energies

Case Report

The Permitting, Licensing and Environmental Compliance Process: Lessons and Experiences within U.S. Marine Renewable Energy

Zachary Barr [1,*], Jesse Roberts [2], William Peplinski [2], Anna West [1], Sharon Kramer [3] and Craig Jones [4]

[1] Kearns & West, Inc., San Francisco, CA 94104, USA; awest@kearnswest.com
[2] Sandia National Laboratories, Albuquerque, NM 87123, USA; jdrober@sandia.gov (J.R.); wjpepli@sandia.gov (W.P.)
[3] H. T. Harvey & Associates, Arcata, CA 95521, USA; skramer@harveyecology.com
[4] Integral Consulting Inc., Santa Cruz, CA 95060, USA; cjones@integral-corp.com
* Correspondence: zbarr@kearnswest.com

Abstract: The marine renewable energy (MRE; renewable energy captured from waves, tides, ocean currents, the natural flow of water in rivers, and marine thermal gradients, without building new dams or diversions) industry has a vital role in the U.S. clean energy strategy as we progress to meet U.S. electricity and blue economy needs with renewable, domestic energy sources. However, a thorough assessment of the U.S. marine energy permitting process from the viewpoints of both developers that propose projects and regulators that permit them has not been performed. Sharing practical experiences in this new industry is vital to increase the efficiency and effectiveness of the permitting process, identify data and information gaps, develop lessons learned, and advance the industry. This paper is a case study of qualitative findings, lessons learned, and recommendations from guided discussions, workshops, and webinars with both marine renewable energy developers and state and federal regulators that have experience in the permitting process in the U.S.

Keywords: marine energy; lessons learned; permitting and licensing; marine hydrokinetic; wave; tidal; current

Citation: Barr, Z.; Roberts, J.; Peplinski, W.; West, A.; Kramer, S.; Jones, C. The Permitting, Licensing and Environmental Compliance Process: Lessons and Experiences within U.S. Marine Renewable Energy. *Energies* **2021**, *14*, 5048. https://doi.org/10.3390/en14165048

Academic Editors: Paula Fernández González, María José Presno and Peter V. Schaeffer

Received: 29 June 2021
Accepted: 12 August 2021
Published: 17 August 2021

1. Introduction

The marine renewable energy (MRE) industry has a vital role in the U.S. clean energy strategy as we progress to meet U.S. electricity and blue economy needs with domestic energy sources (ClearPath, 2021 [1]). A thorough assessment of the U.S. marine renewable energy permitting process from the viewpoints of both developers that propose projects and regulators that permit them has not been performed. Sharing practical experiences in this new industry is vital to develop lessons learned to increase the efficiency and effectiveness of the permitting process, identify data and information gaps, and advance the industry. Although developers have identified the cost and time for environmental permitting and compliance as major development hurdles (Copping et al., 2020 [2]), a lack of information sharing and review of the permitting process has created significant challenges for the MRE industry. Previous studies on the topic to date have only focused on parts of the project permitting process, namely adaptive management of the Ocean Renewable Power Company's Cobscook Bay Tidal Energy Project (Johnson, 2015 [3]) and environmental review of Verdant Power's Roosevelt Island Tidal Energy Project (Verdant Power, 2011 [4]). These projects are a start, but other projects, such as Admiralty Inlet, Igiugig, PacWave North and South, and OPT Reedsport, have been through the permitting process. The present Environmental Compliance Cost Assessment (ECCA) project, as described in Peplinski et al., 2021 [5], has focused on compiling and analyzing the available environmental permitting and compliance costs for a variety of U.S.-based MRE projects that have gone through permitting. This first-of-a-kind effort allows for the development of lessons learned and recommendations for early MRE development based on the understanding of the barriers to permitting, cost savings opportunities, and technical challenges. The objectives of the ECCA project were to:

- Compile cost information for marine energy project permitting and licensing and monitoring and compliance (Peplinski et al., 2021 [5]);
- Collect additional project information to provide context for these costs (Peplinski et al., 2021 [5]);
- Understand developer and regulatory perspectives on the permitting process.

2. Materials and Methods

The overall method of this study followed the Eisenhardt approach for building theories from case study work by selecting cases, crafting instruments and protocols, entering the field, analyzing data, shaping hypotheses, and reaching closure (Eisenhardt, 1989 [6]). Qualitative and quantitative information was collected during interviews, workshops, and webinars with state and federal regulators and developers that have been involved in permitting or licensing a MRE project in the U.S. Additional details on the process of interview selection, surveying instrument and methodology, and organization of information of interest are described in Peplinski et al., 2021 [5]. Workshops conducted in the period 2017–2019 provide the foundational information for this study (Figure 1).

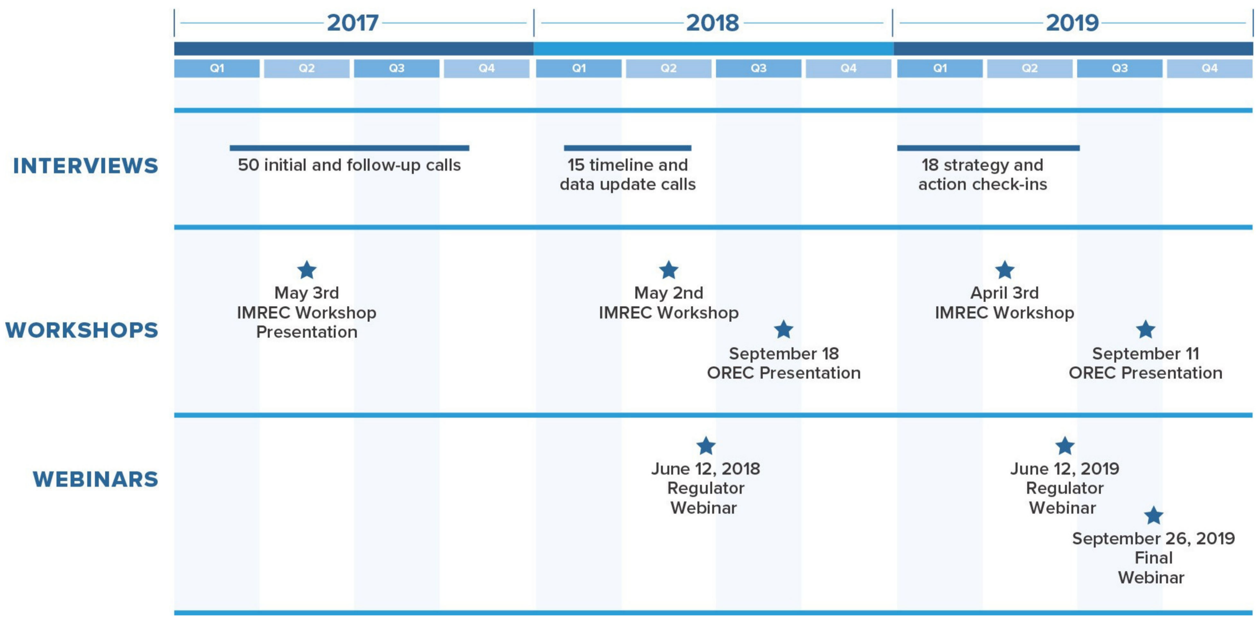

Figure 1. Outreach and Engagement Schedule Including Presentations and Workshops.

Given the different perspectives and the interest in obtaining honest, forthright feedback, each group (developers and state and federal regulators) was convened separately until the initial compilation of findings and lessons learned was prepared. During the developer workshops, mutual gains negotiation techniques and best management practices in facilitation were used to reduce conflict, with a focus on removing existing competitive relationships among participants (Fisher et al., 1991 [7]). For example, all comments in both private and group discussions as well as any ranking exercises were attributed when shared with a larger group. Consensus-building techniques were used to resolve potential differences among regulators and developers, with a neutral facilitator managing feedback exercises and discussions (Susskind et al., 1987 [8]). All webinars employed best management practices for virtual facilitation to reduce barriers to communication and collaboration such as polling techniques, technical support and training for the platform used, and ground rules to establish expectations for attendees (Mittleman et al., 2000 [9]).

Five workshops were convened targeting developers around the International Marine Renewable Energy and Ocean Renewable Energy Conferences, popular MRE industry conferences in the U.S. (Figure 1). The latest findings, quantitative cost analyses, and lessons learned were shared with participants and facilitated exercises were employed to gather targeted feedback. To engage regulators from the east and west coasts, two webinars with state and federal agencies were convened (Figure 1). Invitations focused on state and federal regulators who have either participated in permitting or licensing a MRE project and agency staff with permitting authority or a role in the process. Similar to the developer workshops, lessons learned and findings were shared and facilitated exercises were employed to gather targeted feedback. A final webinar was convened with all MRE stakeholders (regulators, developers, and researchers) to share a first draft of final findings and lessons learned. All discussions in the workshop and webinars were summarized and synthesized to further inform analyses and to identify additional lessons learned.

Strategies and supporting actions to increase the efficiency and effectiveness of permitting and licensing of MRE projects were developed based on the findings and lessons learned through stakeholder engagement, as well as lessons learned from evaluating permitting pathways for other industries as summarized in Kramer et al., 2020 [10]. The strategies and actions were organized into two categories: those that apply to a single project and more global strategies and actions that would apply broadly to the industry at a national scale. Regulators and developers were engaged and consulted during the development to further refine the proposed strategies and actions. In total, six strategies were identified, two project specific and four industry wide, and 24 associated actions, 11 project specific and 13 industry wide (Table 1).

Table 1. Strategies and Actions to increase the efficiency and effectiveness of permitting and licensing of MRE projects.

Category	Strategy	Supporting Actions
Project Scale	Improvements within Individual Projects	Pre-license Meetings Early Collaboration Experienced Staff Site Tours Study Plans Collaborative Drafting Partnerships Additional Efficiency
	Phased Development and Permitting	Adaptive Management Device-level Testing for Environmental Impacts Proportional Study and Monitoring Scrutiny
Industry Wide	Establish a Framework for Sharing and Distributing MRE Information	MRE Permitting Guidance MRE Repository Workshops
	Encourage Collaborative Industry Development	MRE Collaborative Working Groups
	Advance Permitting	FERC Licensing Process USACE Nationwide Permit
	Further Scientific Knowledge and Technical Capabilities	Predictive Modeling Targeted Research Baseline Information Advance Technologies Opportunities for Research

MRE Permitting Overview

To better understand the context of the information collected from the regulators and developers, it is important to broadly understand the permitting process. The Federal Energy Regulatory Commission (FERC) has authority to license grid-connected marine renewable energy technologies and their associated facilities and interconnection through the 2005 Energy Power Act and Federal Power Act, respectively (O'Neil et al., 2019 [11]). The pathways for developers to gain a FERC license are identical to hydroelectric power projects: integrated, alternative, and traditional licensing processes (FERC, 2020 [12]). The FERC has a pilot license pathway for small projects (<5 MW), for short-term (<5 year) deployments, that avoid sensitive locations. In addition, the FERC also has a permit pathway that allows small-scale demonstration projects to deploy without providing power to the grid (FERC, 2021 [13]); under the "Verdant Exemption", the FERC may grant developers a license to deploy a 5 MW or smaller device for 18 months or less for the purpose of data collection if the power generated is not sold (Verdant Power, FERC Decision, 2005 [14]). The FERC is the federal lead agency which grants a license and is responsible for complying with the requirements of the National Environmental Policy Act [NEPA] 40 CFR 1501.5) for grid-connected projects. The permitting process for a marine energy project in the U.S. can take up to eight years, with the average process taking six years (Peplinski et al., 2021 [5]).

The U.S. Army Corps of Engineers (USACE), under Nationwide Permit 52, also provides developers with a pathway to permit up to 10 pilot demonstration devices that only result in a loss of less than half an acre-foot of water (USACE, 2017 [15]). The process to permit under Nationwide Permit 52 is regionally specific based on the policy of the jurisdiction of the USACE regional office and coordinates with other federal and state agencies during the process (Kramer et al., 2020 [10]).

3. Results

Through all these efforts, the project team presented the strategies and actions developed to 53 stakeholders, including developers and regulators, to solicit feedback on the relative priority (i.e., popularity) of actions associated with each strategy. The project team hosted a workshop for developers on 3 April 2019, with 26 participants, and a webinar for regulators on 12 June 2019, with 27 participants. The attendees were asked to vote for up to five actions that they thought were the most important for permitting/licensing ME projects. The workshop documented 108 votes from a potential 130 votes (i.e., 26 $\times$ 5), and the webinar recorded 68 votes from a potential 135 votes (i.e., 27 $\times$ 5). Based on the response percentages ranking of strategies and actions from regulators and developers, the 10 most popular actions (Figure 2) among the original 24 are:

- Baseline Information;
- Advance Technologies;
- Device-Level Testing for Environmental Impacts;
- Early Collaboration;
- Targeted Research;
- Permit Guidance;
- MRE Repository;
- Adaptive Management;
- Workshops;
- MRE Collaborative.

The findings and lessons learned from the discussions are organized into three categories to facilitate assessment. The categories are barriers to permitting, cost-saving resources, and lack of technical knowledge. Barriers to permitting are perceived or actual inefficiencies in the permitting process. Cost-saving resources include tools used during the process that save time or resources for developers. Lack of technical knowledge refers to the knowledge gaps that regulators and developers found most challenging during the permitting and licensing process. The findings may be applicable to other developed nations with similar consenting or permitting processes to the U.S. but are most applicable to the U.S. permitting and licensing processes.

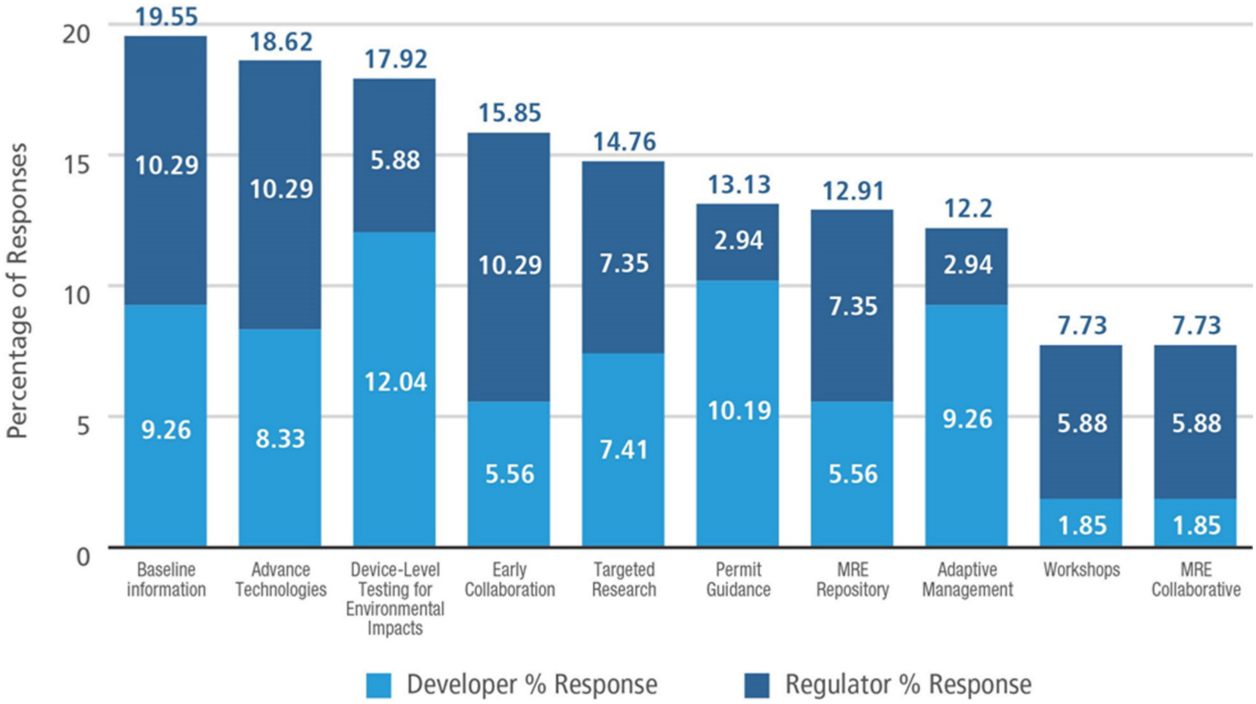

Figure 2. Action rankings at developer workshop and regulator webinar and workshop, dates.

3.1. Barriers to Permitting

3.1.1. Lack of Shared Information on Scientific Findings across Projects Creates a Conservative, Precautionary Approach by Federal and State Regulators, Adding Complexity, Time, and Cost

When asked about barriers to MRE project permitting and licensing, participants cited a range of issues related to limited precedent, lack of shared understanding among developers and regulators, funding constraints, and other challenges tied to the emergent nature of the MRE industry.

There is limited science on environmental effects of MRE projects in the U.S., and limited applicability of best available science from international locations or projects to inform licensing and permitting. Both agencies and industry were not necessarily aware of findings from other projects in U.S. waters, associated environmental reviews, and general research. This lack of cohesive knowledge of existing science and MRE project experiences has led to a precautionary approach to evaluate potential environmental impacts that have affected the development of required studies, including study methods, protocols and duration, and the need for adaptive management and post-construction decision making and mitigation. The lack of state and federal agency familiarity with MRE technology and potential environmental effects is due, in part, to the novelty of the industry, lack of designated MRE staff, staff turnover, limited existing relationships with MRE industry partners, limited understanding of the transferability of monitoring results from other areas, and lack of experience with and understanding of costs and feasibility of monitoring effects in the marine environment. Agency unfamiliarity with technologies and their potential environmental effects, combined with a precautionary or risk-averse approach, has caused some regulators to request significant and sometimes long-term data collection and monitoring efforts (pre- and post-construction) that can make MRE permitting/licensing and compliance costly. Baseline information data are growing; however, applicability of existing information may be limited depending on the project site. Some developers suggested that for those areas where projects are anticipated, a clear understanding of specific information and metrics needed to meet permitting requirements would be helpful prior to initiating project permitting. Information needs may include site-specific monitoring needs, such as conducting bathymetric surveys, or synthesis of existing information on endangered species and applicability of the information to a project site. Additionally, geographic information system (GIS) spatial data (on location of species, habitat types, and migration patterns) would be helpful, as well as advancing, improving, and decreasing costs of monitoring technologies/instrumentation.

Regulators and developers sometimes disagree on the type and amount of monitoring data needed to demonstrate effects or impacts and inform adaptive management decision-making. However, the industry, the U.S. Department of Energy (DOE), and the Bureau of Ocean Energy Management (BOEM) are focusing research to improve understanding of potential environmental effects and risks. For example, many stakeholders, including federal and state agencies, are now suggesting that concerns around potential electromagnetic field (EMF) impacts from transmission cables have been resolved based on recent study findings of negligible EMF emissions, reducing the need for developers to conduct studies or agencies to require monitoring associated with this topic in future MRE project licensing. Continuing efforts to improve understanding of risks associated with other potential environmental effects needs to be communicated to regulators and developers as science develops.

Interviewees affirmed that the primary resources and topics to be addressed during permitting are the following:

- Fisheries;
- ESA-listed species;
- Habitat;
- Marine mammals;
- Archeology;
- Collision;
- Noise;
- Avian;
- Terrestrial habitat;
- Entanglement.

Some have suggested that conducting air emissions studies on vessels servicing a wave or tidal deployment is unnecessary since these emissions are understood based on decades of permitting offshore oil and gas activities, and other ocean activities (Kramer et al., 2020 [10]).

3.1.2. Technology Developers' Lack of Understanding the Regulatory Process Compounds the Complexity in Permitting

Some technology developers within the industry who are new to permitting generally would benefit from expert permitting guidance early in the process. Local, state, and federal agency permitting requirements that are not aligned can create confusion and time-intensive coordination for applicants, especially those with no previous experience. This is true for licensing hydropower projects, and is nuanced further for MRE projects given the roles of the FERC, state agencies, and the BOEM if the projects are in federal waters. Similar to licensing hydropower projects, the permitting complexity requires the developer or applicant to understand federal and state regulatory requirements and often necessitates proactive coordination and collaboration, which is time- and resource-intensive. This lack of understanding of regulatory requirements by the applicant can be frustrating to both the agencies who need to educate or inform the applicants and the applicants who have missed expectations and timelines for permitting. This can aggravate the applicant, add tension to their relationship with the regulatory agencies, and slow the process vital to obtaining a permit.

Almost all agencies and developers have suggested that early engagement of agencies and potentially impacted stakeholders (e.g., fishing communities) is essential for project success. Stakeholders commonly identified include those related to fisheries, the environment, and coastal communities. All these interactions require a significant time investment and are necessary for successful permitting.

3.1.3. Guidance Documents or a MRE Regulatory Toolkit Sharing Experiences across Projects Could Be Helpful

Many agencies and developers have suggested that having guidance documents based on previously permitted projects would be very helpful. With few fully permitted projects in the water and a wide range of types of technologies deployed in different geographies, a wide range of experiences can be expected. Some projects have been fairly straightforward to permit and implement, while others have been more complex and costly. It will be important for future projects to be aware of these different situations, their circumstances, and solutions for the industry to continue to mature. The general theme of these opportunities revolves around developing a standardized MRE regulatory toolkit that simplifies and guides the MRE permitting and licensing process through guidance documents for applicants and agency supported MRE management practices (MMPs) throughout the environmental permitting and compliance lifecycle. These include

- Identify resource topic-specific approaches (e.g., marine mammal and seabird entanglement, collision) for baseline studies needed to inform permitting, and approaches for monitoring and adaptive management (during construction and implementation), including identification of new monitoring technologies/instrumentation needs;
- Identify process recommended practices (collaboration, proportionality—aligning the risk with the extent of environmental requirements), ideally best practices that increase efficiency of permitting;
- Help applicants develop a clear project description which is essential for permitting clarity;
- Identify permitting requirements and agencies' roles and responsibilities;
- Consider a way to have one online, easily navigable source that holds all MRE project environmental permitting documents (similar to the FERC e-Library (https://elibrary.ferc.gov/eLibrary/search, accessed on 12 August 2021), including MRE projects that are not FERC licensed).

Additionally, several industry representatives suggested that it would be helpful to have a simplified FERC permitting process for smaller deployments. For instance, in addition to the Verdant Exemption, consider some of the innovations for small hydropower projects and in conduit exemptions (18 C.F.R. § 4.30) and see whether they can be applied to MRE projects. MRE and offshore wind are relatively new uses of our marine environment and are seen as conflicting with and encroaching upon existing marine stakeholders (fishing, navigation, etc.). At the same time, with climate change and other factors, there is increased interest and concern associated with protecting marine resources. Combined, these factors lead to increased scrutiny and detail of environmental reviews for MRE projects compared to other more traditional uses of the marine environment. For example, the FERC pilot license pathway is not turning out to be an effective option, because there is no similar simplified, streamlined approach for other regulations such as the Endangered Species Act.

Several regulators and developers suggested, and the initial economic information has affirmed, that permitting a site first (a test center, or a pre-permitted area such as PacWave North or the Navy's Wave Energy Test Site), and then completing permitting for the specific technology deployment is helpful. While permitting a test center is a significant undertaking, once it is complete, the permitting for the specific deployment is very efficient (the potential, device-specific effects are relatively small). Permitting both a site and a specific technology at once compounds the complexity. However, interviews have also suggested that being clear on the main attributes of a device to have a clear project description for the test deployment and associated devices that may be deployed during the development of a test center is important. In other words, it is important to clarify the general type of device to be installed at the test site, such as the general types of wave energy converters (WECs): point absorbers, oscillating water columns, and attenuators. In this way, the general potential effects of these WEC types can be determined. Similar techniques could be used for a current energy converter test site.

3.2. Cost-Saving Resources

Tethys (https://tethys.pnnl.gov/marine-renewable-energy, accessed on 12 August 2021), the FERC e-library (https://elibrary.ferc.gov/eLibrary/search, accessed on 12 August 2021), and other resources were identified by participants as valuable for permitting and licensing MRE projects (Table 2). Many agencies and developers acknowledged the value of the Tethys references and webinars. We received feedback that having the Tethys webinars recorded was very valuable to be able to share with others, or to view after the fact if not able to attend the live webinar. Some agencies are not aware of the Tethys resource. It was suggested that Tethys would be even more valuable if one could access the full journal articles, not only the abstracts. This issue is caused by copyright laws. If a journal paper is not open access, Tethys cannot legally provide the full paper.

Table 2. Resources for informing MRE project permitting and licensing.

Resource or Tool	URL
Tethys Knowledge Base and Webinars	https://tethys.pnnl.gov/marine-renewable-energy
FERC e-Library	https://elibrary.ferc.gov/eLibrary/search
OES-Environmental (formerly Ocean Energy Systems Annex IV)	https://tethys.pnnl.gov/about-oes-environmental
BOEM Marine Cadastre	https://marinecadastre.gov/
NREL Wind Prospector	https://maps.nrel.gov/wind-prospector/
Project SOWFIA	https://www.plymouth.ac.uk/research/coast-engineering-research-group/sowfia-project
The UK Offshore Renewables Joint Industry Programme (ORJIP)	http://www.orjip.org.uk/oceanenergy/about
Pacific Northwest National Laboratory Research and Impact/Permitting Overview Documents	https://tethys.pnnl.gov/sites/default/files/publications/MHK-Regulatory-Processes-Literature-Review_Final.pdf
Scottish National Heritage Research and Impact/Permitting Overview Documents	https://www.nature.scot/research
National Oceanic and Atmospheric Administration (NOAA) Atlantic Marine Assessment Program for Protected Species	https://www.fisheries.noaa.gov/resource/publication-database/atlantic-marine-assessment-program-protected-species.

Several, particularly those agencies who also license hydropower projects, spoke of the value of the FERC e-library. However, it was acknowledged that one needs to know the project's docket number and how to navigate the site to access FERC documents, and given the lack of systematic labeling of documents, accessing information on the FERC e-library is difficult.

Additionally, it was suggested that having one site that houses all project key environmental documents, including study plans and environmental analyses, would be helpful since not all projects go through FERC licensing and accessing documents on the FERC e-library is difficult.

Specific tools mentioned throughout the process are listed below.

3.3. Lack of Technical Knowledge

The team received varied responses on which were the most or least difficult technical challenges to overcome. The following is a summary of responses received regarding technical challenges and information gaps:

- Advancing knowledge of marine resource ecology and potential MRE effects would help MRE projects in general, but project-specific research will be important to truly advance understanding;
- Some developers encouraged more studies on the potential positive impacts of MRE technology on the marine environment (e.g., reduction in coastal erosion, habitat creation);

- Some developers have found a "chicken and egg" problem between securing funding and getting through permitting. Projects need regulatory certainty to attract funding; however, they also must raise funds to get through the pre-permitting and permitting phases;
- Several suggestions were made for organizing future research efforts including tackle research by scale—"near" and "far" field or micro-/meso- (interactions such as collision, strike, and evasion), and macro- (where organisms first detect the project, resulting in changes to behavior such as avoidance) impacts; use new technologies and remote monitoring methods to improve understanding of species interactions and behaviors with MRE projects.

3.4. Recommendations

Based on feedback, it is clear that there are several pathways to increase the efficiency and effectiveness of the permitting and licensing process. The project team recommends the implementation of the identified strategies, with defined overarching goals and supporting actions, and identification of discrete tasks or tactics.

3.5. Project-Scale Strategies and Actions

3.5.1. Improvements within Individual Projects

Individual projects should follow best practices and build on past project licensing and implementation processes. Actions associated with this strategy will be led by developers with the overall goal of improving the effectiveness of the entire process, from pre-licensing to deployment. Individual projects that use this approach will enhance the collaborative tools identified in industry-wide strategies and actions. Suggested actions are:

- Pre-License Meetings: Conduct pre-license application meetings to engage stakeholders prior to site selection, to identify issues such as competing ocean uses and sensitive species, to select the site, and to develop a clear project design;
- Early Collaboration: Share draft permitting and licensing documents (e.g., environmental analyses, monitoring and adaptive management plans) early with agencies to identify and address concerns proactively;
- Experienced Staff: On a project-to-project basis, developers might consider engaging experienced staff, consultants, or agency staff to navigate and support the permitting process;
- Site Tours: Conduct educational site tours for key stakeholders to improve understanding of projects and their potential impacts, familiarize regulators with technology, allow other ocean users to become familiar with the project, and facilitate permitting of future projects;
- Study Plans: Negotiate study plans, adaptive management, and protection, mitigation, and enhancement measures;
- Collaborative Drafting: Collaborate with regulators when developing the Endangered Species Act biological assessment (BA), to gain an understanding of the level of detail expected by agencies and provide the scope of acceptable incidental take;
- Partnerships: Develop and engage in partnerships with regional experts and local academia to increase the efficiency and quality of environmental studies;
- Additional Efficiency: Ensure efficiencies throughout the project by innovating and holistically managing processes, to facilitate project licensing and operation, expedite deployment, and reduce overhead costs.

3.5.2. Phased Development and Permitting

Proportionally scaled development and permitting would better align potential environmental effects with the spatial and/or temporal scales of the project development. For an individual permitting process, it is important for the developer, state and federal regulatory agencies, and other stakeholders to keep scale in mind: smaller projects (i.e., fewer devices installed) or projects with devices installed for relatively short time frames should have proportionally fewer environmental effects. Larger projects, with a greater number of devices deployed over a longer time, would likely have more significant environmental effects, and might require the collection of more environmental information. Suggested actions are:

- Adaptive Management: Use an adaptive management and monitoring framework to phase project development;
- Device-Level Testing for Environmental Impacts: Use test centers and small-scale deployments to obtain device performance information, identify potential environmental impacts, and provide data to regulatory agencies to facilitate permitting;
- Proportional Study and Monitoring Scrutiny: Develop and implement proportionate degrees of analysis, monitoring, and adaptive management requirements to small-scale projects, and use what has been learned to inform permitting as projects scale-up.

3.6. Industry-Wide Strategies and Actions

3.6.1. Establish Framework for Sharing and Distributing MRE Information

As part of a new industry, MRE stakeholders must strive to employ the most credible, current information to increase the efficiency and effectiveness of the process. There must be collaborative sharing of knowledge among developers, regulatory agencies, and other interested stakeholders, plus a framework through which this information can be shared. Developing a framework will enable regulatory agencies, industry professionals, and others to share and access the most up-to-date MRE information. Suggested actions are:

- MRE Permitting Guidance: Create, update, disseminate, and implement MRE permitting guidance documents, study protocols, and siting tools;
- MRE Repository: Develop a single online repository that houses all key MRE project environmental documents, including study plans, monitoring and adaptive management plans, progress reports, and environmental analyses;
- Workshops: Host or participate in MRE environmental workshops to share new information.

3.6.2. Encourage Collaborative Industry Development

Many developers, regulatory agencies, and other stakeholders involved in MRE projects operate within the framework of individual projects and are not always aware of (or applying) lessons learned from the industry as a whole. Additionally, failing to document lessons learned over the life of an MRE project is a missed opportunity for industry progression. This strategy aims to encourage collaboration across the industry (and between industry, regulatory agencies, and other stakeholders) by establishing an MRE collaborative with working groups to address industry guidelines for relevant topics, such as baseline assessments, impact assessment, and environmental compliance standards, and to come to a mutual understanding of the environmental risks associated with MRE projects and to reduce risk over time. Suggested actions are:

- MRE Collaborative: Form a MRE collaborative of developers, regulators, researchers, and other relevant stakeholders;
- Working Groups: Convene working group(s) to develop study standards and guidance for monitoring and data handling of environmental topics (e.g., fish and fisheries, noise, collision, marine habitat); identify and develop technology for monitoring; and develop adaptive management frameworks.

3.6.3. Advance Permitting

The current permitting process can be time-intensive and difficult to coordinate across multiple jurisdictions (i.e., federal, state, and local agencies), with nuances between national and regional permitting requirements often miscommunicated unintentionally to developers as they are led through the process. These factors can result in lag time between project initiation and short-term testing of new WEC or tidal energy converter designs. Longer-term MRE projects require the same coordination among national and regional permitting entities. Identifying opportunities to simplify and create flexibility in the permitting processes, while maintaining multiple permitting pathways, is vital to the growth and progress of the MRE industry. As more projects are installed, and as developers gain additional permitting experience, there may be opportunities to improve the permitting process.

- FERC Licensing Process: Improve the existing licensing process for grid-connected MRE projects, once impacts are well known;
- USACE Nationwide Permit: Continue renewal of the USACE Nationwide Permit 52 for MRE projects.

3.6.4. Further Scientific Knowledge and Technical Capabilities

The growth of the MRE industry is contingent on high-quality scientific knowledge and state-of-the-art technical capabilities, which support licensing, project deployment, and monitoring phases. Studies show that the process can be costly and occasionally ineffective if conducted without the proper focus (Copping, 2018 [16]). Therefore, the actions associated with this strategy are recommendations for improving the environmental data gathering process and determining the environmental resources that will require focused technical studies. The continued development of improved monitoring technologies, through collaboration with test center deployments, will provide unique opportunities for MRE research and will improve regulators' comfort with the new technology. In addition, furthering scientific knowledge and technical capability will play an important role in engaging stakeholders and providing data-backed answers to their questions. Suggested actions are:

- Predictive Modeling: Develop predictive models to identify potential effects to marine ecosystems and increase process efficiency through improved understanding of impacts;
- Targeted Research: Conduct targeted research on environmental resources with high study costs;
- Baseline Information: Collect regional baseline information to characterize the local environment;
- Advance Technologies: Improve technologies and instruments used for site characterization and monitoring;
- Opportunities for Research: Conduct research in concert with test center deployments.

4. Discussion

The challenges facing the MRE industry are largely due to its nascency and unique use of an already crowded ocean with several established industry uses. There are several devices, configurations, and functionality that make projects viable for developers. This means uncertainty for regulators permitting these projects uniqueness and therefore increases time and costs of the permitting and licensing process. Environmental interactions between MRE devices are often complex, with ongoing research that continually changes our understanding of environmental effects. The limited number of projects, typically with single or small numbers of devices, that have been fully permitted provide little precedent for permitting and licensing commercial projects with numerous devices. Information sharing often occurs at conferences with high registration costs preventing some stakeholders, primarily regulators, from attending and furthering their understanding of the environmental interactions between MRE devices and certain species and habitat. A summary of the most popular actions is provided below separated into industry-wide efforts and project-specific efforts organized by their popularity as shown in Figure 2.

4.1. Industry-Wide Efforts

Industry-wide efforts should: (1) further scientific knowledge by collecting baseline information, advancing technologies for site characterization and monitoring, and targeting research on environmental resources with high study costs; (2) establish a framework for sharing and distributing MRE information by developing a data repository, permitting guidance, and workshops for stakeholders; and (3) encourage collaborative industry development through the establishment of a MRE collaborative.

4.1.1. Baseline Information

The available baseline study data and information collected for individual MRE projects are accessible through the FERC e-library. These baseline studies were conducted using a variety of methods and their results used multiple metrics that depended on study design, site location, potentially affected species, MRE project type, and potential device interactions (e.g., collision for tidal projects). The BOEM has funded large-scale baseline studies such as the Pacific Continental Shelf Environmental Assessment, which entailed aerial seabird and marine mammal surveys off northern California, Oregon, and Washington from 2011 to 2012 (Adams et al., 2014 [17]). These efforts included standardized, low-elevation aerial surveys conducted in winter, summer, and fall over three bathymetric domains: inner shelf waters (depths less than 100 m), outer shelf waters (depths of 100–200 m) and continental slope waters (depths of 200–2000 m) (Adams et al., 2014 [17]). The BOEM is also funding several large-scale environmental studies on the U.S. East Coast that provide baseline information for many species potentially affected by offshore wind projects. This information reduces the need for offshore wind developers to conduct baseline studies in their project lease areas and supports efficient and effective permitting/licensing for offshore wind projects.

A strategic approach to developing baseline studies is lacking. Appropriate baseline study methodologies are needed to obtain information that can be used to evaluate post-deployment environmental effects, support decision making, and inform adaptive management. Determining priority regions or areas for conducting baseline studies is needed to effectively focus funding efforts. An MRE and offshore wind collaborative, potentially through a working group, could assist in identifying regions or areas where near-term MRE developments are likely (e.g., Oregon Territorial Sea Plan); prioritizing these locations for conducting baseline studies; and determining the appropriate study methodologies for each priority location. The baseline studies identified for priority locations could be funded by the DOE and/or the BOEM and conducted by academia, national laboratories, or subject matter experts. These studies would provide developers and regulators with baseline information in advance of site selection and improve developers' understanding of environmental conditions prior to investing finite resources.

4.1.2. Technologies for Site Characterization and Monitoring

The costs and effectiveness of site characterization and monitoring technologies and methods are critical challenges for successful MRE project permitting/licensing and deployment. To reduce developers' financial constraints for site characterization and monitoring, the DOE could provide near-term funding through funding opportunity announcements (FOAs) to develop more accurate and cost-efficient instrumentation and data analysis tools.

The recommended path forward is to convene focused working groups of developers and regulators through the MRE Collaborative (described below) to prioritize and resolve issues related to site characterization and monitoring, particularly: (1) identifying the metrics that need to be measured; (2) developing technologies to conduct measurements in a robust, reliable, and cost-effective manner; and (3) establishing measurement specifications (e.g., frequency, duration). Convening these working groups would shorten monitoring periods by achieving consensus between developers and regulators on priorities and data collection/analysis approaches that can be used to inform adaptive management and future decision making.

4.1.3. Targeted Research

According to Peplinski et al., 2021 [5], the costliest types of marine studies associated with permitting/licensing for both wave and tidal MRE projects were acoustics, marine habitat, and fish/fisheries. Therefore, near term targeted research efforts should focus on baseline and compliance study needs for these three study areas to obtain data on:

- Tidal and wave energy device acoustic characterization (e.g., methods needed to understand and evaluate MRE device sound signatures under different ambient conditions) and the effects of MRE device sound on biota;
- Marine habitat effects, particularly for benthic habitat and community composition, associated with the installation of MRE project structures (e.g., anchoring types, transmission cables) on the sea floor;
- Fish distribution and seasonality in environments where interactions with an MRE device/s are likely to occur and the outcomes of specific interactions (e.g., tidal turbine collision).

4.1.4. Permitting Guidance

Existing guidance for permitting MRE projects in the U.S. are primarily:

- FERC Website: existing documentation and guidance on how to obtain a preliminary permit, the pilot project process, and developing MRE on the Outer Continental Shelf;
- Handbook of Marine Hydrokinetic Permitting Processes: a collection of relevant statutes, processes, and agencies for permitting and licensing MRE projects in various states across the United States;
- A Citizen's Guide to the BOEM's Renewable Energy Authorization Process (only applicable to MRE on the Outer Continental Shelf): a simplified process document sharing the steps of the BOEM to consider competitive, and non-competitive leasing for renewable energy.

The lessons learned from previous and ongoing project permitting/licensing efforts should be synthesized to update the Handbook of Marine Hydrokinetic Permitting Processes that integrates collaboration and outreach. Similar to the Annex IV 2016 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World (Copping et al., 2016 [18]) and OES-Environmental 2020 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World (Copping and Hemery, 2020 [19], a continual update of the handbook with lessons learned would provide a permitting/licensing strategy based on lessons learned from previous permitting attempts.

4.1.5. Data Repository

Multiple online databases have been developed to share different types of MHK-related information more broadly with developers, regulators, and stakeholders. Examples include Tethys Knowledgebase and the databases discussed below; most of these databases are continually updated.

- MHK Data Repository: A user-curated database of DOE-funded research related to MHK projects that includes various research and monitoring data, simulations, and project reports;
- The FERC e-library: A searchable online document repository for all permits/licenses that are in the process of being reviewed by the FERC or have been issued;
- Marine Cadastre: A joint BOEM and NOAA initiative that provides authoritative GIS data and ocean reports in an interactive mapping tool. Available data sets include species data for birds, corals, fish, marine mammals, and sea turtles; marine habitats; ocean planning and economic uses; political jurisdictions and boundaries; and physical and oceanographic information (wind and wave speed and direction, surface height, temperature and salinity, nutrients, etc.);
- Wind and Water Materials and Structures Database: A DOE-funded database that contains data and analyses from extensive testing of turbine blades and materials for MRE and wind devices by Sandia National Laboratories and its partner, Montana State University;

- Marine and Hydrokinetic Technology Database: A crowd-sourced database that contains information on MHK technology used in the U.S and globally, including a comprehensive map of MHK projects.

While across these resources there is important data and information, they are not easily accessible across all database websites and GIS software and are frequently difficult to integrate with the permitting/licensing process. The development of the MRE Environmental Toolkit for Permitting and Licensing should help incorporate scientific information into the regulatory process, which will enable regulators, developers, and interested stakeholders to find information that will be useful for permitting/licensing. This web portal will also provide links to the online sources identified above to create an improved user interface for all the websites/tools. The challenges will be keeping the rapidly changing information up to date as the nascent MRE industry grows and continuing to regularly engage regulators, developers, and other stakeholders.

4.1.6. Workshops on Environmental Permitting

Although workshops are held to increase engagement and access to information for key stakeholders are held, there are no consistent efforts that provide reliable and regular updates on new developments in the industry across the U.S. Because there is no regular funding, some of these workshops are offered sporadically and provide little continuity for participants. Another gap is the lack of a centralized stakeholder database; not all stakeholders may be informed of upcoming workshops. A consistent database of developers should be developed and maintained, and a master schedule of workshops addressing key regulatory topics should be held consistently over time.

4.1.7. MRE Collaborative

There are currently no efforts in the U.S. to establish a national collaborative forum for MRE stakeholders to communicate project experiences, discuss permitting/licensing challenges, and share lessons learned and solutions. The only comparable ongoing program is the Offshore Renewables Joint Industry Programme (ORJIP) in the United Kingdom (UK).

The effort to establish a national MRE collaborative that could potentially occur in partnership with the U.S. offshore wind industry, has many of the same permitting/licensing and environmental challenges. A national collaborative initiated by the two industries would create connections between dispersed geographies and promote common interests. The collaborative should include representatives from industry, state and federal regulatory agencies, environmental organizations, academic researchers, local coastal communities, existing ocean users, and other interested parties. The purposes of the national collaborative would be to: (1) share research findings and permitting/licensing experience; (2) identify and prioritize ongoing research and outreach needs by addressing environmental challenges at site-specific and regional levels; (3) discuss how international experiences can inform advances in the U.S. MRE and offshore wind industries; and (4) develop collaborative funding mechanisms to support identified research and outreach needs.

4.2. Project-Specific Recommendations

Project-specific recommendations focus on device-level monitoring for environmental effects, early collaboration during the permitting and licensing process, and increase use of adaptive management. The end products of the recommendations below would be applicable to any MRE project.

4.2.1. Device-Level Monitoring for Environmental Effects

While test centers currently allow the evaluation of individual MRE devices, the data being collected are not being used to encourage the scaling of deployment from a single device to an array. Additionally, data from device-level testing are not shared across the U.S. MRE community; they are informing individual developer's efforts. For the MRE industry to reach commercialization, developers will need to continue device level testing for environmental effects and use the data and information collected to inform the future adaptive management frameworks of larger projects. However, these adaptive management approaches will need to reflect the unique combination of potential environmental effects at proposed array sites.

4.2.2. Early Collaboration

Early coordination among stakeholders does occur but is not mandated or formalized. Therefore, each project goes through different steps to ensure the most efficient process. Permit/license applicants should consider establishing a process plan early in the permitting/licensing process with regulatory agencies to maintain coordination among developers and regulators throughout the process. This process plan is a requirement in the FERC Integrated Licensing Process (ILP) which focuses on working with stakeholders to identify and resolve early issues and needs for studies early to fill information gaps, integration of other stakeholder permitting process needs, and a comprehensive timeframe for all stakeholders involved. ILP process plans have been a well-received practice to identify project milestones (developing, negotiating study plans, baseline data gathering, reviewing results and planning monitoring and adaptive management plans), and mutual responsibilities to achieve the schedule.

4.2.3. Adaptive Management

The benefits of adaptive management have been realized while managing the monitoring of a single MRE device. However, adaptive management has not been used yet for scaling projects or managing an array of devices. In order to elevate the MRE industry to commercialization, it is vital that scaling from a single device to an array is conducted using adaptive management frameworks. Regulators and developers must keep in mind that adaptive management is a complex, multidisciplinary, and rapidly evolving strategy. Experiences with the framework range from a variety of management problems with "different spatial scales, ecosystem types, socioeconomic characteristics, risks, and regulatory/jurisdictional complications" (Gregory, 2006 [20]). Therefore, although an understanding of the adaptive management approach by the U.S. MRE community is key for the industry's advancement, there is no universal implementation strategy. However, the sharing of adaptive management lessons learned from ongoing and past projects at single-device and array scales can inform future adaptive management approaches.

5. Conclusions

Permitting, licensing, and compliance in the growing MRE industry present significant challenges due to few projects in the water, and lack of coordination and knowledge sharing across projects. The qualitative research findings shared here and associated suggested strategies and actions can assist in advancing mutual understanding of the permitting process, the environmental findings based on project information, and best practices for permitting and compliance. Combined, these efforts can enable the industry to develop and thrive as it advances from individual devices to full-scale arrays.

Author Contributions: The article conceptualization was developed by the entire team; the methodology development and analysis was conducted by Z.B. and A.W.; writing—original draft preparation, Z.B.; writing—review and editing, S.K., C.J., J.R., W.P. and A.W.; supervision, A.W. and Z.B.; project administration, Z.B.; funding acquisition was conducted by the entire team. All authors have read and agreed to the published version of the manuscript.

Funding: This work completed by Sandia National Laboratories was funded by the U.S. Department of Energy's Water Power Technologies Office. Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC., a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. This paper describes objective technical results and analysis. Any subjective views or opinions that might be

expressed in the paper do not necessarily represent the views of the U.S. Department of Energy or the United States Government.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Restrictions apply to the availability of these data. Data were obtained from project developers and agency regulators under an agreement of anonymity and are available stripped of attribution from co-authors at Sandia National Laboratories.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. ClearPath. Available online: https://clearpath.org/our-take/the-energy-act-of-2020-a-monumental-climate-and-clean-energy-bill/ (accessed on 1 May 2021).
2. Copping, A.E.; Freeman, M.C.; Gorton, A.M. *Risk Retirement for Environmental Effects of Marine Renewable Energy*; Pacific Northwest National Laboratory: Richland, WA, USA, 2020.
3. Johnson, T.R.; Jansujwucz, J. Understanding and informing permitting decisions for tidal energy development using an adaptive management framework. *Estuaries Coasts* **2015**, *38*, 253–265.
4. Adonizio, M.; Smith, R. *Roosevelt Island TiEal Energy (RITE) Environmental Assessment Project*; New York State Energy Research and Development Authority: New York, NY, USA, 2011.
5. Peplinski, W.J.; Roberts, J.; Klise, G.; Kramer, S.H.; Barr, Z.; West, A.; Jones, C. Marine energy environmental permitting and compliance costs. *Energies* **2021**, *14*, 4719. [CrossRef]
6. Eisenhardt, K. Building Theories from Case Study Research. *Acad. Manag. Rev.* **1989**, *14*, 532–550. [CrossRef]
7. Fisher, R.; Ury, W.; Patton, B. *Getting to Yes: Negotiating Agreement without Giving*, 2nd ed.; Houghton Mifflin: New York, NY, USA, 1991.
8. Susskind, L.; Cruikshank, J. *Breaking the Impasse: Consensual Approaches to Resolving Public Disputes*; Basic Books: New York, NY, USA, 1987.
9. Mittleman, D.D.; Briggs, R.; Nunamaker, J. Best practices in facilitating virtual meetings: Some notes from initial experiences. *Group Facil. A Res. Appl. J.* **2000**, *2*, 5–14.
10. Kramer, S.; Jones, C.; Klise, G.; Roberts, J.; West, A.; Barr, Z. Environmental permitting and compliance cost reduction strategies for the MHK industry: Lessons learned from other industries. *J. Mar. Sci. Eng.* **2020**, *8*, 554. [CrossRef]
11. O'Neil, R.; Staines, G.; Freeman, M. *Marine Hydrokinetics Regulatory Processes Literature Review*; Report for USA Department of Energy; Pacific Northwest National Laboratory: Richland, WA, USA, 2019.
12. Federal Energy Regulatory Commission. Integrated, Traditional and Alternative Licensing Processes. Available online: https://www.ferc.gov/industries-data/hydropower/licensing/licensing-processes (accessed on 25 May 2021).
13. Federal Energy Regulatory Commission. Hydrokinetic Projects. Available online: https://www.ferc.gov/licensing/hydrokinetic-projects (accessed on 1 February 2017).
14. Federal Energy Regulatory Commission. Maine Maritime Academy; Project No. 12777-001; DI10-1. Available online: https://www.ferc.gov/sites/default/files/2020-04/p-12771.pdf (accessed on 25 May 2021).
15. United States Army Corps of Engineers. Available online: https://www.swt.usace.army.mil/Portals/41/docs/missions/regulatory/NationwidePermits/Nationwide%20Permit%2052%20-%20Water-Based%20Renewable%20Energy%20Generation%20Pilot%20Projects.pdf?ver=2017-03-31-150710-850 (accessed on 25 May 2021).
16. Copping, A. *The State of Knowledge for Environmental Effects Driving Consenting/Permitting for the Marine Renewable Energy Industry. Prepared for Ocean Energy Systems*; Pacific Northwest National Laboratory: Richland, WA, USA, 2018.
17. Adams, J.; Felis, J.J.; Mason, J.W.; Takekawa, J.Y. *Pacific Continental Shelf Environmental Assessment (PaCSEA): Aerial Seabird and Marine Mammal Surveys off Northern California, Oregon, and Washington, 2011–2012*; Bureau of Ocean Energy Management: Camarillo, CA, USA, 2014.
18. Copping, A.; Sather, N.; Hanna, L.; Whiting, J.; Zydlewski, G.; Staines, G.; Gill, A.; Hutchison, I.; O'Hagan, A.; Simas, T.; et al. *Annex IV 2016 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World*; Pacific Northwest National Laboratory: Richland, WA, USA, 2016.
19. Copping, A.E.; Hemery, L.G. OES-Environmental 2020 State of the Science Report: Environmental Effects of Marine Renewable Energy Development around the World. Report for Ocean Energy Systems (OES). 2020. Available online: https://tethys.pnnl.gov/sites/default/files/publications/OES-Environmental-2020-State-of-the-Science-Report_final.pdf (accessed on 25 May 2021).
20. Gregory, R.; Ohlson, D.; Arvai, J. Deconstructing adaptive management: Criteria for applications to environmental management. *Ecol. Appl.* **2006**, *16*, 2411–2425. [CrossRef]