Pacific Region Marine Renewables Environmental Regulatory Workshop Report

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On behalf of Oregon Wave Energy Trust

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Oregon Wave Energy Trust (OWET) is a nonprofit public-private partnership funded by the Oregon Innovation Council. Its mission is to support the responsible development of wave energy in Oregon. OWET emphasizes an inclusive, collaborative model to ensure that Oregon maintains its competitive advantage and maximizes the economic development and environmental potential of this emerging industry. Our work includes stakeholder outreach and education, policy development, environmental assessment, applied research and market development.

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On behalf of Oregon Wave Energy Trust
Oregon Wave Energy Trust/ Pacific Offshore Energy Trust
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Summary

The Pacific Region Marine Renewables Environmental Regulatory Workshop was held in conjunction with the 11th Annual Ocean Renewable Energy Conference in Portland, Oregon, on September 21, 2016 in response to frustrations and concerns expressed by members of the marine renewable energy (MRE) industry about permitting processes for MRE development being long, drawn out, challenging, and expensive, even for very small devices and pilot-scale deployments.

The workshop participants included federal and state regulators, MHK developers, and researchers. Two documents—*Annex IV 2016 State of the Science Report* and *A Review of the Environmental Impacts for Marine Hydrokinetic Projects to Inform Regulatory Permitting: Summary Findings from the 2015 Workshop on Marine Hydrokinetic Technologies, Washington D.C.*—were presented to the participants. Estimates of the perceived risks to the marine environment ("dashboards") for six key interactions were also presented and discussed.

Acknowledgments

We thank Jason Busch and his staff at OWET/POET (Oregon Wave Energy Trust/Pacific Offshore Energy Trust) for supporting and encouraging us to present this workshop. All the panelists and participants at the September 2016 OWET workshop provided great insight into the dashboards, and helped keep us on track. We are grateful to Mikaela Freeman for improving the dashboards and for the editing assistance of Susan Ennor, both of Pacific Northwest National Laboratory. We also thank the U.S. Department of Energy (DOE) Water Power Technologies Office for sponsorship that laid the basis for this work, and for the many fruitful discussions with DOE staff, particularly Jocelyn Brown-Saracino, Hoyt Battey, and Samantha Eaves.

Acronyms and Abbreviations

BIMEP	Biscay Marine Energy Platform
BOEM	Bureau of Ocean Energy Management
DOE	U.S. Department of Energy
EMF	electromagnetic fields
MHK	marine and hydrokinetic
MRE	marine renewable energy
MSP	marine spatial planning
NOAA	National Oceanic and Atmospheric Administration
NREL	National Renewable Energy Laboratory
ORPC	Ocean Renewable Power Company
OWET	Oregon Wave Energy Trust
POET	Pacific Ocean Energy Trust
WEC	wave energy converter
WETS	Wave Energy Test Site

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1.0 Introduction

The Pacific Region Marine Renewables Environmental Regulatory Workshop was held in conjunction with the 11th Annual Ocean Renewable Energy Conference in Portland, Oregon, on September 21, 2016. Hosted by the Oregon Wave Energy Trust (OWET) and the Pacific Ocean Energy Trust (POET), the workshop highlighted the publication of two documents that address potential environmental effects from marine renewable energy (MRE) development, and that provide scientific support for permitting MRE development in the west coast region. The workshop was led by Andrea Copping of Pacific Northwest National Laboratory and Sharon Kramer of H. T. Harvey & Associates. The two documents—*Annex IV 2016 State of the Science Report* and *A Review of the Environmental Impacts for Marine Hydrokinetic Projects to Inform Regulatory Permitting: Summary Findings from the 2015 Workshop on Marine Hydrokinetic Technologies, Washington D.C.*—were presented to the participants. Estimates of the perceived risks to the marine environment ("dashboards") for six key interactions were also presented and discussed by the workshop leaders.

The workshop brought together a panel of federal and state regulators and a panel of MRE applicants to discuss their experiences, hopes, and concerns about the environmental regulatory process for MRE project development in the United States. Three guest speakers at the workshop provided insight into the current state of environmental research and development for MRE.

This report captures the key messages and summarizes discussions from the workshop, and sets the stage for taking additional steps to further understand, communicate, and optimize understanding of the environmental effects of MRE to support permitting and facilitate the development of the MRE industry.

1.1 Need for the Workshop

The workshop was devised by OWET/POET in response to frustrations and concerns expressed by members of the MRE industry about permitting processes for MRE development being long, drawn out, challenging, and expensive, even for very small devices and pilot-scale deployments.

MRE development represents a new use of ocean space and the use of new and relatively unknown technologies, so it is difficult for regulators and the resource managers who advise them to readily determine the level of risk associated with key interactions of devices with marine animals, habitats, and ecosystem processes. In the absence of definitive proof of no environmental effects, and lacking significant data for analysis, regulators are cautious and tend to ask for considerable baseline assessment and post-installation effects monitoring data. The requests for data and the conservative approach taken by regulators require that the wave and tidal industry invest significant resources in studies, data collection, and analysis that lead to multi-year permitting processes. Delays in permitting and monitoring requirements are thought to jeopardize the development of the technologies and cause uncertainty and doubt in financing circles. Early deployments and research studies indicate few clear detrimental effects from device installation or operation; however, the significant uncertainty that remains drives regulatory concerns.

This workshop examined some of the most recent research findings and sought to establish open lines of communication among the regulatory, development, and research community about the environmental effects of MRE development as they relate to informing and improving the process for permitting and licensing projects.

1.2 Workshop Agenda

Jason Busch, Executive Director of the OWET and POET, introduced and explained the background of the workshop. He described how the U.S. MRE industry continues to be concerned about environmental permitting processes slowing the development of wave and tidal projects, and how greater engagement within the community of industry, regulators, and researchers can help accelerate the process for siting and permitting, and ensure that monitoring and mitigation requirements are commensurate with the risk to the marine environment.

Hoyt Battey from the DOE set the stage for participant engagement by introducing the DOE-sponsored efforts that led to the two key documents featured at the workshop, and by describing why the topic of environmental assessment and permitting is of importance to DOE and their efforts to support the MRE industry.

Sharon Kramer of H. T. Harvey & Associates presented the outcomes from a workshop held for regulators in 2015 entitled *A Review of the Environmental Impacts for Marine Hydrokinetic Projects to Inform Regulatory Permitting: Summary Findings from the 2015 Workshop on Marine Hydrokinetic Technologies, Washington D.C.* Andrea Copping of Pacific Northwest National Laboratory summarized the content of the *Annex IV 2016 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World*. She presented the draft dashboards for interactions of concern for MRE development.

Three guest speakers presented outcomes of research studies and industry perspectives, as follows:

- Ann Bull from the Bureau of Ocean Energy Management (BOEM) presented an overview of research on the potential effects of electromagnetic fields (EMFs) from export cables for MRE and offshore wind energy operations, including the results of three recent research studies sponsored by BOEM and DOE. The overall message is that EMF from alternating current cables is likely to be measureable only within close proximity to the cables, and has not been observed to cause deleterious harm to marine populations.
- Patrick Cross from the University of Hawaii presented the status of testing wave energy converters (WECs) at the Wave Energy Test Site (WETS) Navy/DOE test center off Oahu, and focused on the environmental baseline assessments and monitoring that they have performed as part of establishing the test center.
- John Ferland of the Ocean Renewable Power Company (ORPC) provided his perspective on the environmental studies and permitting processes the company engaged in to deploy their tidal energy devices off a barge and in open water in Cobscook Bay, Maine, and the beneficial learning from that project that allowed the company to simplify a river deployment in Alaska.

The panel of regulators included Keith Kirkendall with National Oceanic and Atmospheric Administration (NOAA) Fisheries, Ann Bull of BOEM, and Andy Lanier of the Oregon Department of Conservation and Land Development. Each provided his/her perspective on the portion of the permitting process under his/her jurisdiction, and discussed the need for collaboration and sharing of information early and often; the panel provided their feedback on the dashboards.

The panel of applicants included Patrick Cross of University of Hawaii and WETS, Justin Klure of Pacific Energy Ventures, Cherise Gaffney of Stoel-Rives, and John Ferland of ORPC. Each provided insight into his/her involvement in permitting projects, including what each saw as areas of concern for the industry and where he/she would like to see streamlining or improvements in the process; the panel provided their feedback on the dashboards.

The remainder of the workshop was a facilitated discussion led by Andrea Copping and Sharon Kramer to discuss the status of the dashboards, identify what was missing that might keep the dashboards from accurately representing the status of environmental understanding of MRE interactions with the marine environment, and consider additions or changes needed to improve the representation. The overall discussion was aimed at forging a pathway to allocating levels of risk to interactions, to retiring risks where feasible, and to providing monitoring and mitigation commensurate with those risks to the remaining risks.

2.0 State of the Science Report

The MRE industry worldwide is still in the early stages of development, deployment, and commercialization. In a new industry like MRE, there may be interactions between devices and marine animals or habitats that regulators or stakeholders perceive as risky. In many instances, this perception of risk is due to the high degree of uncertainty that results from a paucity of data collected in the ocean. However, the possibility of real risk to marine animals or habitats cannot be discounted; the lack of data that informs risk continues to confound our ability to differentiate between real and perceived risks.

Ultimately, risk will be governed by a variety of factors that include the attributes of a particular device (static or dynamic), the type of device (wave or tidal), the spatial scale of a particular installation (single device or arrays), and the form of the interaction (e.g., whether it may result in injury or fatality or have indirect effects). As the MRE industry continues to develop, it is important to acknowledge all potential mechanisms of harm these technologies may pose to the marine environment, even though many of the perceived risks are likely to be small and easily avoided or mitigated. Additional strategic research investments will likely help to minimize uncertainty and elucidate actual risk. Most interactions and associated risks from single devices are unlikely to harm the marine environment; as larger arrays are deployed, additional monitoring and strategic research may be required to prepare for the commercial development of the industry.

Studies to date have shown that most of the perceived risk to animals from MRE devices is due to uncertainty about the interactions because of the lack of definitive data, and continue to present challenges to permitting/consenting of commercial-scale development.

The best information available has been gathered and is summarized for the key interactions in the following sections.

2.1 Collision Risk for Tidal and River Turbines

Animals considered to be at potential risk include marine mammals, fish, and diving seabirds. No marine mammal or seabird has been observed to collide with a device, and no harm to fish from interactions with devices has been observed. Environmental technologies needed to observe collision are not well developed and are difficult to operate in high-energy environments. In addition, collision of animals with turbines is likely to be very rare, making it particularly difficult to ensure the event will be observed. It is important to quantitatively estimate the number of animals potentially in the area of turbines, and to understand their capability to sense and evade devices. Studies of potential collisions with turbines are estimated for individual animals, but it is most important to be able to place such collision this in the context of risk to the populations of animals.

2.2 Electromagnetic Fields from Cables and Energized Devices

EMFs from power export cables and energized parts of devices can add to naturally occurring magnetic fields and have the potential to disturb certain marine animals. Some marine animals, including some elasmobranchs and invertebrates, are known to be electro- or magneto-sensitive and could be disturbed by EMFs from MRE devices. Power cables will generally be buried, effectively keeping animals from exposure to higher levels of EMF that occur close to the cables. Most studies to date have focused on behavioral responses of animals to EMFs. Laboratory and field studies have shown no evidence that EMFs, at the levels expected from MRE devices, will have an effect on marine species. Power cables and telecommunication cables are already abundant in the marine environment; no adverse effects of these cables have been documented to date.

2.3 Acoustic Output from Devices (Wave and Tidal)

Marine animals use underwater sound as terrestrial animals use light to see, especially for navigation and communication. Sound from MRE devices may add to other anthropogenic sounds and could diminish animals' abilities to respond normally to their environment, especially marine mammals and fish. Noise from single turbines and WECs is being measured, and predictions can be made about what arrays may sound like to marine animals. Excess underwater noise could cause physical harm to animals near the devices, including loss of hearing ability, physical harm to tissues, and/or behavioral changes. Additional data are needed to understand how sounds from devices may affect animals.

2.4 Changes in the Physical Environment (from Changes in Flow and Removal of Energy)

Placement of MRE devices in the oceans can change circulation and remove energy from the system, as well as potentially change patterns of sediment movement. The amount of change that will occur from single devices or small arrays is likely to be immeasurably small and localized. Numerical models suggest that changes may be measureable only with the operation of very large arrays that are probably too large to be realistically considered for most waterbodies.

2.5 Changes in Habitats (Benthic Communities and Attraction of Organisms)

MRE devices can change the bottom habitats by disturbing sediments under their foundations, as well as around anchors and mooring lines. Devices will attract fish and invertebrates that will remain around the parts of the devices and mooring systems. No evidence collected to date shows that significant negative effects will occur to benthic areas around MRE developments, or that the attraction of marine animals to devices will harm populations of those animals. Some research suggests that fish and other organisms around underwater structures (e.g., artificial reefs) could provide some ecological benefit to some species; deleterious effects are also possible if installations function as stepping stones for invasive species.

2.6 Marine Spatial Planning and the Role of MRE

Marine spatial planning (MSP) involves planning and managing sea uses and users to support sustainable development of marine areas. Annex IV representatives were surveyed about use of MSP in their nations. Several nations have formal MSP processes, others have coastal management plans that embody principles of MSP, and several have no MSP in place. MSP must use a stable and transparent planning system for maritime activities and users within agreed environmental limits, working across multiple sectors, including the MRE industry.

2.7 Case Studies of Consenting (Permitting) Processes

Four consenting processes were reviewed: WaveRoller wave technology installed in Portugal; TidGen® Power System tidal technology installed in the United States; SeaGen tidal technology installed in Northern Ireland; and BIMEP (Biscay Marine Energy Platform), a designated wave test site in the Basque country, Spain. Reviewers found that projects tend to achieve success by carrying out strong stakeholder outreach throughout the process, and developing robust monitoring plans, adaptive management strategies, and a sound Environmental Impact Assessment. At present, there are no dedicated federal policies that streamline development of wave and tidal projects.

2.8 A Path Forward for Resolving Environmental Risk

Interactions with MRE devices are perceived to be risky, largely due to uncertainty. Additional information will help to retire insignificant risks, while other risks may be determined to need mitigation. Regardless, monitoring requirements will likely be reduced as we learn more. There are no methods for monitoring certain interactions now; these will require strategic research investments to move forward.

3.0 Report on the Marine and Hydrokinetic Regulator Workshop

The Marine and Hydrokinetic (MHK) Regulator Workshop, held in Washington, D.C. in May 2015, engaged resource managers from key regulatory agencies, scientists, researchers, facilitators, and technical experts and provided an opportunity to examine the risks of single-device and small-scale deployments. Workshop participants explored what can be learned and observed from single devices and small-scale arrays, considered the environmental information needed to satisfy permitting requirements for projects at varying scales of deployment, and identified key remaining information gaps. Initial discussions focused on differentiating between required monitoring and MHK impact research for single or small-scale deployments. It was concluded that the research, although important and useful, may go beyond what is feasible or should be required to meet specific project regulatory requirements.

Four areas of potential environmental impacts provided the focus for the workshop: acoustic output impacts, EMF emissions, physical interactions, and effects of MHK energy installations on the physical environment. The workshop presenters were asked to address these topics using three levels to reflect our current understanding of the potential environmental impacts:

- "Known Known" topics were identified issues that the science community wants to continue to gather information about or issues that are understood well enough that no further monitoring is warranted.
- "Known Unknowns" topics were identified issues for which the research community has the knowledge and technology to study but for which the impact and cost of a study are uncertain.
- "Unknown Unknowns" topics were issues that have not been widely assessed, and for which it needs to be determined whether further study of the issue is warranted to make it better known.

For issues that should be studied further, presenters discussed when and how to address the issue and whether the technology exists to study it effectively. Key findings included the following:

- Acoustic Impacts. Information collected to date about small projects indicates that operational devices are typically less noisy than other anthropogenic sources and that monitoring is generally not warranted because significant acoustic impacts are unlikely and may not be distinguishable from background noise. However, research data from demonstration-scale MHK projects are needed to inform modeling for larger-scale arrays, and more research on the biological and behavioral implications of sound and particle motion may be important.
- EMFs. No significant effects on organisms have been observed to date from small- or demonstration-scale projects, and monitoring is generally not warranted because EMFs are likely to be of low intensity and approach background levels within a few meters from the source. EMF emissions are scalable as power and voltages increase, but the responses of any receptive animals are not; thus, research on single devices or small-scale arrays may not be directly transferable to larger-scale projects. Also, existing energy subsea cables can be used to assess EMF levels and animal behavioral responses.
- Physical interactions (strike): No physical interactions have been observed in the field for small- or demonstration-scale tidal projects. Lab experiments have found that fish can detect and avoid or swim around turbines and have very high survival rates when forced to pass through turbines. Any required monitoring should be based on a quantitative risk assessment determined for the project of interest and should consider that strike events are likely to be extremely rare, difficult to detect, and very costly to monitor. For larger-scale projects, research to better understand the risk of strike and development of predictive models (e.g., location in the water column relative to the device, avoidance and evasion behaviors) and identification of potential mitigation actions would be informative.
- Impacts on physical systems: Numerical modeling consistently predicts that arrays of <10 devices will have minimal impact on wave heights, flow patterns, and sediment transport. Monitoring is generally not warranted because the impacts from a single device or small arrays will likely be minimal. However, the impacts of larger arrays are unknown and will require more research, including data from future large arrays to validate predictive models.

4.0 Risk Profile Dashboards

A series of dashboards that represent the currently understood risk profile for key interactions between MRE development and the marine environment were developed and presented to workshop participants. Each dashboard (presented in the following sections) is represented by a dial that shows the level of environmental risk to be between low (green), medium (yellow), and high (red), as well as a series of bars that indicate the paths forward that can help reduce the current risk level. The purpose of the dashboards is to

- provide a means for discussing and achieving consensus around the state of knowledge for each interaction;
- demonstrate where each interaction falls on the continuum from low to high risk;
- indicate the mechanisms by which risk might be further reduced; and
- track the reduction in risk for each interaction over time.

The goal of displaying the dashboards is to represent each risk as

- green or low risk that may be approaching discountable or retired from investigation for subsequent MRE projects;
- yellow or medium risk that may be further reduced to green (low risk) with additional monitoring and/or strategic research studies; or
- red or high risk that may require mitigation unless the risk can be further reduced.

With the goal of eventually moving each of the major stressors identified into the low-risk category (or in some cases identifying the need for ongoing mitigation of higher risks), four strategies were identified and incorporated into the dashboards:

1. Increase sharing of existing information. Sufficient information exists to describe and bound the risk that can be used to help to clarify the effect of the stressor. With further sharing of this information broadly among regulators, stakeholders, and developers, the level of environmental risk may be reduced.
2. Improve modeling of the interaction. As additional data on the stressor become available, effort is needed to model the stressor receptor interactions, thereby allowing for a better understanding of the level of risk and minimizing the need to collect similar data at every project site.
3. Acquire the monitoring data needed to verify findings. Additional data need to be collected around deployed devices and arrays to better describe and bound the effects of the stressor, and to validate and verify numerical models of the stressor effects.
4. Conduct the new research needed. At present there are outstanding questions that can only be solved by directly addressing the processes by which the stressor may be affecting marine animals and habitats.

These dashboards represent the understanding of the MRE community at the time of the workshop (September 2016). The dashboards are meant to document the current state of knowledge, and should be updated as additional monitoring data, research findings, or other new information become available and our collective understanding progresses.

4.1 Acoustic Output (Noise)

Although the ability to measure the acoustic output from single tidal turbines and WECs has improved, and the likely acoustic output from arrays can be modeled, the paucity of data on the reaction of marine animals (largely marine mammals and fish) indicates that the risk remains medium (yellow). Increased sharing of existing information can help to place this risk in proper context, but there is a strong need for monitoring of animal behavior around deployed devices to better understand the effects, and to drive development of improved models of animal reactions. In addition, new research and sensor development are needed to enable monitoring at sea (Figure 1).

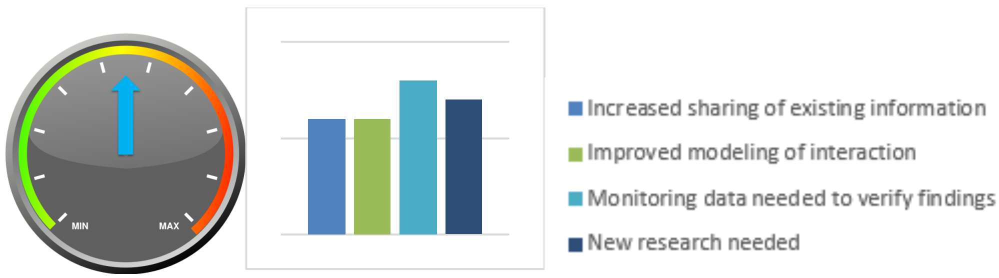

Figure 1. Dashboard of Acoustic Output (Noise) Effects on Marine Animals

4.2 Electromagnetic Fields

Information from surrogates for MRE power export cables, such as existing subsea power cables and telecom cables, as well as the ability to bury and effectively shield the environment from these cables, help to make EMF emissions a relatively low risk. However, the potential for EMF effects from devices and cables draped in the water column between and among devices prevents this risk from being retired. Currently understood effects of EMF on marine organisms need to be broadly shared, and improved models driven by monitoring data collected around deployed devices are needed to move this risk toward retirement. While research on specific effects on particular benthic or pelagic marine animals may help elucidate specific effects, generally this is not an important target for priority research (Figure 2).

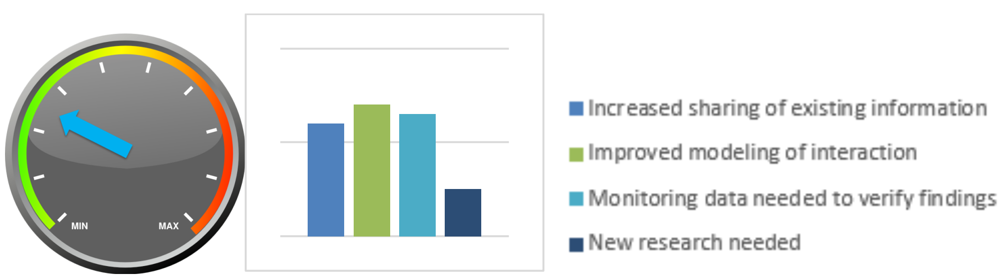

Figure 2. Effects of Electromagnetic Fields on Marine Animals

4.3 Physical Changes (Energy Removal and Changes in Flow)

Modeling studies of the potential effects of changes in flow and energy removal from single devices and small arrays point to physical changes being of small importance to waterbodies where tidal energy production is anticipated, or along open coastlines where WEC deployment will harvest wave energy. Existing knowledge needs to be made widely available to ensure this understanding (Figure 3). In addition, as larger arrays are developed, modeling potential deleterious effects and collection of data for validation will be needed.

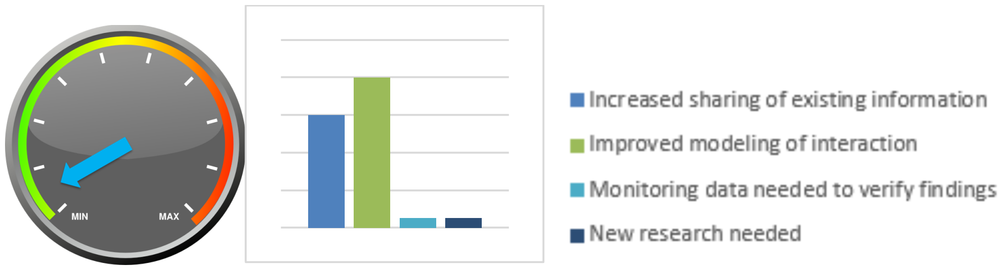

Figure 3. Physical Changes (Energy Removal and Changes in Flow)

4.4 Changes in Habitats/Attraction of Organisms to Artificial Reefs

The small footprint of wave or tidal devices on the seafloor, provided appropriate siting practices have been followed, ensures that the changes to the benthic communities are likely to be highly localized. The presence of hard, vertical relief in the form of an MRE installation in an otherwise rather structureless ocean almost ensures that fish and other organisms will congregate around them; however, no direct or indirect mechanism of harm to the organisms has been demonstrated. Many surrogate devices, such as buoys, pilings, and artificial reefs, help to demonstrate this interaction is a very low risk. Sharing of continuing research on artificial reefs generally is needed and should help to ensure that this risk is understood. The potential for a stepping stone effect, linking discontinuous reef habitat, and facilitating or enhancing the dispersal of reef-dependent organisms also needs further study (Figure 4).

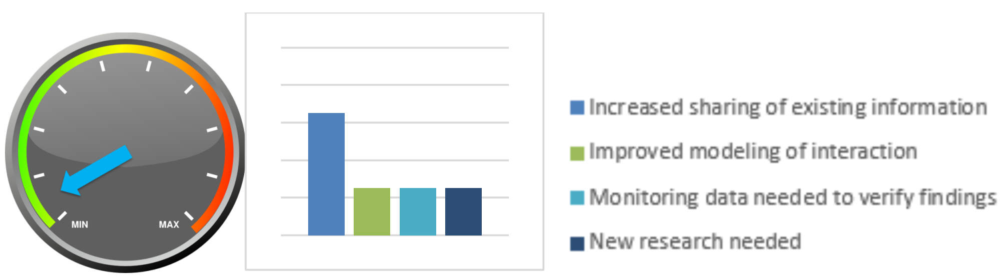

Figure 4. Changes in Habitats/Attraction of Organisms to Artificial Reefs

4.5 Collision Risk – Tidal

Observations of marine animals around tidal turbines is extremely challenging. There are no appropriate surrogates with which to estimate the risk, which leads to regulatory agencies concerns that collision continues to be a high risk for individual devices and arrays. Sharing of existing information is needed, but the best paths forward for lowering this risk involve the collection of data around deployed devices, and the examination of existing collision risk models (and possible development of new risk models), validated with field data. Research is needed to better direct modeling efforts and to develop and apply technologies to measure the interactions of marine animals with turbines. Until this risk can be decreased significantly, mitigation may be required to ensure the safety of marine animals. Much of the risk is attributable to the lack of good information; the risk is likely to be reduced significantly as our knowledge base increases (Figure 5).

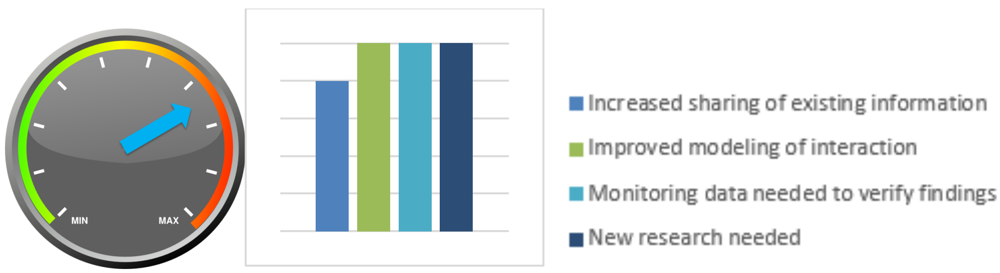

Figure 5. Collision Risk (Tidal)

4.6 Entanglement/Debris

MRE devices that are moored to the seabed with lines, including many WECs and mid-water tidal turbines, are highly unlikely to entrap or entangle large marine mammals because these lines are expected to be under such tension that even a fast-swimming cetacean would be unable to create the loops or snarls necessary to become entangled. The associated level of risk is indicated by the dashboard Ecological Effects of Entanglement (Figure 6).

In addition, mooring lines may trap marine debris including fishing nets, lines, and traps. This debris on the lines could pose a threat to fish, sea birds, and marine mammals, based on our understanding of fishery gear and marine organism interactions, indicating a medium risk to marine life. Development of best practices guidelines for MHK maintenance and agency regulations on monitoring for and removing debris from MHK installations is likely to reduce the risk from debris entanglement. Monitoring of deployed devices will be needed to estimate the risk of derelict gear. The associated level of risk is indicated by the dashboard Entanglement of Fishing Gear (Figure 7).

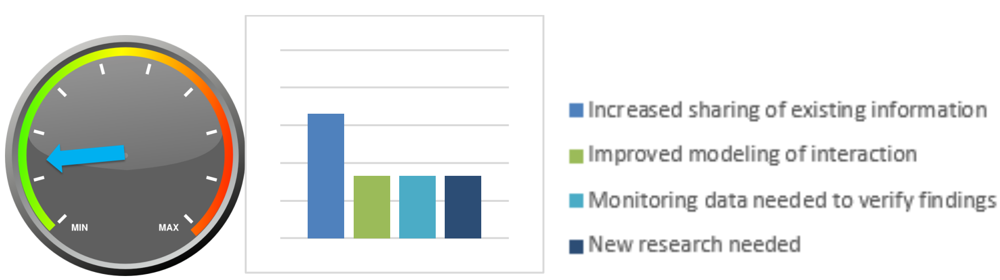

Figure 6. Ecological Effects of Entanglement

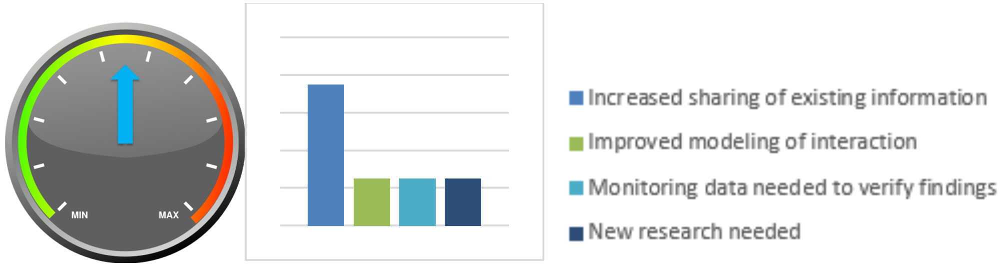

Figure 7. Entanglement of Fishing Gear

5.0 Regulators Panel

The regulators panel, comprising state and federal representatives, offered diverse perspectives of and experiences with MRE. Each of the panel participants highlighted the need for and value of collaboration and cooperation among agencies and permitting teams. For example, coordination between Federal Energy Regulatory Commission and BOEM would allow for efficient efforts to acquire a license and a lease at the same time. Activities such as the creation of networked programs, collaborative working groups, and implementation of MSP offer opportunities to streamline permitting of MRE projects. However, institutional capacity at resource agencies is a genuine challenge. Staffing issues (capacity, turnover, etc.) will affect how environmental risk is perceived and how issues are handled. The agency staff capacity issue may adversely affect the ability of agencies to respond as the pace of MRE development increases.

The participants noted that it will be critical to understand how MRE effects will scale from single devices to small arrays, and then to large commercial developments. In the past, there have been issues associated with a lack of monitoring and sharing data and information. The panelists saw the value of allocating public funds to data collection because doing so provides opportunities for ensuring that data are adequately collected and shared broadly. Collection of monitoring data is essential to determining the level of effect (e.g., injury, mortality, harm, harassment) on animals and habitats under the Endangered Species Act, the Marine Mammal Protection Act, and other statutes. From the industry perspective of the regulatory imperatives, the cost of environmental studies may seem to be out of proportion to the size of a project. The panelists debunked the common misunderstanding that studies showing no effect are of no use. Regulators need confirmation of low levels of effect and no effect to eliminate them as concerns. This could be construed as "retiring" risk.

Reaching consensus on defining biological effects and impacts on populations is a very real challenge. More needs to be done in terms of monitoring and research, including standardizing data collection methods, to help streamline regulatory evaluations. We are getting close to having this level of understanding for some but not all interactions between devices and the environment. Future efforts ought to focus on studies that will inform MRE technology development and allow devices to be engineered to lessen their potential effects on the environment (e.g., EMF and acoustics). The panelists felt that real-time monitoring offers good opportunities for understanding the interaction of devices with the environment, and could be useful for developing appropriate mitigation measures.

Overall, the regulators' responses to the dashboards indicated that they believed developing accepted approaches for standardizing data collection and transferability of data sets to other geographic locations will help identify trends in the level of risk associated with each priority interaction. In addition, the panel suggested that standardization of data collection and criteria that would allow transferability of data sets and results should be led by publicly funded agencies, such as DOE. Public funding of these aspects of data collection and analysis will prove beneficial to the industry, and will provide the regulators with consistent unbiased data upon which to base decisions. Working with the research community will help ensure that the most effective methods are used.

The regulators' responses to the dashboards were as follows:

- Acoustic Output. The regulators perceived that acoustic output of MRE devices is a fairly high risk and the current dashboards capture that perception. The existing acoustic standards (under NOAA jurisdiction) are complicated and additional research is needed to support understanding of the potential acoustic effects, particularly as the MRE industry begins to scale up to commercial-scale arrays. Some additional pieces of information would help to elucidate risk associated with noise; for example, a better understanding of the acoustic output of devices in relation to ambient noise would provide greater context for evaluating the risk. In addition, we need to understand the relative contributions of sound in the marine environment from MRE devices in comparision to those from other anthropogenic effects, such as oil and gas development. The dashboard must capture the biological implications of noise, including the mechanisms and implications for changes in animal behavior due to MRE acoustic output. The effects of noise on organisms and the mechanisms for evaluating instantaneous versus long-term risks need to be identified and modeled.
- Electromagnetic Fields. In general, the regulators suggested that additional monitoring of EMFs from cables is not necessary. There are currently few models that can be used for evaluating EMFs; improvements in modeling (as one of the pathways to reducing the risk) could be useful. It was acknowledged that while the regulators may be in agreement on this topic, stakeholders may not be. Existing information needs to be shared and disseminated more broadly. The scalability of EMFs has become increasingly important and predictions need to be verified as larger commercial arrays come on line.
- Physical Changes – Energy Removal and Changes in Flow. The regulators felt the dashboard fairly represented this topic. The difficulty in segregating the signal from the noise is particularly relevant at the array scale when larger, overarching environmental factors, such as changes in circulation and movement of sediment from climate change and erosion, may provide strong effects. Understanding sediment transport processes will become increasingly important as the number of devices and the size of arrays increase.
- Changes in Habitats/Artificial Reef. The regulators felt that there are numerous examples of changes in habitats and artificial reef effects to draw upon, but they could not discount that this issue might reappear with larger arrays. Potential changes in community structure and ecosystem-level changes may need to be explored, with particular attention given to examining potential risks and benefits of artificial reefs.
- Collision Risk. The regulators felt that collision constitutes a high risk for marine animals with tidal development. Sharing of information is critical to quantifying this level of risk and it was suggested that the associated bar on the dashboard be increased to capture this perception.
- Entanglement/Debris. The regulators felt that entanglement/debris are perceived as a significant issue of concern to the fishing industry, but there is no clear signal that they pose a significant ecological risk for MRE development. Moving forward, the MRE industry will need to collaborate with the local fishing communities. Good siting practices can probably help decrease some concerns, but modeling, data collection, and research may not significantly inform the interaction.

6.0 Applicants Panel

The applicants panel provided examples of the collaborative processes they have engaged in to obtain permits, as well as their experiences with interacting with the regulatory and resource agencies. In some cases, the need to collaborate with many agencies slowed the overall process, but the applicants did not necessarily perceive this slower pace as being harmful to the process. The applicants felt that pursuing many regulatory pathways in parallel with several regulatory and resource agencies (e.g., Federal Energy Regulatory Commission, BOEM, U.S. Army Corps of Engineers) helped to avoid potential pitfalls in the process, such as litigation.

The applicants panel felt they needed to be able to address and understand how much uncertainty around potential interactions with devices is allowable. For example, test facilities have many unknowns in terms of device types, footprints, duration of installation, etc. In the case of permitting the Pacific Marine Energy Center-South Energy Test Site (PMEC-SETS) project, there has been an inherent conflict between maintaining the flexibility needed to test unknown WEC designs in the future and the burden of assuming the maximum possible risks associated with interactions. Adaptive management is perceived to be a useful tool for addressing permitting situations that include high risk and high uncertainty.

The applicants noted a lack of consistency in applying permitting processes, largely driven by which individual within an agency is on point; this can lead to a lack of consistency and continuity within and among projects. It was also noted that laws and regulations are perceived to be applied differently in different regions; this differential exacerbates the complications for an emerging industry like MRE that requires a level of certainty to survive and expand. The applicants suggested that handling of uncertainty, as well as the acceptability of transferring environmental monitoring data sets from other locations and/or other industries, need to be addressed at a level above the regulatory staff reviewing projects. For some interactions that remain uncertain due to a paucity of data and/or extreme difficulty in monitoring interactions (e.g., collision), the applicants felt that it may be necessary to adjust policies to account for the uncertainties and provide opportunities for the MRE industry to move forward in a responsible manner.

The applicants' responses to the dashboards were as follows:

- Acoustic Output. The applicants panel felt that methodologies for measuring acoustic output of devices are well established.
- Electromagnetic Fields. The applicants felt that there are some continuing uncertainties about EMF output from the devices themselves, but that the risk from cables is well known. They felt that the risk from EMFs does not rise to the same level as issues and questions surrounding the potential risk from acoustic output from devices. In general, the applicants felt EMF is a low-risk topic, but there might be good value in funding a definitive study to close the gaps on any remaining questions.
- Physical Changes – Energy Removal and Changes in Flow. The applicants perceived physical changes as a low risk.
- Changes in Habitats/Artificial Reef. The applicants concurred that this topic is well covered by other industries and surrogates.
- Collision Risk – Tidal. The applicants were mostly well versed in wave energy development and felt they could not comment on this risk.
- Entanglement/Debris. The applicants concurred that this risk is for the most part associated with fishing concerns, and is therefore mostly a socioeconomic issue, rather than one that constitutes a significant risk to marine animals. The applicants suggested the level of risk represented by the

dashboard could be lower (greener) and that the most important factor moving forward is to share existing information.

7.0 Open Discussion

The workshop participants asked several clarifying questions and discussed their reactions to the dashboards.

The overall consensus was that the dial settings on the dashboards are a good indication of the level of investment needed for each topic, as well as the level of risk associated with each topic. It was noted that if we had cabled instrumentation, much of the work of data collection could be made more efficient and effective. Cabled instrument packages allow more data to be transmitted to shore for easier analysis, and they reduce dependency on data storage and power (battery) limits for instruments.

Some participants felt that the dashboard dials could differ for some interactions between wave and tidal development.

Specific issues concerning the dashboard and other relevant topics raised during the discussion were as follows:

- Acoustic output. The greatest missing piece in our understanding is the behavioral response of animals to noise from devices.
- Noise issues (along with entanglement) are the environmental issues of greatest concern for wave development.
- EMF. This issue might be one we can remove from serious consideration. It will require an investment; recent studies have helped to reduce uncertainties. Several participants felt that the investment in understanding the effects of EMF upfront would be a good idea.
- Entanglement. This risk is of particular concern for wave development off Oregon. The issue appears to be one of potential conflict with fishers rather than an environmental risk that threatens marine animals. Participants wondered if this risk (for direct entanglement) could be retired. Some information is available in a paper by Harnois et al. (2015).
- Test Centers. Considerable discussion centered around the role of test centers in helping to shift more of the dashboard dials into the green and to help retire some risks. The group hoped that, over the next five years, the test centers could take on the responsibility of being the location for data collection, testing, and resolution of many of the outstanding risks. Questions arose about how this might be paid for; in Scotland (and elsewhere) public funds are used to resolve common environmental issues, and developers shoulder some of the site-specific costs or those that are particular to their technologies.

  This led to further discussion about finding the funds for a developer to go to a test center being challenging—on the order of several million dollars—and it is not clear where the funds will come from over the next few years. Representatives of the test centers also weighed in, stating that they provide facilities, but they agree that answering research questions should not be the developers' responsibility. The test centers should and do advocate for research to take place. Currently, the model for funding work at the test center for monitoring and research comes from paying the berthing fees for testing, which can be supported with public funds (e.g., DOE or the Navy) or privately (as it is in Europe) by the developers.

- <u>Overall need for data collection and research</u>. Participants stated that developers and regulators both need environmental monitoring data, as well as strategic, focused research studies. Taken together, these efforts can help to resolve some common risks, and will be much more efficient, reliable, and reproducible than uncoordinated site-by-site monitoring. The participants felt that, as a community, we need to advocate to get these funds. There was a suggestion that the MRE community needs a lobbyist.

8.0 Next Steps

This report documents the workshop discussions and disseminates this information to the public through OWET/POET. The group agreed that conducting this workshop on an annual basis, in association with OWET/POET or other meetings, would be useful, and that it could be conducted regionally. OWET/POET has an interest in conducting an analogous workshop in California because offshore renewable energy is becoming of greater interest there.

When asked whether this workshop was useful, and what might be done better or again, the participants responded as follows:

- Overall the participants felt the workshop was highly valuable, that the progress that has been made, as articulated at this workshop, shows forward motion. Documentation of this work is very useful, and a larger set of the regulatory community and other constituencies needs to be reached.
- The participants suggested that a follow-up exchange would also be useful; e.g., perhaps holding a webinar every six months to update the dashboards with current research and monitoring findings, and provide an open forum for sharing challenges and potential solutions. They felt that there is a challenge in reaching the important audiences, because many of the key players were not present at this workshop.
- The regulatory participants noted that it was useful to hear from the developers and have them share their information and perspectives, because it provided opportunities for shared lessons learned. An example cited involved the methods for measuring acoustic emissions from devices that may provide insight into whether the device is operating within acceptable bounds, and information about a potential stressor on marine animals.
- Requests were made to circulate the attendance list for the workshop, which OWET committed to doing. Also, a request to make the workshop presentation material available was made; the materials will be posted on the *Tethys* (Tethys.pnnl.gov) online knowledge management system.
- A suggestion was made to update the short science summaries (one pagers) from the State of the Science report, and to incorporate the known, unknown-known, unknown-unknowns concept for these science summaries based on the MHK regulators workshop in 2015. It is not clear that this construct will work internationally.

9.0 References Cited

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