respectively). These results suggest an opportunity and a need for NNMREC to provide regional and Oregon-based information to stakeholders.

4.1.2 Stressors and receptor literature

The currently available literature on stressors loosely matches with stakeholders’ interests. For stressors, the most literature addressed sound and acoustics (29%) and new structure/artificial habitat (27%). Stakeholders are interested in those topics (69% and 72% respectively), but also have a great interest in collision information (devices with wildlife - 72%, industry ships with wildlife - 67%). There is little current literature on collision in the wave energy realm. It may exist in related fields so additional searching would identify relevant material to share with stakeholders. This effort may be an opportunity for NNMREC. In

addition, better communication of the available information on acoustics and artificial habitats would probably be appreciated.

The most information on receptors addresses fish and fisheries (64%) and benthic habitats (43%). Stakeholders were interested in fish and fisheries (85%), marine mammals (82%), and the pelagic environment (72%). A similar situation exists for receptors as for stressors - current information is available presenting an opportunity to share it with stakeholders. There is also another gap that should be addressed – information on the pelagic rather than just benthic habitats.

4.1.3 Environmental assessment literature

A major strength of the available literature is the number of documents (36%) related to environmental assessment, or what developers and other stakeholders need to assess before engaging in marine renewable energy development. During the stakeholder interviews, participants identified the need for information about actual environmental effects of marine renewable energy, and 83% of survey participants responded saying they were very interested in this type of information. While it is useful to know what needs to be assessed, it is becoming more critical to understand actual environmental effects. Of all of the literature, 15% identified and discussed actual environmental effects, and of that, only 3% was from research within Oregon. The demand for this type of information has not been met.

Meeting this demand for information is challenging, considering there are currently no wave energy devices in the water. When this type of information does become available, NNMREC and others need to communicate it widely and in a timely fashion.

4.1.4 Synthesis literature

Another strength of the literature is the availability of information in the form of synthesis, with 35% of documents in the database from the synthesis category of research. Much of this information comes from documents outlining the potential ecological effects of marine renewable energy. This aligns with stakeholder desires for synthesis of scientific information, and not scientific literature. Additionally, stakeholders indicated that they like reports from academic institutions, agencies, and consulting firms.

When information is released on environmental effects of wave energy development, information sharing institutions, such as NNMREC, should synthesize the information in a readable format, such as a fact-sheet. These summaries can compliment the more detailed scientific report for the people who want more in depth information and data.

4.2 Stakeholder interview and survey analysis

4.2.1 Trust

The most trusted and used sources of information are academic institutions (94%), state and federal agencies (91%), and conferences (77%). The current levels of trust and usage should be sustained by providing accurate, relevant and timely information.

4.2.2 Consistency

The information is from a wide variety of sources including PNNL's Tethy's MHK knowledge database and Pacific Energy Venture's clearinghouse. Access to these resources needs to be organized and available in one trusted location, making it easy to link to all sources of already available information. Better linkages would enhance access and allow stakeholders to easily and consistently access information. There needs to be a hub of information, by sharing their own work as well as identifying and including links to other outlets of information. NNMREC's setting within an academic institution, a trusted as well as visited source for information, provides a great location to host and provide resources of information, especially those focused on Oregon and Washington.

4.2.3 Communication Outlets

Multiple outlets may be helpful in communicating information to stakeholders, if used judiciously. Stakeholders do not trust information delivered through social networks such as Facebook and Twitter. However, these outlets provide opportunities to push information to stakeholders, and then link to a trusted source such as NNMREC's website. Blogs and media are other ways to initiate communication with links to the website.

5.0 Recommendations for NNMREC

The NNMREC has an opportunity to become a hub of information about potential and actual ecological effects of wave energy development. Resources and expertise will need to be committed to exercise this opportunity. These five areas should be considered:

- Website development
- Literature database maintenance
- Information synthesis
- Social media utilization
- Staffing requirements

5.1 NNMREC website development and maintenance

The NNMREC website has potential to become a hub for good sources of information on potential ecological effects of wave energy development. The current website has very little information on the breadth of potential effects, and is difficult to navigate to find actual literature and information about potential effects and results of scientific research. A lack of current events or recent news on this topic prevents those interested from regularly visiting the website. Updating and maintaining the NNMREC website will be critical for communicating information about potential ecological effects to stakeholders. The following are recommendations for NNMREC for updates to the website.

5.1.1 Update the "Environmental" section

When a current website visitor selects, "Environmental" on the left hand side navigation bar on the NNMREC website (<http://nnmrec.oregonstate.edu/>), they are moved to a landing page with information about potential environmental effects. This page discusses two primary ways in which wave energy devices and arrays of devices can impact the environment. This page should be changed and renamed to become an

“Ecological Effects” landing page with background information and an overall summary of information available on this particular section of the website. This page should also link to a series of other information resources and provides current events and news (Figure 9).

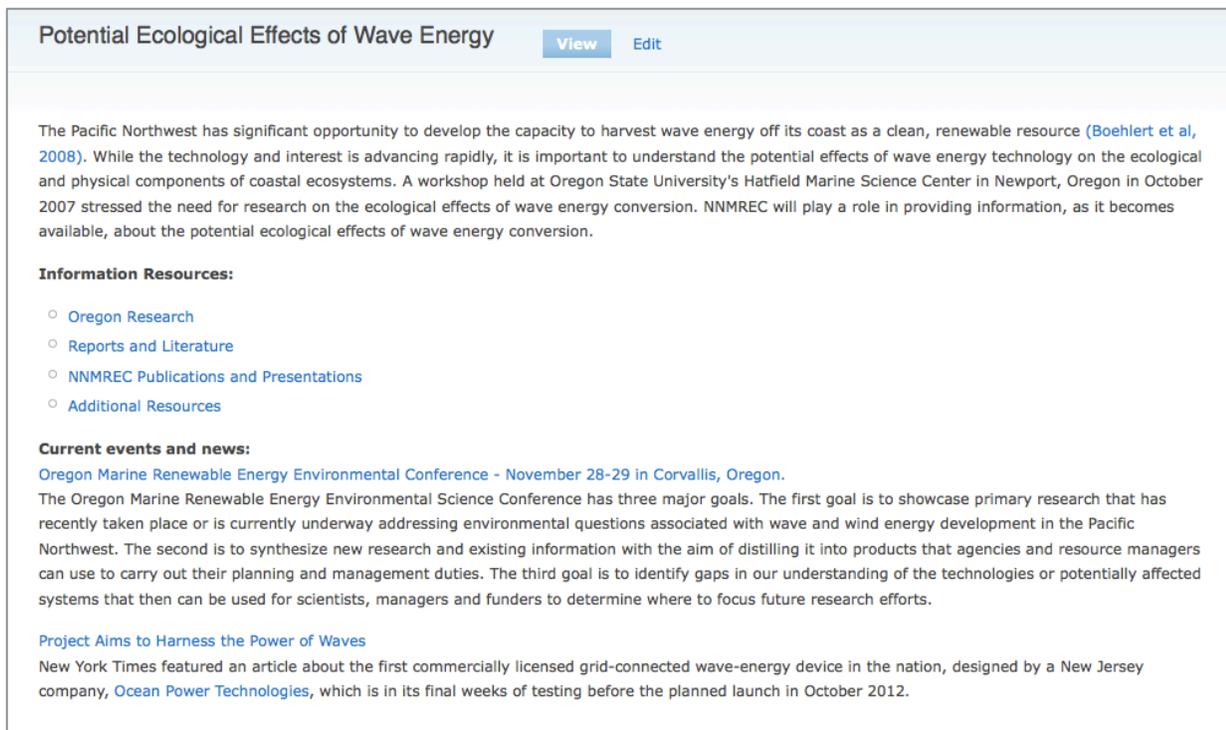


Figure 9: Draft content for an “Ecological Effects” landing page as part of the Northwest National Marine Renewable Energy Center (NNMREC) website.

Based on the interpretation of the results of the stakeholder survey and interviews, the website, in addition to the main “Ecological Effects” landing page, there should be the addition of the following four new webpages of information:

- Oregon specific information on potential ecological effects of wave energy
- More general reports and literature about potential ecological effects of wave energy
- All of the Oregon NNMREC publications and presentations
- Links to additional resources (other websites with information)

This primary landing page for “Ecological effects” should also include relevant press releases and current events such as regional conferences and workshops.

When NNMREC releases any information about potential ecological effects of wave energy development, this “Ecological effects” landing page can be listed as a resource. For example, if there is a NNMREC press release on this topic, it can link to this landing page.

5.1.2 Include an “Oregon” section

Under the "Ecological effects" section on the NNMREC website, there needs to be a link to another sub-webpage of information about Oregon. This page can include the scientific research conducted in Oregon on potential ecological effects of wave energy development. The literature listed on this page can be organized by “stressors” and “receptors” to make it easy for stakeholders to access the information that they want (Figure 9). In addition, this is a good location for NNMREC to link to a fact sheet or document that includes synthesis of information on each of these topics (see recommendation “Create synthesis of information” in this report).

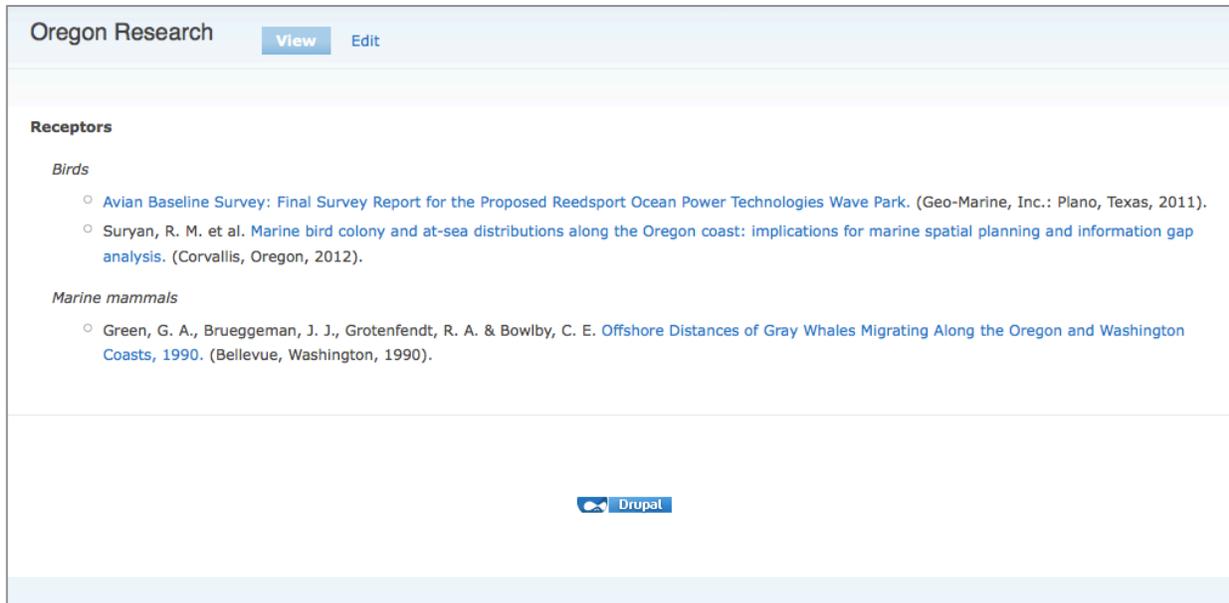


Figure 9: Draft content for an “Oregon” webpage as part of the Northwest National Marine Renewable Energy Center (NNMREC) website. Users will be able to link to this page from the “Ecological Effects” landing page.

5.1.3 Include a “Literature Resources” section

Under the “Ecological Effects” section, a link to a webpage that lists relevant literature from the international community should be added. This section does not need to list all of the literature resources available in the Zotero database, but it can list a few selected and relevant documents that NNMREC thinks are important to highlight and share.

5.1.4 Include a “NNMREC publications and presentations”

Beneath the “Ecological Effects” section, a link to a webpage page that lists the NNMREC specific publications and presentations should be included. A great example of this is the University of Washington NNMREC website (<http://depts.washington.edu/nnmrec/documents.html>). This should be a model for this particular section of Oregon State University’s NNMREC website. This section should include all of the publications and presentations made by NNMREC staff and students, organized by topic. For example, all of the “Ecological effects” topics should be in one sub-section of publications. This will make it easy for stakeholders interested in ecological effects to easily identify publications and presentations of interest.

5.1.5 Include an “Additional Resources” section

The webpage of the “Ecological effects” landing page should link to a list of additional resources. The results of the stakeholder interviews and survey show that there are a variety of web-based resources for information on potential ecological effects of wave energy development, however, there is not one resource for this type of information. It should not be the goal of NNMREC to re-create something another organization or agency has already done. NNMREC can become a hub of information by providing links to different resources as well as providing its’ own content and information. This will give stakeholders a one-

Literature Resources:

Tethys
Tethys is a database and knowledge management system that provides access to information and research pertaining to the potential environmental effects of marine and hydrokinetic (MHK) and offshore wind development. Tethys also hosts data from Annex IV, an international collaboration to gather information on MHK environmental research worldwide.

Advanced H2O Power KnowledgeBase
Dedicated to ocean renewable energy, Advanced Water Power (AWP) is a portal to a broad range of industry, environmental, regulatory, and policy information.

BOEMRE OCS Renewable Energy and Alternative Use Program
Outer Continental Shelf (OCS) Research Data Library hosted by BOEMRE.

OSU Wave Energy - Potential Ecological Impact Literature
Join OSU's Zotero group to gain access to and share literature on the potential ecological impacts of wave energy development.

Marine Spatial Planning and Leasing Resources:

Oregon Ocean Information
A resource for planning in the Oregon Territorial Sea.

National Oceanic and Atmospheric Administration (NOAA) - Coastal and Marine Spatial Planning
NOAA's website with data and information about a national framework for marine spatial planning.

BOEM's Marine Cadastre
The Multipurpose Marine Cadastre (MMC) is an integrated marine information system that provides jurisdictional, legal, physical, ecological, and human use data in a common geographic information system (GIS) framework. The MMC was designed specifically to support renewable energy siting on the U.S. Outer Continental Shelf but is also being used for various other ocean-related efforts.

International Resources:

SuperGen Wind
The SUPERGEN Wind Energy Technologies Consortium (SUPERGEN Wind) is a UK wind energy research consortium which was established by the EPSRC on 23 March 2006 as part of the Sustainable Power Generation and Supply (SUPERGEN) programme.

Other Resources and RSS Feeds:

Energy and the Environment - A Coastal Perspective
A student research blog with information about ocean energy generating technologies and their environmental impacts.

Figure 10: Draft content for an “Oregon” web page as part of the Northwest National Marine Renewable Energy Center (NNMREC) website. Users will be able to link to this page from the “Ecological Effects” landing page.

stop resource for finding information on potential ecological effects of wave energy development. This webpage should include links to websites with literature, marine spatial planning and leasing resources, international resources, and other resources and RSS feeds (Figure 10).

This webpage is a good location to include information about the NNMREC Zotero database that resulted from this project (see Section 5.2). This section gives information about who to contact to be invited to become part of the Zotero database group.

5.2 Literature database maintenance and sharing

One goal of this project was to search for available information about potential ecological effects of marine renewable energy development and create a database of this information. The literature is currently available

in both an EndNote database as well as a Zotero database and covers information that stakeholders want. Zotero is a web-based tool that allows users to collect, cite, and share research and literature sources. It is an effective, free way to store and share information because it is easy to update, and allows members of the group to view all of the literature without continually sending updated files to members.

The literature as a result of this project is currently part of a Zotero group, and other stakeholders can, and should, be invited to be a part of this group. NNMREC should start by inviting the interview participants for this project, as well as other stakeholders involved in wave energy development in Oregon.

It will be important to note when sharing information, that certain files are not available for the public, such as scholarly journal publications. Therefore, two Zotero databases should be made available, one that includes information available to the public, and one that is available internally within NNMREC and academic institutions that have access and permission to view this type of literature.

5.3 Information synthesis

Many stakeholders indicated that they like to receive information in a synthesized form, such as fact sheets and conference presentations and proceedings. As NNMREC releases new information about potential ecological effects of wave energy development, the principal investigators of the research or a designated staff member should create a short synthesis of the information, and make it available to stakeholders. When a new synthesis is created, it can be shared through the NNMREC website and other NNMREC outlets for information sharing.

Additionally, NNMREC staff should synthesize current information on topics with significant literature and high interest, such as fish and fisheries, new structure/artificial habitat, and sound and acoustics. Each new synthesis can be added to the website to meet current stakeholder needs for information on these topics.

5.4 Social media as communication outlets

During the stakeholder interviews and surveys, respondents indicated that even though they may not trust a source of information, they visit it. For example, 71% of respondents indicated that they visit media outlets often or very often, whereas on 28% of respondents said they trust media outlets. A quarter to a third of respondents visits blogs and social networking sites for information about potential ecological effects of wave energy development. In contrast, only 8% and 4% of respondents trust blogs and social networking sites. NNMREC should investigate how to effectively use media outlets to publicize a topic or specific piece of information, and then link to the NNMREC website, a trusted source. The NNMREC website should be the main source of information, with multiple communication outlets including the media, social networking sites (Twitter, Facebook), and blogs as a way to share information. This strategy would promote NNMREC as a hub of strategic information based on stakeholder demands as a result of this project.

5.5 Staffing website maintenance and information sharing

NNMREC needs to have a staff person dedicated to information sharing and website maintenance. A graduate student research assistant could staff this position. The duties would include:

- Maintaining and refreshing website content;
- Creating synthesis reports;

- Searching and managing literature on the ecological effects of wave energy;
- Sharing and promoting information using multiple communication outlets.

6.0 Conclusions

There is currently a lack of information sources on the potential and actual ecological effects of marine renewable energy development in the Pacific Northwest. The available information is scattered and time consuming to discover. Not all is available to all those interested given copyright and intellectual property issues. NNMREC has an opportunity to assume a unique role in organizing and communicating information through the NNMREC website. Stakeholders representing many different organizations, agencies, and governments would trust NNMREC to provide access to the information that they demand, and would expect them to do so in a timely fashion.

Oregon's current marine spatial planning effort is concluding with the revised Territorial Sea Plan. Yet, wave energy development remains contentious in terms of siting and the unknowns of ecological effects. The flow of information about potential and actual effects remains critical to reaching compromise as well as developing a robust plan. NNMREC's implementation of the recommendations outlined above would help management and policy decisions by making information available and easily accessible to stakeholders involved in future decision-making processes about wave energy development.

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8.0 Appendices

8.1 Interview Questions

This document will be used as a way to guide discussion during the formal interview with stakeholders. The lettered lists are there to guide discussion, and will not be listed as part of the interview. Following the interview so as not to influence interview responses, the participants will be shown the survey to make suggestions about word choice, to ensure that the questions will best capture the desired information.

Please describe your involvement with marine renewable energy development.

How often are you in need of information about the ecological effects of marine renewable energy?

Are you currently in need of information about ecological effects of marine renewable energy, or will you be in need of this information in the future?

Why do you need information on potential ecological effects of marine renewable energy?

Do you need the information to determine what type of research should be funded?

Do you need the information to determine what type of research is required?

Do you need the information to determine what kind of research needs to be conducted?

Where do you go to search for information about the ecological effects of marine renewable energy?

Academic institutional websites

State and federal agency website

Blogs

Attend conferences

Conference proceedings

Industry websites

Scholarly journals

Media (newspapers, tv)

Magazines

Social networking sites

Ideally, how would you find or receive information about the ecological effects of marine renewable energy? Are there any limitations for you to receive this information?

Are you interested in any specific geographic area? It can be as broad or as specific as you like.

What type of information do you need?

Baseline observations

Scientific observations of environmental effects

Case studies

Models

Literature reviews

Environmental effects statements and regulatory reports

What format do you prefer for receiving this type of information?

Maps

Species lists

Excel spreadsheets of data

Reports

Scientific literature

White papers

Summary of information

Are there any stressors, in particular, that you are interested in?

Sound and Acoustics

Electromagnetic fields (EMF)

Collision (devices with wildlife)

Collision (maintenance ships with wildlife)

Visual appearance (lighting, change of view)

Construction/maintenance/physical presence of devices (physical changes to wave period/height)

Construction/maintenance/physical presence of devices (sediment transport)

New structure (artificial habitat)

Chemical interactions (including pollution)

Human dimension, social interactions

Are there any specific habitats, in particular, that you are interested in?

Benthic

Pelagic

Rocky shores

Deep ocean

Intertidal zone

Estuary

Are there any specific organisms or groups of organisms that you are interested in?

Marine Mammals (any in particular?)

Birds

Electrosensitive species (fish, sharks/rays)

Migratory species

Others?

Are there any particular people, groups, organizations, or companies that have information on potential ecological effects of marine renewable energy?

Are there any particular people, groups, organizations, or companies that you would like to hear from with information on potential ecological effects of marine renewable energy?

Is there any additional information you would like to share about your information needs on potential ecological effects of marine renewable energy?

8.2 Survey Questions

****This survey was entered in to Qualtrics, an online survey tool.****

The following message was sent requesting participation in the web-based survey.

Dear (insert name),

Attached you will find a letter introducing the project, “Assessing and Addressing Information Needs of Stakeholders Involved in Marine Renewable Energy and Marine Spatial Planning.” The purpose of the project is to have a better understanding of the information needs of different stakeholder groups about potential ecological effects of marine renewable energy. The end goal is to create an effective communication system to share information on this subject across stakeholder groups. Please review the enclosed letter, and let me know of your interest and availability at your earliest convenience.

Sincerely,

Kate Sherman
Graduate Research Assistant
Hatfield Marine Science Center / Oregon State University Libraries

The survey had a preface page and then launched into a the series of questions.

The following survey seeks to gauge your interest in learning about potential ecological impacts of marine renewable energy devices. The purpose of the survey is to learn about what types of information most interest you, as well as what sources of information you trust. The survey will take approximately ten minutes. We appreciate your participation in this survey.

1. Do you have a need for information on potential environmental effects of marine renewable energy?

-Yes.

-No (skip to question 10).

2. How often are you in need of information on potential ecological effects of marine renewable energy?

-More than once a day

-Once a day

-More than once a week

-Once a week

-A few times a month

-Once a month

-Once a year or less

COMMENT BOX

For questions 3-9, check the box under the best choice for the categories listed. Please rate every category listed in each question.

3. Where are you likely to go to find **trusted** information on potential environmental effects of marine renewable energy?

Very Likely

Somewhat likely

Not likely

- Academic institutional websites
 - State and federal agency website
 - Blogs
 - Attend conferences
 - Conference proceedings
 - Industry websites
 - Scholarly journals
 - Media (newspapers, tv)
 - Magazines
 - Social networking sites
 - Other (fill in the blank)
- COMMENT BOX

4. What is your preferred method for **finding** or **receiving** reliable information on potential environmental effects of marine renewable energy?

Most Preferred Neutral

Not Preferred

- Up-to-date website
 - Email / Listserv announcements
 - Newsletters (online)
 - Scholarly journal subscription
 - Videos/Audio documentaries
 - Webinars
 - Conferences
 - Media (newspapers, tv)
 - Blogs
 - Facebook, twitter, other social networking site
 - Other (fill in the blank)
- COMMENT BOX

5. To what extent do the following statements describe your limitations, if any, to accessing information on potential environmental effects of marine renewable energy?

Very True

Neutral

Not True

- I do not have **time** to search for this information

- I do not have **access** to trusted information
- The information I need is **not available**
- I do not **trust** available information

COMMENT BOX

6. What geographic area with information are you interested in?

Very Interested Somewhat Interested Not Interested

- Specific sites within Oregon (please list in comment box below)
- Any place in Oregon
- The Pacific Northwest
- The west coast of the United States
- Anywhere in the United States
- Global information

7. What types of information are you interested in?

Very Interested Somewhat Interested Not Interested

- Baseline observations
- Scientific observations of environmental effects
- Case studies
- Models
- Literature reviews
- Environmental impacts statements and regulatory reports

COMMENT BOX

8. What categories of potential stressors caused by marine renewable energy devices are you most interested in?

Very Interested Somewhat Interested Not Interested

- Sound and Acoustics
- Electromagnetic fields (EMF)
- Collision (devices with wildlife)
- Collision (maintenance ships with wildlife)
- Visual appearance (lighting, change of view)
- Construction/maintenance/physical presence of devices (physical changes to wave period/wave height)
- Construction/maintenance of devices/physical presence of devices (sediment transport)
- New structure (artificial habitat)
- Chemical interactions (including pollution)
- Human dimension, social interactions
- Other

COMMENT BOX

Marine renewable energy devices may interact with various habitats, wildlife and organisms. The following questions seek to determine your interest in the interactions between marine renewable energy devices and each habitat, wildlife and organism.

9. In general, which habitats are you interested in?

- | | Very Interested | Somewhat Interested | Not Interested |
|------------------------------------|-----------------|---------------------|----------------|
| -Benthic (seafloor) | | | |
| -Pelagic (water column/open ocean) | | | |
| -Rocky shores | | | |
| -Deep ocean | | | |
| -Intertidal zone | | | |
| -Estuary | | | |
| -Other (fill in comment box) | | | |
| COMMENT BOX | | | |

10. In general, what type of organisms and wildlife are you interested in?

- | | Very Interested | Somewhat Interested | Not Interested |
|------------------------------|-----------------|---------------------|----------------|
| -Fish | | | |
| -Marine mammals | | | |
| -Sharks/rays | | | |
| -Turtles | | | |
| -Marine birds | | | |
| -Invertebrates | | | |
| -Corals | | | |
| -Other (fill in comment box) | | | |
| COMMENT BOX | | | |

11. What stakeholder group best describes you/your organization?

- Academic institution
- Non-profit/Advocacy group
- Non-extractive recreational ocean user (example: surfing, scuba-diving, sailing)
- Recreational fishing
- Commercial fishing
- Commercial ocean user
- Engineer
- Port/Harbor master/director
- State agency
- Federal agency
- Local government
- State government
- Federal government
- Tribal government
- Other (fill in comment box)

COMMENT BOX

13. Contact Information

NAME

AFFILIATION

CITY

STATE

EMAIL

TELEPHONE

12. Any other comments (COMMENT BOX)

8.3 Resources for Monitoring Information and Published Literature

RSS Feeds

- Oregon Wave Energy Trust (<http://www.oregonwave.org/>)
- Marine Cadastre (<http://www.marinecadastre.gov/Updates/default.aspx>)
- Department of Energy – Energy Citations Database (<http://www.osti.gov/energycitations/alertlogon.jsp>)
- Oregon Ocean Information (<http://oregonocean.info/>)

Websites

- Ocean Renewable Energy (<http://www.oceanrenewableenergy.com/>)
- Environmental Reports – Horns Rev Offshore Wind Farm (<http://www.hornsrev.dk/Engelsk/Miljoeforhold/uk-rapporter.htm#Impact%20Assessment>)
- Orkney Wave Farm Projects (<http://www.eon-uk.com/generation/OrkneyWaters.aspx>)
- Tethys (http://mhk.pnnl.gov/wiki/index.php/Tethys_Home)
- MHK Knowledgebase (<http://www.advancedh2opower.com/default.aspx>)
- BOEMRE OCS Renewable Energy and Alternative Use Program (http://www.boemre.gov/eppd/sciences/data/database/MMS_default.asp)
- OCS MRE leasing and EIS (<http://ocsenergy.anl.gov/guide/links/index.cfm>)
- Northwest National Marine Renewable Energy Center – Washington (<http://depts.washington.edu/nnmrec/>)
- Ireland (http://www.seai.ie/Renewables/Ocean_Energy/Foreshore_Lease_Consultation/AMETS_Foreshore_Lease_Application_-_Documents.html)
- Portugal: (<http://www.wavec.org/index.php/39/papers/>)
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- Idaho National Laboratory: conference proceedings, including presentations: (http://hydropower.inel.gov/hydrokinetic_wave/index.shtml)
- Northwest Power and Conservation Council (<http://www.nwcouncil.org/library/2010/2010-08.htm>)
- SuperGen Wind Farm (<http://www.supergen-wind.org.uk/publications.html>)
- Cefas (<http://www.cefas.defra.gov.uk/our-science/assessing-human-impacts/offshore-renewable-energy.aspx?RedirectMessage=true>)
- OSPAR Commission (http://qsr2010.ospar.org/en/ch09_03.html)
- Atlantic States Marine Fisheries Commission (<http://www.asmf.org/>)
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