Marine Renewable Energy Regulator Survey: *UNITED STATES*

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Introduction

As the marine renewable energy (MRE) industry progresses around the world, understanding of the potential environmental effects of MRE has improved. Opportunities to investigate the environmental effects of operational MRE devices have increased in recent years with more projects in the water. Despite these advancements, some areas of uncertainty persist. Key concerns remain about how MRE devices and arrays interact with surrounding environments, and how marine animals behave around them. These uncertainties continue to pose challenges during permitting processes for MRE. Additionally, the development of larger-scale MRE devices and arrays presents new questions and uncertainty for MRE permitting processes, particularly in understanding how potential environmental effects of MRE scale up and interact with other ocean activities.

To better understand how regulators and advisors perceive and manage environmental risks during permitting processes for MRE projects, a survey was conducted across several OES-Environmental member countries beginning in 2025. Building on a previous regulator survey conducted by OES-Environmental for multiple countries from 2017-2021, this survey included updated questions to reflect changing information needs regarding the environmental effects of MRE. Its purpose was to understand regulators and advisors' familiarity with MRE technologies, perceptions of environmental risks associated with MRE technologies across varying scales, and what they view as best approaches to MRE development, including permitting and the applicability of data transferability. The survey also included some questions to gather Tethys user data. A list of questions and answer options is provided in Appendix A.

This report summarizes the results from the survey of regulators and advisors in the **United States (US)**. Results are compared to the previous survey for the US, conducted and published in 2017[1].

Email invitations to complete the 2025 Survey on Regulatory Needs Regarding Environmental Effects of Marine Renewable Energy were sent to 593 individuals known to be or potentially be involved in permitting MRE in the US. The list of US regulators and advisors was compiled by updating the contact list from the 2017 US Regulator Survey. Additional regulators and advisors were identified through review of agency websites and online directories, with a focus on those in coastal regions or involved in the MRE permitting process. Out of 33 total responses received, twenty were fully completed and represent a 3% response rate, while the remaining 13 had partial responses. While the 2017 US Regulator Survey achieved an 18% response rate, the lower response rate of the 2025 survey may, in part, reflect shifts in federal workforce composition during 2025.

Figure 1 (n = 26) shows the levels of government represented by respondents' agencies. Twenty respondents work at an agency representing the state-level government, five represent the

[1] Dreyer, S. (2017). MRE Regulator Survey Report: United States. https://tethys.pnnl.gov/publications/mre-regulator-survey-report-united-states

federal level, and one represents the county level. No respondents self-identify as working at an agency representing a local level government.

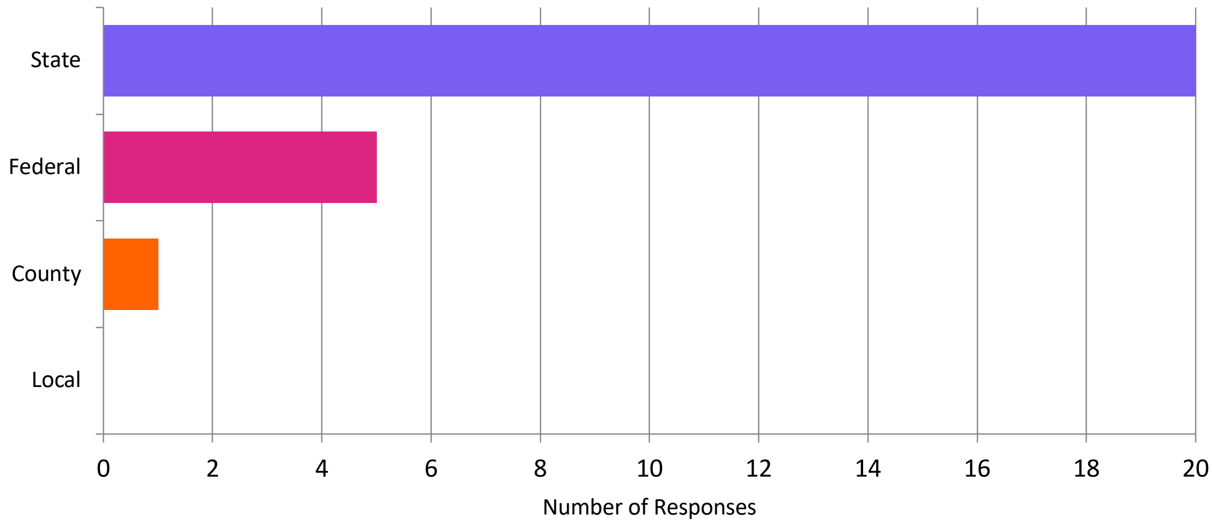

Figure 1. Level of government represented. (n = 26)

Figure 2 (n = 26) shows the states in which the respondents work. A total of 15 states is represented, as well as the District of Washington (D.C.) The top states represented are Massachusetts and Washington, each with five respondents. Seventeen respondents work on the east coast of the US, while ten work on the west coast, including Hawaii and Alaska.

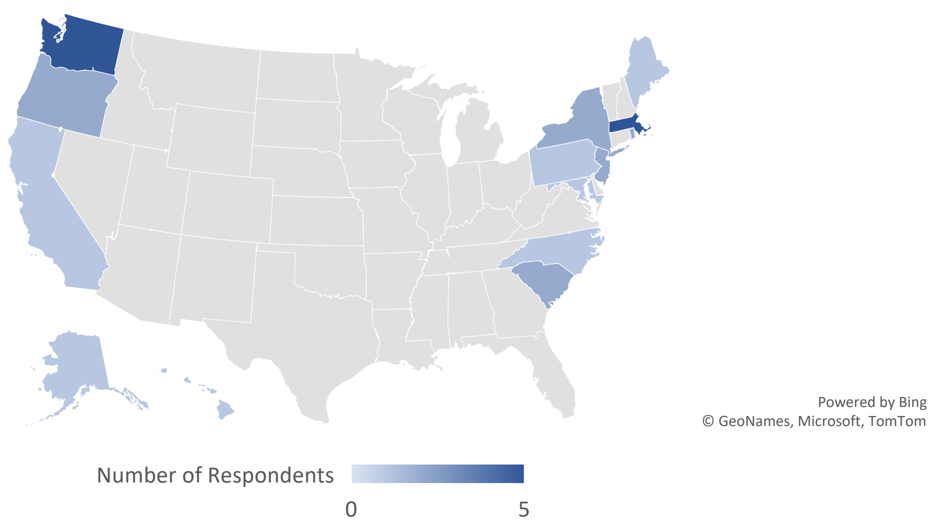

Figure 2. State governments represented. (n = 26)

Figure 3 (n = 26) shows the number of planned, permitted, or operational MRE projects in each respondent's jurisdiction. Eighteen respondents reported that there are between one and five projects, one respondent reported more than 10, and seven respondents reported 0 (Figure 3).

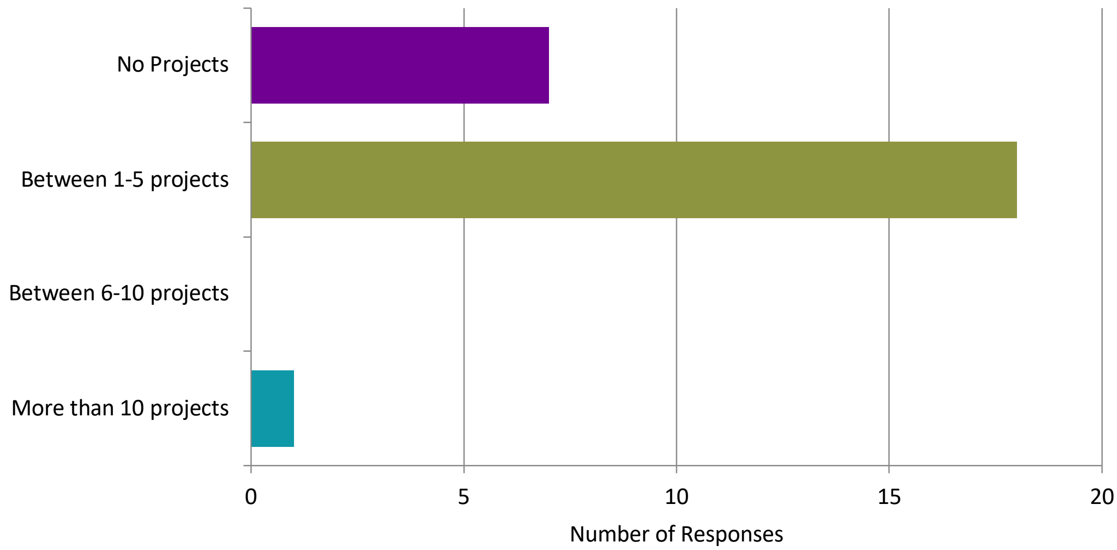

Figure 3. Number of planned, permitted, or operational marine renewable energy projects in each respondent's jurisdiction. (n = 26)

Respondents were asked to indicate their agency's focus areas for permitting MRE developments, selecting all applicable options. As shown in Figure 4 (n = 25), most of the represented organizations focus on permitting seabed and habitat, fish/fisheries, marine mammals, social and economic aspects, and water quality. The most common focus of agencies representing a federal level of government is 'other animals' (80% of federal respondents), while the most common for a state level are seabed and habitat (85% of state respondents) and fish/fisheries (75% of state respondents).

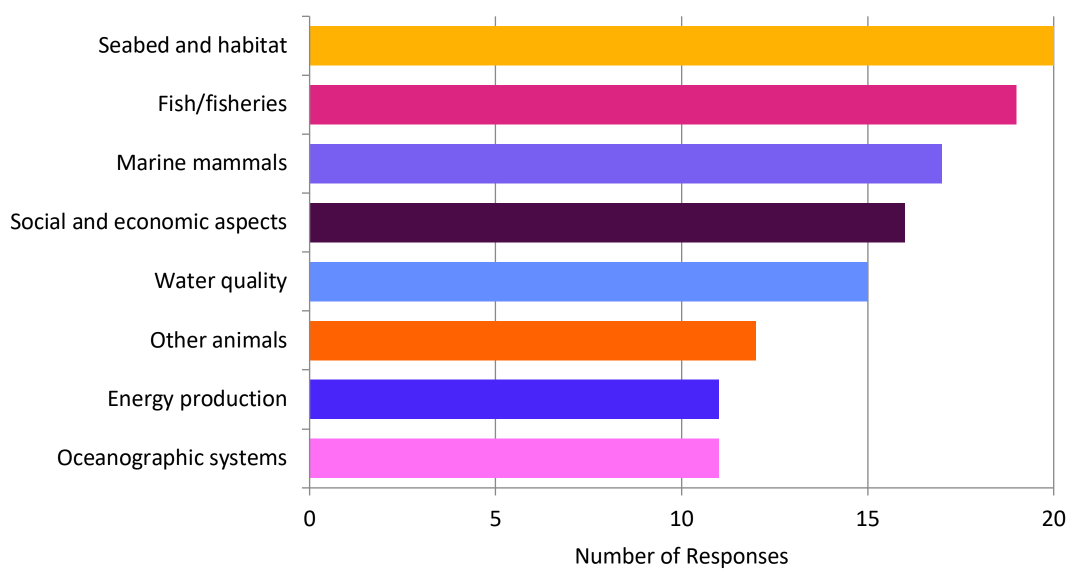

Figure 4. Agency focus on permitting marine renewable energy projects. (n = 25)

Figure 5 (n = 26) shows each respondent's role in permitting MRE projects. The most common roles among respondents are subject matter expert and advisory roles. Respondents could select multiple roles, and a substantial proportion reported working across more than one of the roles included in the survey. Additional responses received under 'Other' include:

- Managing groups procuring projects on behalf of a State
- Provide voluntary measures to reduce impacts to birds
- Submerged lands leasing
- Coastal Zone Management federal consistency review & decision-making
- Federal consistency review with federal permits (e.g., USACE 404)

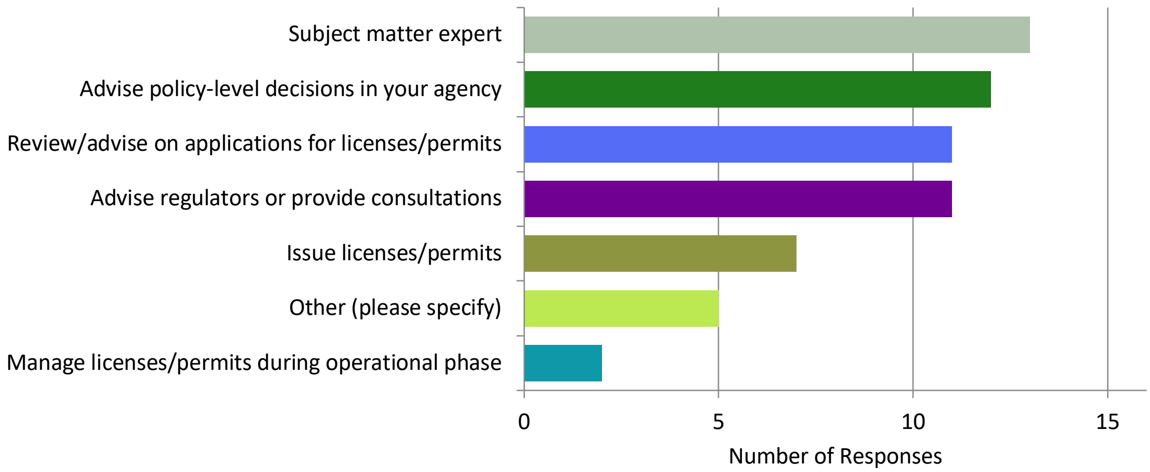

Figure 5. Respondent's role in permitting marine renewable energy projects. (n = 26)

Figure 6 (n = 26) shows the length of time respondents have been in a position related to the permitting process for MRE projects. Most respondents have been in such position for more than five years, including 80% of federal respondents and 50% of state respondents.

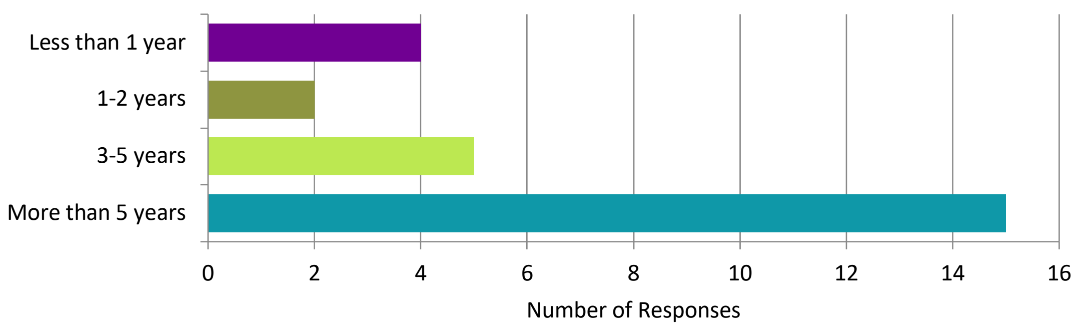

Figure 6. Length of time in a position related to the permitting process for marine renewable energy projects. (n = 26)

Respondents were asked if they had directly participated in the regulatory process for an MRE project. Figure 7 (n = 26) shows the results, with over 50% of respondents not having been directly involved, 10 were involved in permitting, and one was involved in the management of an operational project. No respondents have been involved in decommissioning.

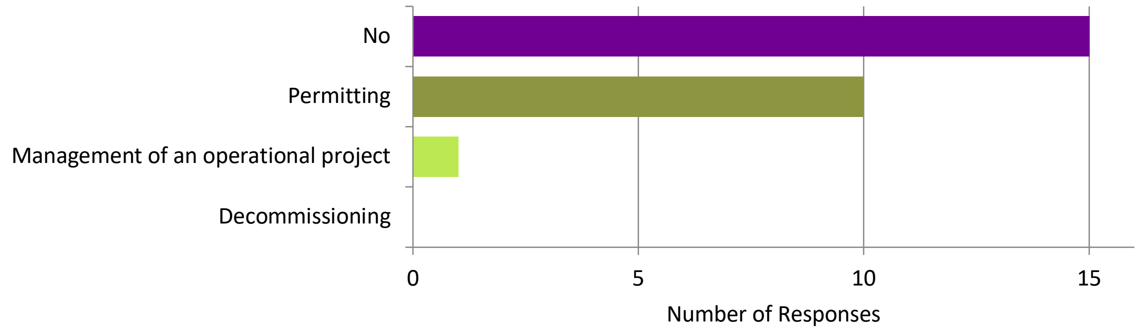

Figure 7. Have you directly participated in a regulatory process for a marine renewable energy project? (n = 26)

Familiarity with MRE Technologies

Respondents were asked to rate their familiarity with MRE technologies (e.g., ocean current energy, tidal energy, wave energy, ocean thermal energy conversion, salinity gradient, riverine energy) on a scale of 1 (not familiar) to 5 (very familiar). They were provided with explanations of all of the terms presented from https://openei.org/wiki/PRIMRE/Basics. The results are presented in Figure 8 . The most familiar technology is tidal energy, with wave close behind, though both still score approximately at 3. The least familiar technology is salinity gradient.

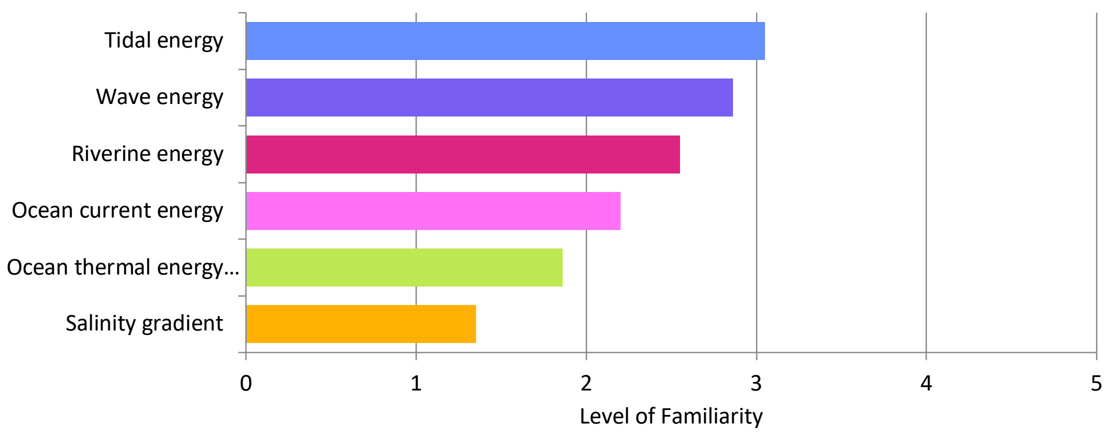

Figure 8. Average level of familiarity with marine renewable energy technologies from 1 (not familiar) to 5 (very familiar). (n = 21)

Top Challenges and Perceptions

The following questions differentiated between small arrays (one to six devices) and large arrays (more than six devices) of MRE devices to understand how perceptions of risk and information needs vary for different MRE project scales. Small arrays refer to projects with one to six devices, and large arrays refer to projects with more than six devices.

Small arrays

Respondents were asked to rank the following environmental effects by how challenging they are when permitting small arrays, from 1 (most challenging) to 7 (least challenging).

- Effects of electromagnetic field emissions from underwater cables and other electrical infrastructure on marine animals
- Attraction, avoidance, or displacement of marine animals
- Changes to habitats
- Effects of underwater noise from devices on marine animals
- Risk of marine animals colliding with turbine blades
- Changes in oceanographic systems (e.g., energy removal, sediment transport, etc.)
- Entanglement of large marine animals with mooring lines and underwater cables

Figure 9 (n = 21) shows respondents' perceptions of the level of challenge posed by environmental effects when permitting small arrays. The top-ranked challenges were calculated by Survey Monkey, such that the answer choice with the largest average ranking, or value, is the top challenge. In the US, the top challenges for respondents in consenting small arrays are changes to habitats; attraction, avoidance or displacement; and entanglement.

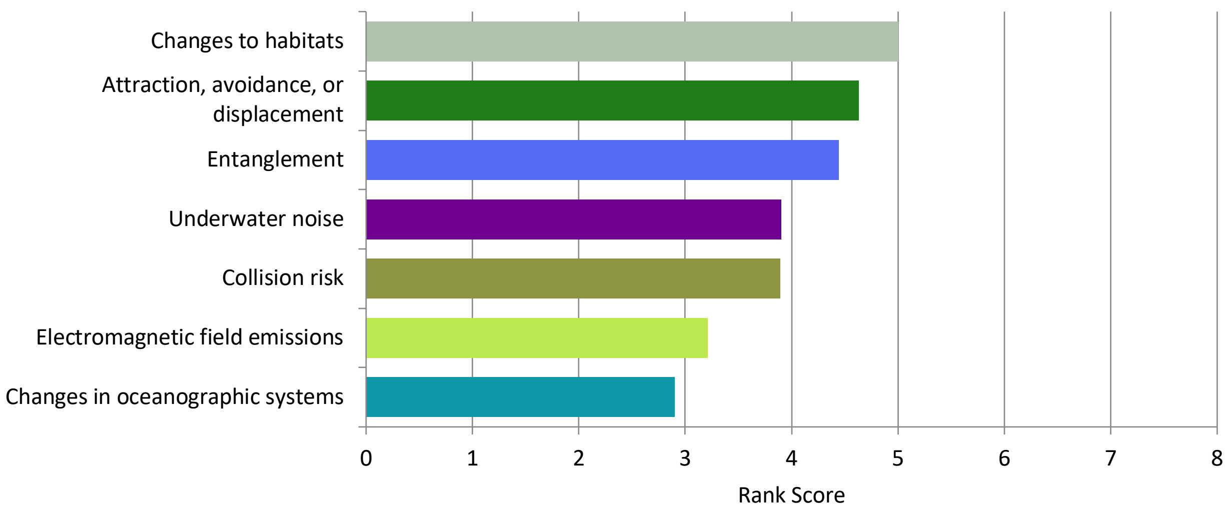

Figure 9. Ranking of challenges to permitting small arrays (one to six devices). (n = 21)

Respondents were also asked to rank their agreement with several statements regarding additional needs for permitting small arrays, with respect to their top-ranked challenges for small arrays. The results of this question are summarized in the heat map below (Table 1). Most respondents were either neutral or in agreement (agreed or strongly agreed with all statements). The strongest agreement was with the statement that regulators/advisors need to be knowledgeable and trained on MRE technologies.

Table 1. Perceptions of small array statements. (n = 21)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Additional research/studies are needed to understand the likely risk	0	0	5	8	8
Field data are needed to determine the risk and uncertainty of an MRE project	0	1	1	9	10
Validated numerical models are needed for environmental permitting	0	1	3	11	6
Agency/policy guidance is needed to interpret potential environmental risk and manage uncertainty	0	1	4	13	3
Regulators/advisors need to be knowledgeable and trained on MRE technologies, environmental interactions, etc.	0	0	1	7	13
Additional monitoring methods, instruments, etc. are needed to document environmental interactions	0	0	5	10	6

Large arrays

Respondents were asked to rank the following environmental effects by how challenging they are when permitting large arrays. Note that cumulative effects and ecosystem-wide effects were added for this question in contrast to small arrays.

- Effects of electromagnetic field emissions from underwater cables and other electrical infrastructure on marine animals
- Attraction, avoidance, or displacement of marine animals
- Changes to habitats
- Effects of underwater noise from devices on marine animals
- Risk of marine animals colliding with turbine blades
- Changes in oceanographic systems (e.g., energy removal, sediment transport, etc.)
- Entanglement of large marine animals with mooring lines and underwater cables
- Cumulative effects with other anthropogenic activities/marine developments, including other MRE projects
- Ecosystem-wide effects

Figure 10 (n = 21) shows respondents' perceptions of the level of challenge posed by environmental effects when permitting large arrays. The top-ranked challenges were calculated by Survey Monkey, such that the answer choice with the largest average ranking is the top challenge. In the US, the top challenges for respondents in permitting large arrays are changes to habitats, cumulative effects, ecosystem-wide effects, and entanglement.

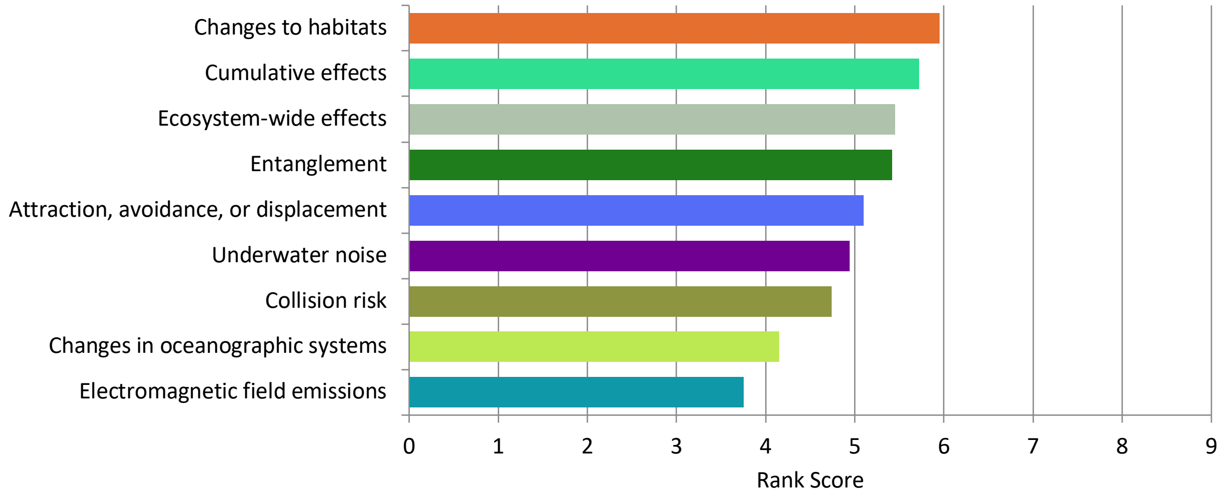

Figure 10. Ranking of challenges to permitting large arrays (more than six devices). (n = 21)

Respondents were also asked to rank their agreement with several statements regarding additional needs for permitting large arrays, with respect to their top-ranked challenges for large arrays. The results of this question are summarized in the heat map below (Table 2). Most respondents were either neutral or in agreement (agreed or strongly agreed with all statements). The strongest agreement was with the statements that regulators/advisors need to be knowledgeable and trained on MRE technologies, and that additional research is needed to understand the risk. There was also an increase in agreement that validated numerical models are needed for environmental permitting for large arrays and that guidance is needed to interpret risk compared to small arrays or single devices.

Table 2. Perceptions of large array statements. (n = 21)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Additional research/studies are needed to better understand the likely risk	0	0	2	7	12
Field data are needed to determine the risk and uncertainty of an MRE project	0	0	3	8	10
Validated numerical models are needed for environmental permitting	0	0	3	14	4
Agency/policy guidance is needed to interpret potential environmental risk and manage uncertainty	0	1	5	7	8
Regulators/advisors need to be knowledgeable and trained on MRE technologies, environmental interactions, etc.	0	0	3	5	13
Additional monitoring methods, instruments, etc. are needed to document environmental interactions	0	0	4	9	8

Barriers to Permitting

Respondents were asked to select statements that "Describe a barrier to permitting for you or your agency regarding environmental effects of MRE projects". The predefined statements and associated responses are shown in Figure 11.

In the US, the top barriers to permitting based on survey responses are scientific uncertainty regarding environmental effects; limited availability of research or environmental monitoring data; and inadequate technical knowledge of MRE devices. More than half of the state respondents and one federal respondent selected 'lack of expertise and/or access to subject matter experts' and 'inadequate knowledge of MRE devices' as a barrier to MRE permitting.

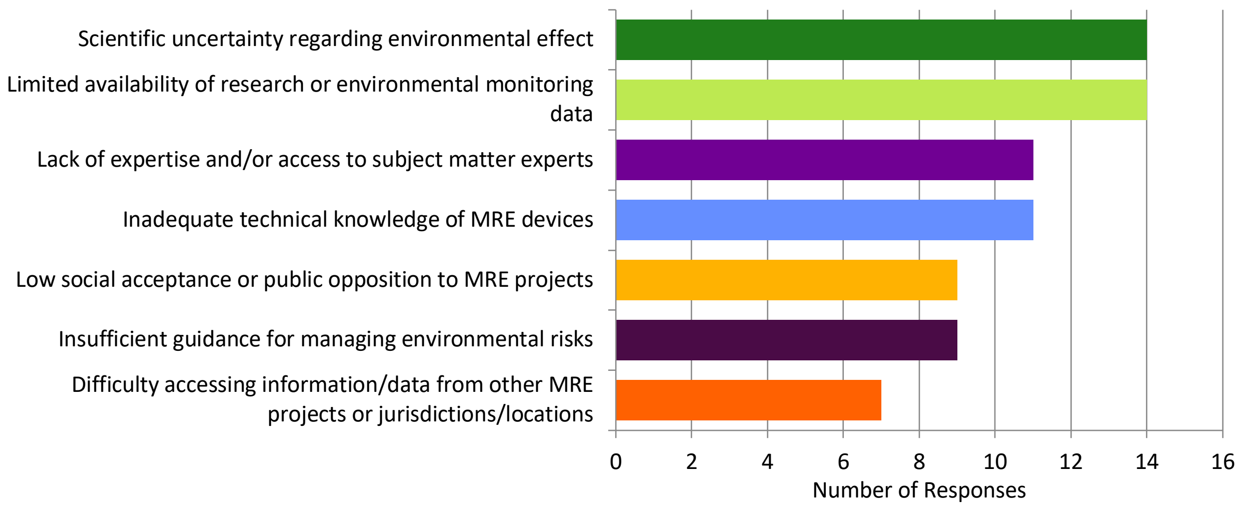

Figure 11. Barriers to permitting marine renewable energy projects. (n = 20)

Data Transferability and Risk Retirement

Risk retirement is a process to help simplify permitting processes for MRE devices by "retiring" risks of specific environmental interactions that are unlikely to cause harm to marine animals or habitats so that extensive investigations for every new MRE project are not required. Through data transferability, MRE developers and respondents may rely on what is known from already permitted projects, from related research studies, or from findings from analogous offshore industries. Risk retirement does not take the place of any existing regulatory processes or replace the need for appropriate data collection before, during, and after MRE device deployment. To guide the application of risk retirement and data transferability by MRE developers and respondents, OES-Environmental has created various tools and resources available on the Tethys Risk Retirement page and Data Transferability page.

Respondents were provided with the following definition of risk retirement:

> "Risk retirement is a process by which available data and information are examined to identify environmental effects that are unlikely to cause significant effects on marine

habitats, animals, or ecosystem processes. These effects can therefore be retired and may not require extensive investigation for each new MRE project."

Based on this definition, respondents were asked, "Can any of the following potential risks be retired for small arrays (one to six devices) in your jurisdiction?" Respondents ranked the ability to retire each of the following potential environmental risks as either strongly disagree, disagree, neutral, agree, or strongly agree.

- Effects of electromagnetic field emissions from underwater cables or other electrical infrastructure on marine animals
- Changes to habitats
- Attraction, avoidance, and displacement of marine animals
- Effects of underwater noise from devices on marine animals
- Risk of marine animals colliding with turbine blades
- Changes in oceanographic systems (e.g., energy removal, sediment transport, etc.)
- Entanglement of large marine animals with mooring lines and underwater cables

Figure 12 shows respondents' perceptions on retiring risks for small arrays (one to six devices). Most disagreed with retiring the pre-defined risks, particularly changes to habitats (68% strongly disagree or disagree) and entanglement (63% strongly disagree or disagree). Few respondents agreed on retiring the risks, with retirement of collision risk receiving the highest level of agreement (26% agree). Open response comments provided explanations for respondents' disagreement with retiring the environmental risks of MRE, emphasizing insufficient data and a lack of commercial scale examples, unique species and habitats, technology-specific risks, and potential changes in environmental conditions or species distributions during permitting processes.

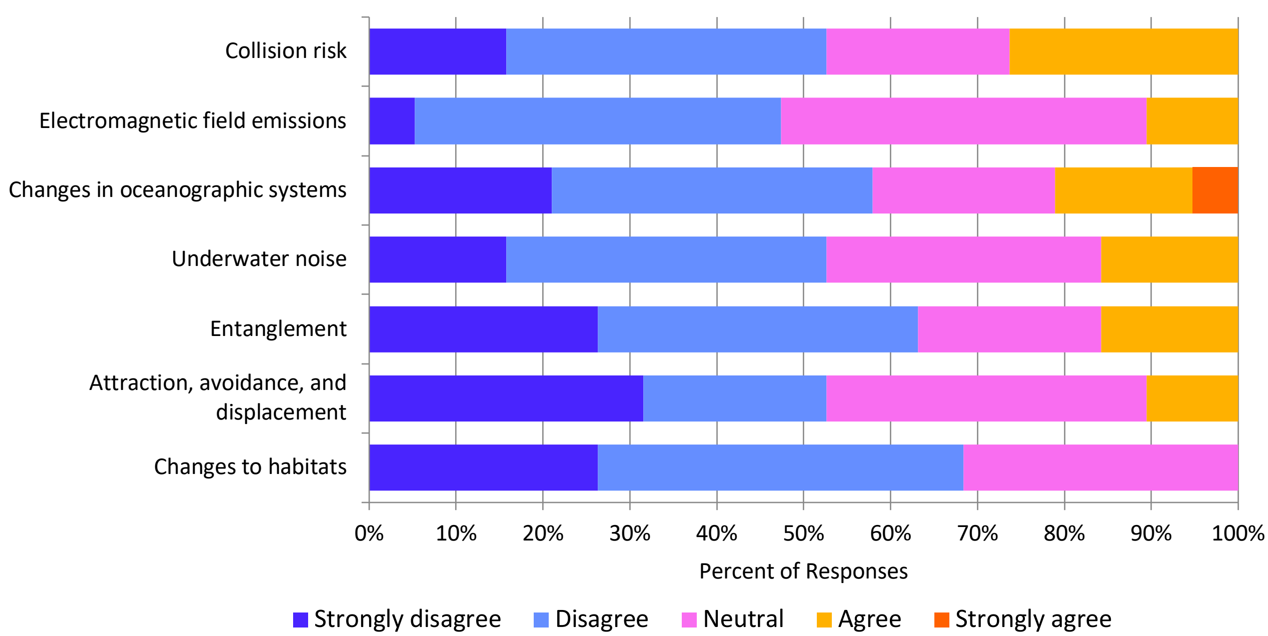

Figure 12. Ability to retire risks for small arrays (one to six devices). (n = 19)

Selected comments on risk retirement are included below.

- "Some [risks] may be close to retirement but without deploying and monitoring after commercial scale projects, it can be difficult to conclude that all risks are adequately understood."
- "… if the data was all from one region, it seems more likely that some of the risks could be retired. However, my response is based on these [data] not necessarily being from the same region."
- "… each location has different characteristics that must be understood to understand the impacts and formulate a plan to avoid, mitigate or compensate. Species are moving due to climate change so one location can never rule out that they will never see a species and hence forever into the future not need to consider them... We need our eyes open to monitor the situation as it evolves. The earth is not in a steady state... Human policies and actions can change more rapidly than the permitting cycle."
- "Changes to habitats should be further studied, given the novelty of these devices/approaches. The cumulative impacts of these activities should also be evaluated for small arrays."
- "For most marine animals, impacts of MRE systems (specifically tidal) have been assessed with a single device, or with playback studies, [and] the data don't yet appear to exist to provide a sufficient understanding of what kind of displacement/avoidance, or acoustic impacts might occur…"
- "I personally have not read any studies that would lead me to believe that tidal or wave turbines would have no effects on species (birds, whales, fish, inverts) [in my area]..."
- "There are much more disruptive technologies that are permitting and in operation. It's ridiculous that renewable energy sources are given more scrutiny than deep sea drilling or industrial scale fishing operations."
- "I understand the scientific rational for retiring risk but do not agree it is appropriate for most public permitting processes."
- "[I d]on't know enough about MRE to make a determination of effects, but if an entity can clearly demonstrate no effect or not likely to adversely affect, then the consultation process becomes much quicker."

Respondents were also asked to respond to the question: "Can data collected at other locations be used to inform permitting processes for proposed MRE developments within your jurisdiction?" Respondents were given the options of 'Never', 'Maybe', and 'Absolutely'. The majority of respondents selected 'Absolutely' (40% of respondents) or 'Maybe' (50% of respondents), while only 10% of respondents selected 'Never' (Figure 13). Additional comments provided by respondents emphasized the challenges of transferring data between sites due to site-specific environmental conditions, MRE technology differences, and changing data collection methods. They noted that baseline data must be collected locally, and location-specific conditions limit the applicability of data transferability.

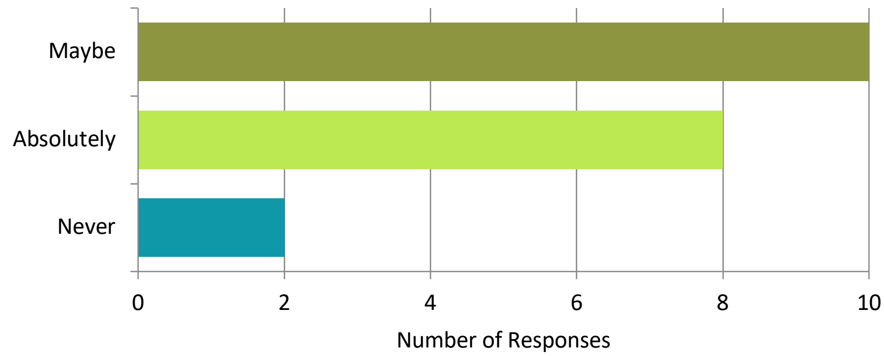

Figure 13. Ability to use data collected at other locations to inform permitting processes for proposed marine renewable energy developments. (n = 20)

Selected comments on data transferability are included below.

- "There are so many variables that need to be considered when comparing projects between different locations and in many cases it is not possible to transfer all of the data collected between sites/projects. Examples of such variables include: substrate type; contours of project area and overall waterbody; depths of installed devices; channel width; tidal flow and variation across the project area and waterbody; technology utilized; number of devices installed; fetch; sensitivity of species. Further, the way that data is collected is shifting as this field grows, so there may be inconsistencies in approaches. Even in large estuary, there may be so much difference between specific locations that not all of the data collected at one site would be relevant to another (e.g., sediment movement, habitat impacts)."
- "Of course this depends on species that were found in the environment prior to surveys and installation and operation... it depends on the physical characteristics of the environment. The initial and boundary conditions may be different from site to site. Variables of interest may change from location to location… Data from ideal and other locations must be reviewed and considered for each case, nothing will apply universally. This is the same for all applied science…"
- "Many findings can be translatable, some findings are specific to certain settings and assemblages of organisms."
- "Environmental data collected at other locations will likely be able to inform the permitting process to a degree, especially if there are similarities in species presence… But the applicability of the data will also depend on the device type and how many devices were deployed when the data were collected... However, regardless, baseline environmental data will need to be collected that is site-specific and this will require field measurements and monitoring..."
- "Locations would have to be fairly similar both ecologically and in terms or predominant socioeconomic uses in the area such as fishing and recreation."
- "We have learned a lot about some of the effects (or no effects) of offshore wind from the experiences of European countries. I think it is fine to use studies from other areas to predict impacts in [my area] but the predictions should be followed with local monitoring."
- "While conceptually I think it is possible, I have never seen in practice."

- “There are unique species in [my area] that may not be applicable elsewhere.”
- “Quality data collected at other MRE locations would be useful to inform other MRE developments even if environmental conditions are different. That said, all conditional differences would need to be considered.”

Best Approach to MRE Development

Respondents were asked, “Which of the following approaches best describes your strategy for managing environmental risks and uncertainties during the permitting process when moving from small arrays (one to six devices) to large arrays (greater than six devices) (Choose one)”. The options, as provided to respondents in the survey, are listed below:

- *Precautionary principle*. Potential environmental risks should be avoided through preventative measures and consideration of alternatives to avoid unacceptable impact, particularly when there is scientific uncertainty. Project proponents are responsible for proving that a risk will not cause irreversible environmental harm.
- *Mitigation hierarchy*. Potential environmental risks should be systematically limited by taking actions to avoid, minimize, mitigate and/or compensate for risks through siting and/or mitigation measures.
- *Adaptive management*. Potential environmental risks and scientific uncertainty can be managed through a flexible, learning-based approach that includes adapting monitoring and mitigation over time to understand risks, decrease uncertainty, and mitigate impacts.
- *Survey, deploy, monitor*. Potential environmental risk level should be identified through surveys or available data at a proposed project site. If low risk, permitting may be fast-tracked. If high risk, the project may require additional surveys. Surveys and post-deployment monitoring should be based on a risk-based approach and proportionate to the project scale.

When managing environmental risks and uncertainties during permitting processes for MRE projects scaling from small to large arrays, the most common strategy was precautionary principle (41% of respondents), followed by adaptive management (29% of respondents) and mitigation hierarchy (29% of respondents) (Figure 14).

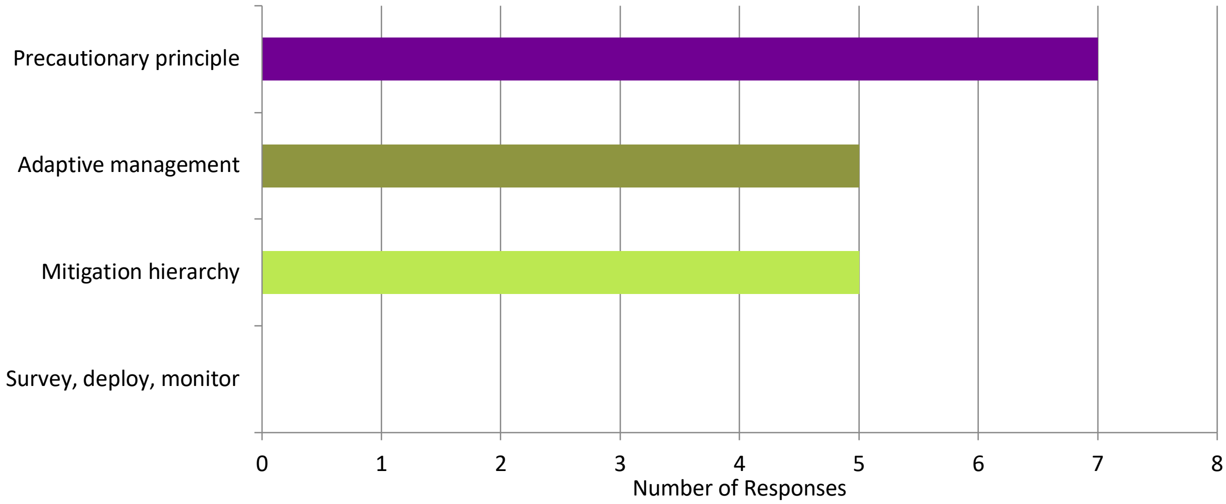

Figure 14. Strategy for managing environmental risks and uncertainties during the permitting process when moving from small arrays (one to six devices) to large arrays (greater than six devices). (n = 17)

Respondents provided additional responses, which are shown in Table 3 next to the management strategy selected. Open response options highlighted the need for flexibility in applying various management strategies, with most respondents using a combination of listed strategies. Two respondents noted a norm or mandate to initially manage risks using the precautionary principle, and another respondent emphasized the use of adaptive management to expedite development and ensure stakeholder involvement.

Table 3. Selected strategies for managing environmental risks and uncertainties during the permitting process when moving from small arrays (one to six devices) to large arrays (greater than six devices. (n = 17)

Management strategy selected	Additional Comment
Precautionary principle	"The precautionary principle is the default for how we regulate. Mitigation hierarchy is also possible depending on the level of impact (must be small). The other approaches are unlikely."
	"Actually, I agree with all of these statements. I think you start with the precautionary principle, use a mitigation hierarchy to address impacts that are both known and unknown, use adaptive management to change projects or monitoring methods as new data comes in, and you have to survey and monitor in order to inform adaptive management and to verify your assumptions in the original mitigation framework."
	"State law requires avoidance and minimization via an alternatives analysis before any mitigation can be considered"
Mitigation hierarchy	"Generally, mitigation hierarchy is applied, but there is also a component of surveying and monitoring for effects with adaptive management as needed depending on what is observed. Mitigation may be required for impacts not initially anticipated."

Adaptive Management	"Marine development must be adaptive management. The capital cost of marine infrastructure is larger than terrestrial. Thus, we should be planning and permitting for long life infrastructure. This approach requires that we move slowly and deliberately toward a unified goal. This approach would also provide permitting certainty to investors who have the resources to develop MRE infrastructure. Most importantly, the staged and managed development would allow stakeholders to be involved with the process and not steamrolled or disregarded and we could learn together as a community with the understanding that if we negatively impact resources, the activity will be limited to what has been developed. This will oppose the economic gain models for levelized cost of energy, but it will actually get the projects built. MRE installations are new technologies, and the opposition will be strong. We need adaptive management to include the various stakeholders and the public to learn together if the MRE is a viable technology for that area."
	"A combination of all of these, and mainly mitigation hierarchy and adaptive management."
Other	"A combination of all 4 options is ideal."

Off-grid MRE

Respondents were asked:

> "MRE devices are being designed for uses other than supplying electricity to the national grid. These systems are likely to consist of fewer and/or smaller-scale devices, to provide power to remote, coastal, or island communities or at-sea applications such as aquaculture, ocean observations, and navigation. Would the permitting process for these smaller MRE projects differ from national grid-scale projects in your jurisdiction?"

Responses were collected via an open comment box and categorized by level of certainty (e.g., no difference, potential difference, known difference). While "No" was the most frequent response (33%), the majority of respondents (61%) indicated a potential or known difference between permitting processes for national grid-scale projects and smaller-scale MRE projects (Figure 15). Respondents highlighted several factors that could lead to permitting differences, including higher local benefits and community support for smaller devices, energy capacity thresholds used to inform permitting processes, simplified processes in state waters versus federal waters, and reduced risks to large mammals for nearshore deployments. However, some respondents argued that permitting would not differ due to similar environmental risks across project scales and the early stage of MRE technologies. Notably, 55% of responses expressed certainty (Yes/No), while 45% showed less confidence in their response (Maybe/Unknown) (Figure 15).

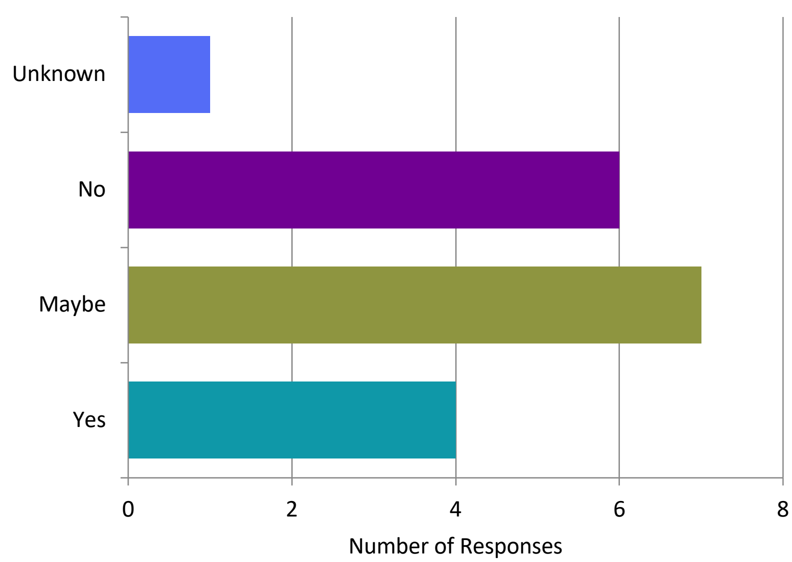

Figure 15. Would the permitting process for smaller marine renewable energy projects differ from national grid-scale projects in your jurisdiction? (n = 20)

Use of Tethys

In addition to questions about permitting MRE projects, respondents were asked how they find information on the environmental effects of MRE and their awareness and use of the [Tethys online database.](#) The results are provided in the subsections below.

Finding Information

Respondents were asked, “What resources or methods do you use to find information on the environmental effects of MRE and support permitting? (check all that apply)”. The response options included:

- Other regulators/colleagues
- MRE project developers
- Conferences/workshops
- Newsletters
- Scientific journals
- Government agency reports
- Tethys

Figure 16 (n = 20) shows that respondents most frequently obtain information on the environmental effects of MRE from other regulators or colleagues, followed by scientific journals and MRE project developers. All of the respondents working at a federal level of government obtain information on MRE from project developers, while state-level respondents most commonly rely on other regulators or colleagues (88% of state-level respondents).

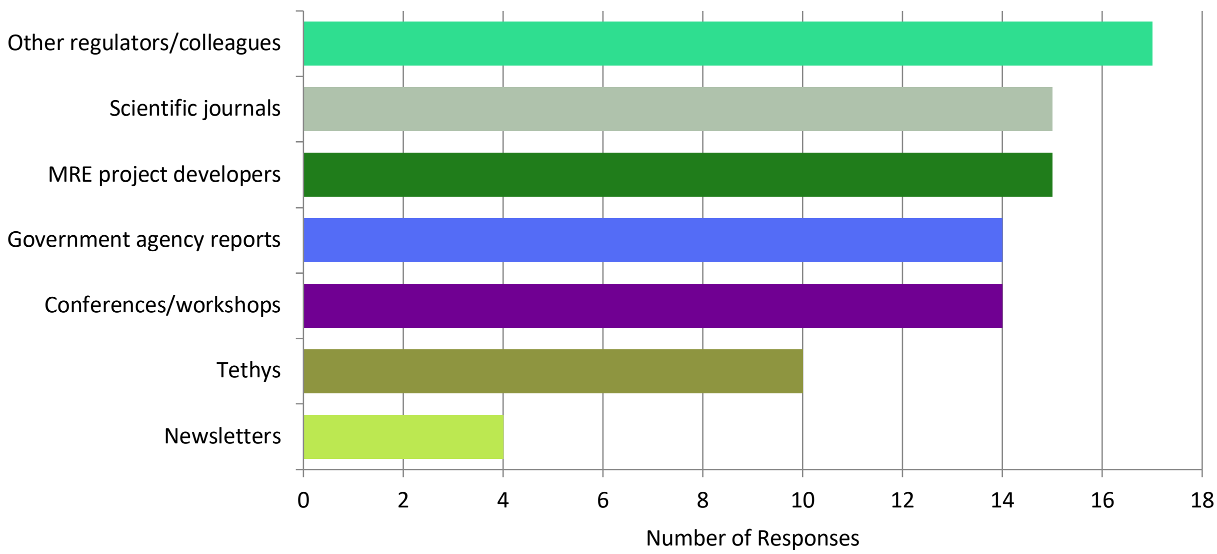

Figure 16. Resources and methods used to find information on environmental effects of marine renewable energy and support permitting. (n = 20)

Awareness, Purpose, and Usefulness

When asked if they had heard of Tethys, 60% of respondents responded “Yes” and 40% responded “No”. Respondents unfamiliar with Tethys were asked a follow-up question, “After learning about Tethys, is it likely that you will explore it further?”. Most expressed potential interest, selecting "Maybe" (62%), while a smaller portion indicated clear interest in exploring Tethys further.

Respondents who were familiar with Tethys were asked to indicate how they use Tethys by indicating all uses that apply from the following list:

- To find papers and reports on the environmental effects of MRE
- To view live or archives webinars and expert forums
- To receive Tethys Blast newsletter
- To find project information (e.g., OES-Environmental metadata)
- To use tools and resources (e.g., data discoverability matrix, management measures tool, etc.)

Shown in Figure 17 (n = 12), most respondents use Tethys to find papers and reports on environmental effects of MRE and to receive the Tethys Blast Newsletter. One respondent noted under “other” that they use Tethys to reduce duplication of effort, stating: “If I do not want to redo an analysis or [if] yours parallels mine, I will cite your conclusions...”

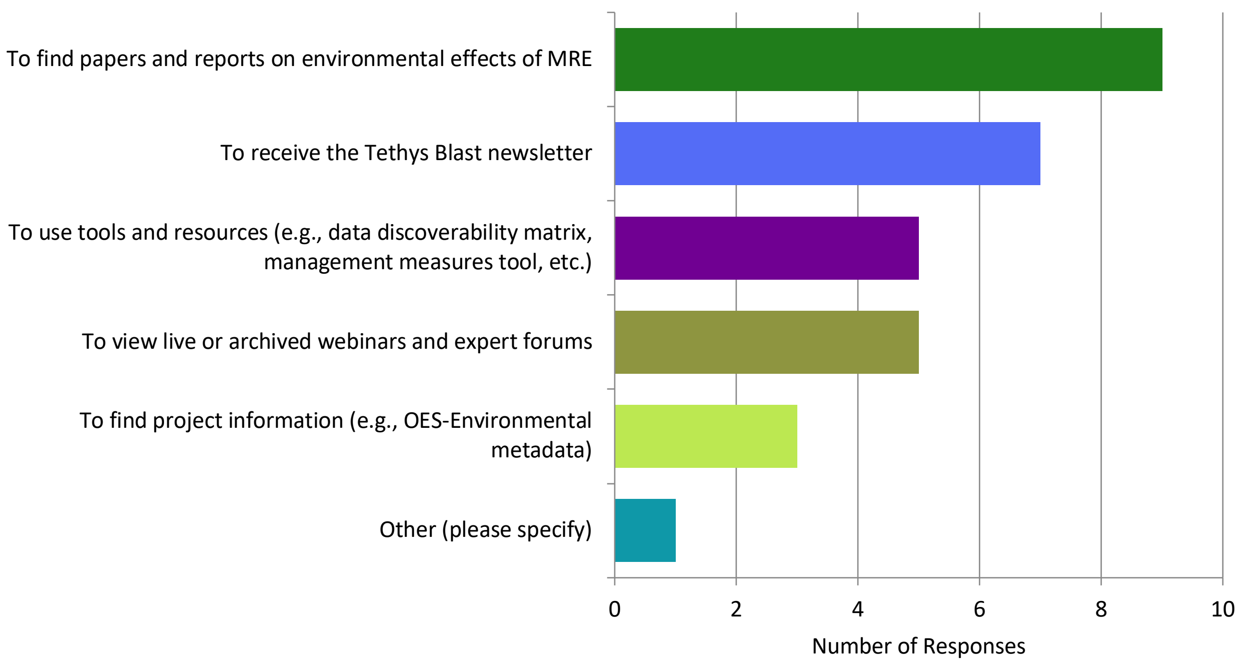

Figure 17. How do you use Tethys? (n = 12)

Respondents who were familiar with Tethys were also asked how useful they find Tethys (not useful, somewhat useful, very useful). Most respondents indicated that they find Tethys very useful (58%), while the rest find it somewhat useful (42%) (Figure 18).

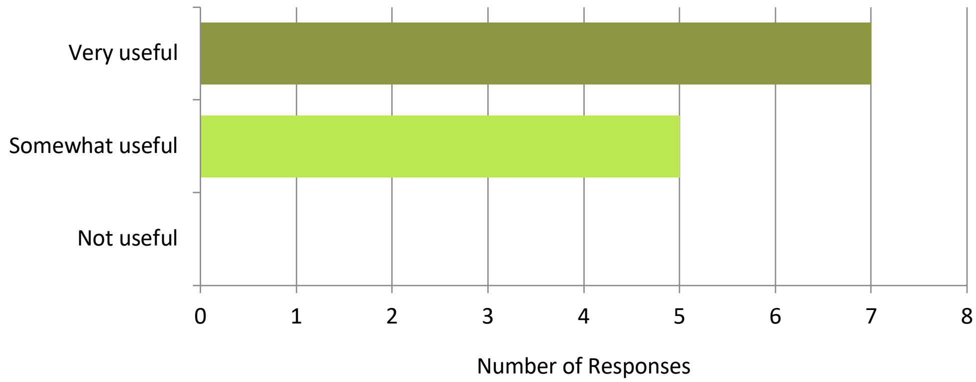

Figure 18. Do you find Tethys useful? (n = 12)

Conclusion

Most of the 33 respondents in the US who participated in the survey have more than five years of experience in a position related to permitting processes for MRE projects. The respondents are most familiar with tidal and wave energy but their overall knowledge of MRE technologies is limited. While MRE projects are relatively common in respondents' jurisdictions, most lack direct experience with the regulatory process for MRE, suggesting that the survey may not fully represent the broader population of US regulators and advisors involved in MRE projects.

Listed below are the key findings and implications from the 2025 US Regulator Survey:

- Regardless of MRE project scale, respondents perceived changes to habitat as the most challenging environmental effect of MRE. They also highlighted the need for more research and field data to assess environmental risks. This suggests that efforts to support MRE permitting in the US may benefit further from additional research, environmental monitoring, and the development of accessible materials focused on habitat-related risks across different MRE technologies and project scales.

- Respondents viewed entanglement as more challenging for large arrays (more than six devices) than for small arrays (one to six devices). This suggests that US regulators and advisors may associate larger deployments with more complex mooring systems and greater entanglement risk. As projects scale up, MRE developers may need to examine mooring system design and installation to reduce the risks of entanglement.

- Notable differences in perceptions were observed between respondents working at the federal and state levels of government. Regardless of array size, federal respondents ranked collision risk as the most challenging environmental effect of MRE, while state respondents ranked it as one of the least challenging. In contrast, federal respondents ranked changes to habitat as one of the least challenging, while state respondents ranked it as the most challenging. One potential explanation for this difference in perception is that federal regulators and advisors are involved in every MRE project through consultation, direct regulation, or as a National Environmental Policy Lead, whereas state regulators and advisors may see only a small number of projects within their jurisdictions. However, broader conclusions about differences in perceptions across government levels cannot be drawn due to the low number of federal respondents.

- The respondents strongly agreed on the need for additional environmental data to better understand potential risks, increased access to information and expertise, and additional training for regulators to increase understanding of MRE technologies. This, coupled with their strong opinions on the usefulness of Tethys and related tools, suggests that continued use of Tethys as a communication platform for environmental data, as well as additional educational or training materials, will be valuable to regulators.

- Most of the respondents disagreed that environmental risks can be retired, citing site- and technology-specific factors, along with rapidly changing environmental conditions and species distributions. Some respondents were more supportive, emphasizing a need for additional monitoring and data collection, especially for larger-scale arrays to better understand the risk of cumulative effects. More widespread acceptance of risk retirement in the US would likely require additional environmental data collected from diverse types and scales of MRE projects, as well as targeted outreach and education.

- The respondents indicated openness or support for using data from other locations to inform permitting for new MRE projects, while emphasizing the need for locally collected baseline data and acknowledging the limitations of data transferability due to site- and technology-specific factors. This suggests that data transferability, when applied in appropriate circumstances, could be widely accepted as a method to streamline MRE permitting processes in the US. Additionally, the limitations mentioned by respondents reflect a widespread need for additional information and guidance on data transferability based on environmental- and MRE technology-specific characteristics.

- While cumulative effects were not provided as a response option for small arrays, their ranking as a greater challenge for large arrays suggests heightened concern or uncertainty among US respondents regarding the potential environmental risks of larger-scale MRE projects as they are added to an already busy marine environment.

- The respondents suggested that permitting processes for off-grid MRE devices may differ from grid-connected projects. However, mixed confidence in responses highlights uncertainty surrounding the permitting requirements for small-scale MRE projects in the US.

Additionally, similarities and differences in responses were identified between the 2025 US Regulator Survey and the previous US Regulator Survey conducted by OES-Environmental in

August 2017[2]. In both iterations, respondents reported low familiarity with MRE technologies, agreed that data can be transferred across sites and projects, and emphasized the need for additional training for regulators and advisors. However, top permitting challenges differed: in 2017, the most common challenge for arrays was "Avoidance, Attraction, and Displacement," while in 2025 it was "Changes to Habitat" for small arrays. Attitudes toward management approaches also shifted. Few respondents selected the 'Precautionary Principle' in 2017, while it was the most common strategy selected in 2025. This suggests either a shift in the use of the precautionary principle in regulatory language in the US, or that, as MRE projects expand, US regulators and advisors may be increasingly favoring risk-averse management approaches. Differences in respondents as well as question language between the 2017 and 2025 iterations—broad risk management for general MRE projects versus scaling to larger projects—make it unclear if this observation accurately reflects changes in US regulatory language, regulator and advisor perceptions of MRE permitting, or risk tolerance for single devices as compared to larger arrays.

Understanding regulators and advisors' needs and challenges over time helps address key barriers to the advancement of the MRE industry. By identifying these evolving needs, information and tools can be developed that are relevant in various contexts. Accordingly, expanded training and more direct engagement with regulators across the US are needed to address persistent information gaps that limit confidence in permitting MRE devices and arrays.

[2] Dreyer, S. (2017). MRE Regulator Survey Report: United States. https://tethys.pnnl.gov/publications/mre-regulator-survey-report-united-states

Appendix A

#	Question	Potential Choices
1	What level of government does your agency represent?	- Federal - State - County - Local - Other (please specify)
2	What state do you work in?	- Text box
3	How many MRE (wave, tidal, current, thermal or salinity gradient) projects are currently planned, permitted or operational in your jurisdiction?	- 0 - 1-5 - 6-10 - >10
4	Please indicate your agency's focus for permitting MRE projects. Check all that apply.	- Water quality - Marine mammals - Fish/fisheries - Other animals - Seabed and habitat - Oceanographic systems - Energy production - Social and economic aspects - Other (please specify)
5	Please indicate your role in permitting MRE projects. Check all that apply.	- Issue licenses/permits - Manage licenses/permits during operational phase - Advise regulators or provide consultations - Review/advise on applications for licenses/permits - Advise policy-level decisions in your agency - Subject matter expert - Other (please specify)
6	How long have you held a position related to the permitting process for MRE projects?	- Less than 1 year - 1-2 years - 3-5 years - >5 years
7	Have you directly participated in the regulatory process for an MRE project?	- Permitting - Management of an operational project - Decommissioning - No

8	How familiar are you with the following MRE technologies on a scale of 1 (not familiar) to 5 (very familiar)? For more information on these technologies, see https://openei.org/wiki/PRIMRE/Basics.	- Ocean current energy - Tidal energy - Wave energy - Ocean thermal gradient conversion (OTEC) - Salinity gradient - Riverine energy
9	How challenging are the following MRE environmental effects when permitting **small arrays (1-6 devices)**? Rank the below options from 1 (most challenging) to 7 (least challenging).	- Effects of electromagnetic field emissions from underwater cables and other electrical infrastructure on marine animals - Attraction, avoidance, or displacement of marine animals - Changes to habitats - Effects of underwater noise from devices on marine animals - Risk of marine animals colliding with turbine blades - Changes in oceanographic systems (e.g., energy removal, sediment transport, etc.) - Entanglement of large marine animals with mooring lines and underwater cables
10	Based on your top-ranked response from Question 19, how strongly do you agree or disagree with the following statements for **small arrays (1-6 devices)**?	- Additional research/studies are needed to better understand the likely risk - Field data are needed to determine the risk and uncertainty of an MRE project - Validated numerical models are needed for environmental permitting - Agency/policy guidance is needed to interpret potential environmental risk and manage uncertainty - Regulators/advisors need to be knowledgeable and trained on MRE technologies, environmental interactions, etc. - Additional monitoring methods, instruments, etc. are needed to document environmental interactions
11	How challenging are the following MRE environmental effects when permitting **large arrays (greater than 6 devices)**? Rank the below options from 1 (most challenging) to 9 (least challenging).	- Effects of electromagnetic field emissions from underwater cables and other electrical infrastructure on marine animals - Attraction, avoidance, or displacement of marine animals - Changes to habitats - Effects of underwater noise from devices on marine animals - Risk of marine animals colliding with turbine blades - Changes in oceanographic systems (e.g., energy removal, sediment transport, etc.) - Entanglement of large marine animals with mooring lines and underwater cables - Cumulative effects with other anthropogenic activities/marine developments, including other MRE projects - Ecosystem-wide effects
12	Based on your top-ranked response from Question 11, how strongly do you agree or disagree with the following statements for **large arrays (greater than 6 devices)**?	- Additional research/studies are needed to better understand the likely risk - Field data are needed to determine the risk and uncertainty of an MRE project - Validated numerical models are needed for environmental permitting

		- Agency/policy guidance is needed to interpret potential environmental risk and manage uncertainty - Regulators/advisors need to be knowledgeable and trained on technologies, environmental interactions, etc. - Additional monitoring methods, instruments, etc. are needed to document environmental interactions
13	Do any of the following statements describe a barrier to permitting for you or your organization regarding environmental effects of MRE projects? Select all that apply.	- Insufficient guidance for managing environmental risks - Limited availability of research or environmental monitoring data - Inadequate technical knowledge of MRE devices - Lack of expertise and/or access to subject matter experts - Difficulty accessing information/data from other MRE projects or jurisdictions/locations - Scientific uncertainty regarding environmental effect - Low social acceptance or public opposition to MRE projects
14	Can environmental data collected at other locations be used to inform permitting processes for proposed MRE developments within your jurisdiction?	- Never - Maybe - Absolutely - Comment box: Please explain your answer.
15	Risk retirement is a process by which available data and information are examined to identify environmental effects that are unlikely to cause significant effects on marine habitats, animals, or ecosystem processes. These effects can therefore be retired and may not require extensive investigation for each new MRE project. Can any of the following potential risks be retired for **small arrays (1-6 devices)** in your jurisdiction? (Strongly disagree, disagree, neutral, agree, strongly agree)	- Effects of electromagnetic field emissions from underwater cables or other electrical infrastructure on marine animals - Changes to habitats - Attraction, avoidance, and displacement of marine animals - Effects of underwater noise from devices on marine animals - Risk of marine animals colliding with turbine blades - Changes in oceanographic systems (e.g., energy removal, sediment transport, etc.) - Entanglement of large marine animals with mooring lines and underwater cables - Comment box: For environmental effects that cannot be retired, please explain
16	Which of the following approaches best describes your strategy for managing environmental risks and uncertainties during the permitting process when moving from small arrays (1-6 devices) to large arrays (greater than 6 devices)? (Choose one)	- Precautionary principle. Potential environmental risks should be avoided through preventative measures and consideration of alternatives to avoid unacceptable impact, particularly when there is scientific uncertainty. Project proponents are responsible for proving that a risk will not cause irreversible environmental harm. - Mitigation hierarchy. Potential environmental risks should be systematically limited by taking actions to avoid, minimize, mitigate and/or compensate for risks through siting and/or mitigation measures. - Adaptive management. Potential environmental risks and scientific uncertainty can be managed through a flexible, learning-based approach that includes adapting monitoring and mitigation over time to understand risks, decrease uncertainty, and mitigate impacts. - Survey, deploy, monitor. Potential environmental risk level should be identified through surveys or available data at a proposed project site. If low risk, permitting may be fast-tracked. If high risk, the project may require additional surveys. Surveys and post-deployment monitoring

		should be based on a risk-based approach and proportionate to the project scale. - Comment box: Please explain your answer or note a different approach used.
17	MRE devices are being designed for uses other than supplying electricity to the national grid. These systems are likely to consist of fewer and/or smaller-scale devices, to provide power to remote, coastal, or island communities or at-sea applications such as aquaculture, ocean observations, and navigation. Would the permitting process for these smaller MRE projects differ from national grid scale projects in your jurisdiction?	- Open comment box
18	Tethys (https://tethys.pnnl.gov/) is an online knowledge hub with information and resources on the environmental effects of MRE. Have you heard of Tethys?	- Yes - No
19	After learning about Tethys, is it likely that you will explore it further?	- Yes - No - Maybe
20	Do you find Tethys useful?	- Not useful - Somewhat useful - Very useful
21	How do you use Tethys? Indicate all that apply.	- To find papers and reports on environmental effects of MRE - To view live or archived webinars and expert forums - To receive the Tethys Blast newsletter - To find project information (e.g., OES-Environmental metadata) - To use tools and resources (e.g., data discoverability matrix, management measures tool, etc.) - Other (please specify)
22	What resources or methods do you use to find information on the environmental effects of MRE and support permitting? (check all that apply)	- Other regulators/colleagues - MRE project developers - Conferences/workshops - Newsletters - Scientific journals - Government agency reports - Tethys - Other (please specify)