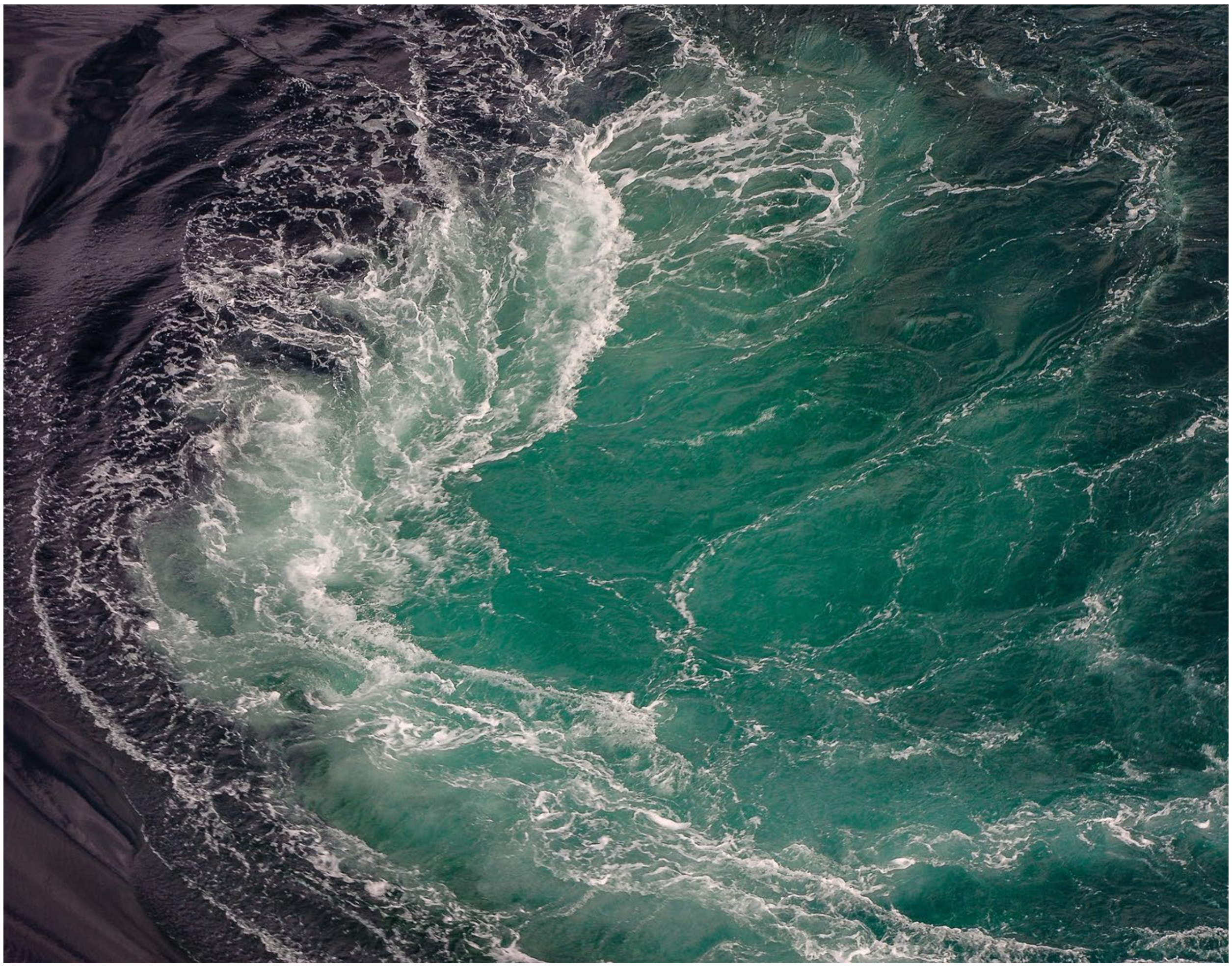
Marine Renewable Energy Regulator Survey: *CANADA*



Prepared by Jacob McGrath, Deborah Rose, and Mikaela Freeman

April 2026

Table of Contents

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 potential environmental effects of MRE. Its purpose was to understand regulators and advisors' familiarity with MRE technologies, perceptions of potential environmental risks associated with MRE technologies across varying scales, and views on best approaches to MRE development, including permitting and the applicability of data transferability. The survey also included questions to collect information on the use of Tethys. A list of questions and answer options are provided in Appendix A.

This report summarizes the results from the survey of regulators and advisors in **Canada**. Results are compared to the previous survey for Canada, conducted and published in 2020[1].

Participants

Email invitations for the 2026 Survey on Regulatory Needs Regarding Environmental Effects of Marine Renewable Energy were sent to 40 individuals known to be involved in permitting MRE in Canada. Nine full responses were received and retained for analysis.

When asked which levels of government respondents' organizations represent, five respondents indicated that they work at the federal government level and three indicated a provincial or territorial level. One respondent added an additional comment, noting that they work for a university. While this respondent stated they are "Not directly involved in any permitting decision", they have been included in the survey results due to their self-reported advisory role in MRE permitting processes.

[1] Rose, D.; Freeman, M. (2020). MRE Regulator Survey Report: Canada. https://tethys.pnnl.gov/publications/mre-regulator-survey-report-canada

Figure 1 shows the provinces in which the respondents work. Three respondents work in Nova Scotia, five respondents work in British Columbia, and one respondent works in Alberta. Due to survey confidentiality, it is unknown whether the respondents working at a federal level of government hold responsibilities across multiple provinces.

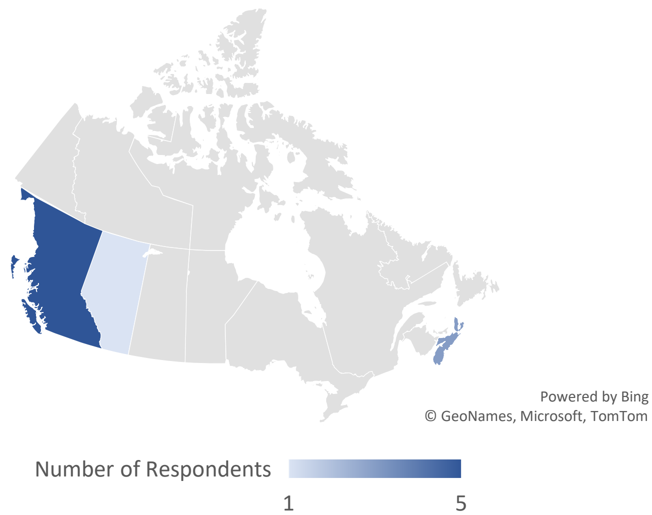


Figure 1. Provinces represented. (n = 9)

When asked about the number of planned, permitted, or operational MRE projects in their jurisdiction, two respondents reported that there are no projects and seven respondents reported between one and five projects.

Respondents were also asked to indicate their agency's focus for permitting MRE developments (Figure 2). Under 'other', one respondent added "First Nations" and the respondent working at a university noted "Not directly involved in any permitting decision" but that they advise as a subject matter expert. Only respondents working in Novia Scotia selected oceanographic systems, other animals, and water quality.

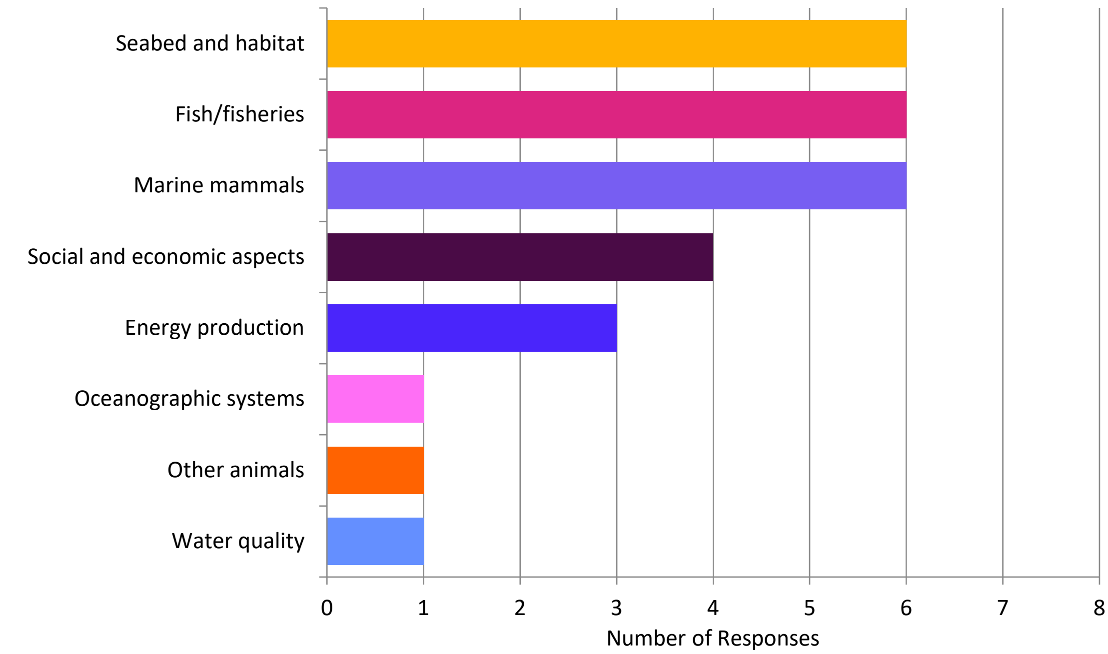


Figure 2. Agency focus in permitting marine renewable energy projects. (n = 8)

Figure 3 shows each respondent's role in permitting MRE projects. The most common roles among respondents are reviewing or advising on applications for licenses or permits, as well as issuing licenses or permits. Respondents could select multiple roles, and many reported working across more than one of the roles included in the survey.

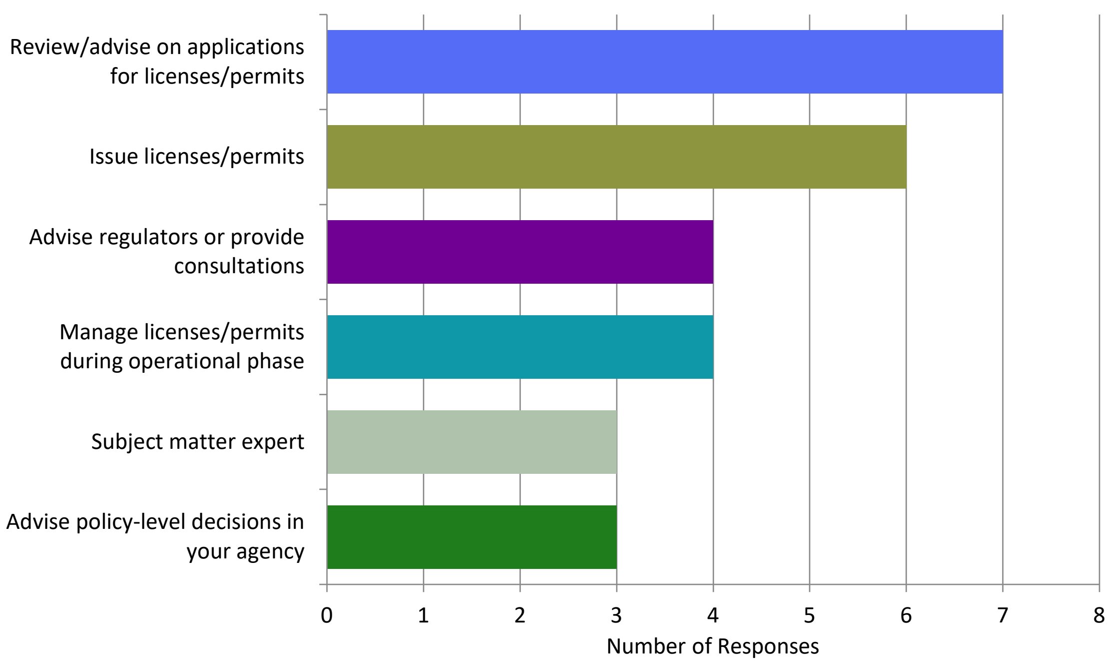


Figure 3. Respondent's role in permitting marine renewable energy projects. (n = 9)

Figure 4 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 positions for more than five years.

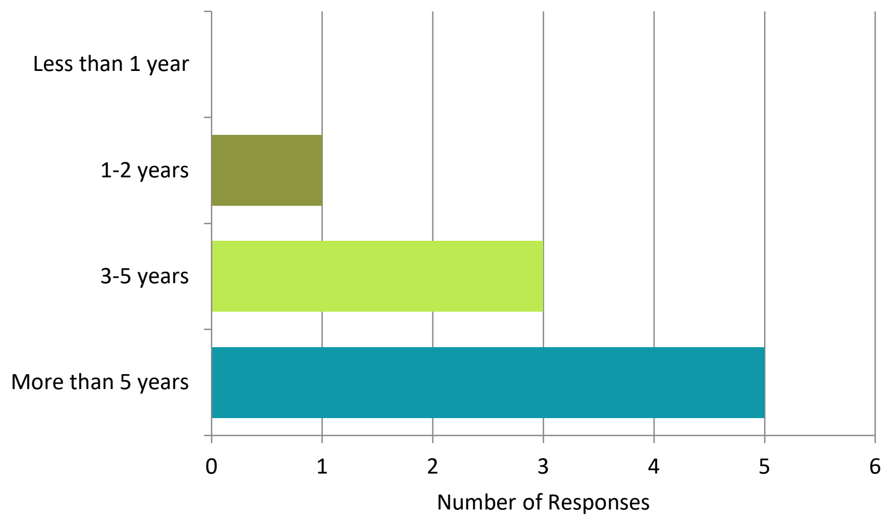


Figure 4. Length of time in a position related to the permitting process for marine renewable energy projects. (n = 9)

Respondents were asked if they had directly participated in the regulatory process for an MRE project. Eight of the respondents indicated that they have been directly involved in an MRE project permitting process, while only one respondent indicated that they have not been directly involved.

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 the terms presented from https://openei.org/wiki/PRIMRE/Basics. The results are presented in Figure 5. The respondents indicated a high level of familiarity with tidal energy and moderate familiarity with wave, ocean current, and salinity gradient energy. The least familiar technologies are salinity gradient and ocean thermal energy conversion. While respondents working in British Columbia and Alberta reported high levels of familiarity with wave energy, it was the least familiar MRE technology for respondents in Nova Scotia, who instead were most familiar with tidal energy. This aligns with the regional distribution of MRE resources in Canada, as British Columbia has significant wave energy potential while the Bay of Fundy in Nova Scotia has significant tidal energy potential.

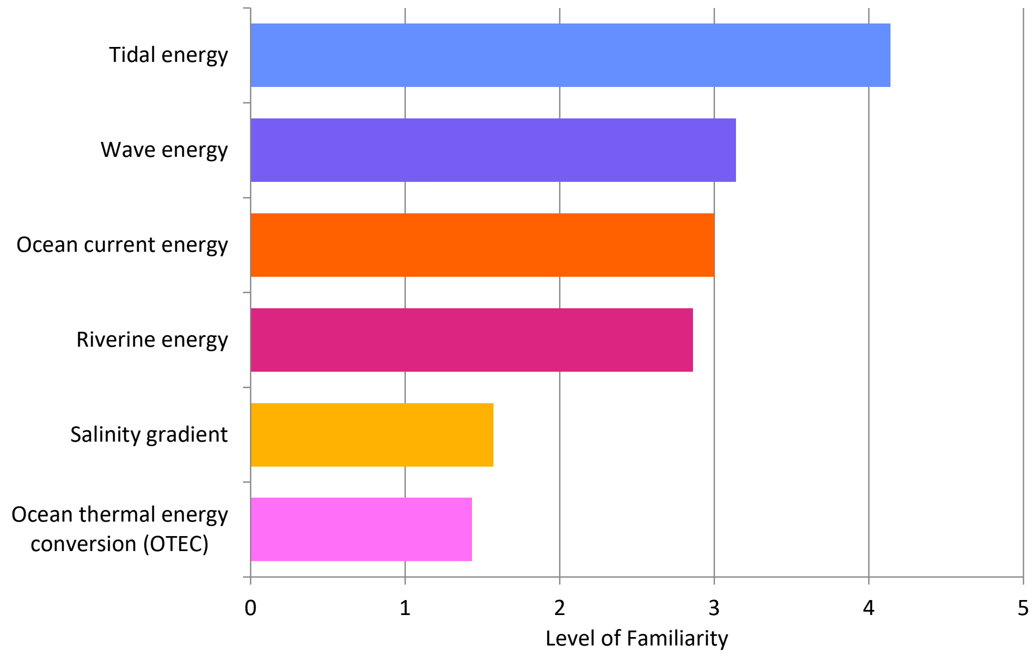


Figure 5. Average level of familiarity with marine renewable energy technologies from 1 (not familiar) to 5 (very familiar). (n = 7)

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.

- 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 6 shows respondents' perceptions of the level of challenge posed by environmental effects when permitting small arrays, when asked to rank from most challenging to least challenging. 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 Canada, the top challenges for respondents in permitting small arrays are collision risk with turbines; attraction, avoidance or displacement; and changes to habitats.

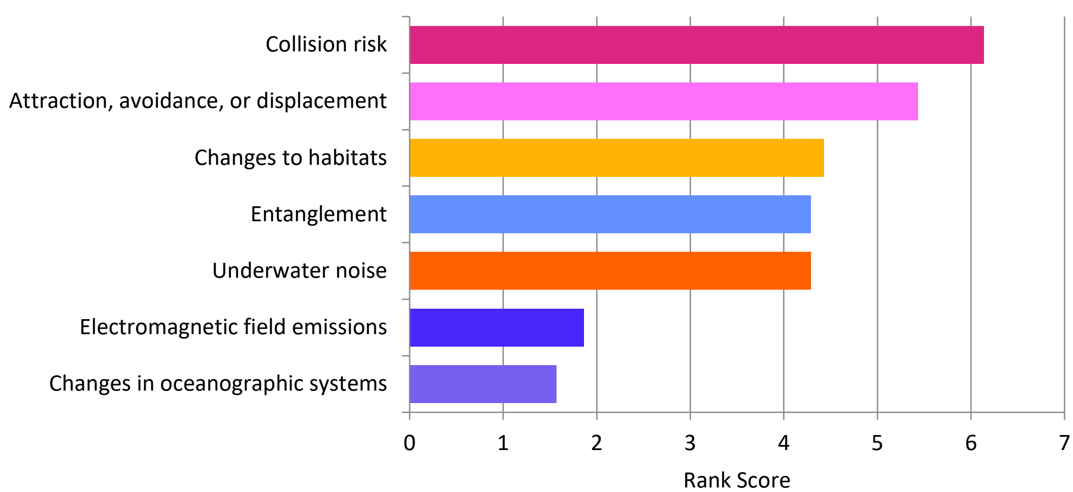


Figure 6. Ranking of challenges to permitting small arrays (one to six devices). (n = 7)

Respondents were also asked to rank their agreement with several statements regarding additional needs for permitting for small arrays, with respect to their top-ranked challenges for small arrays.

The results of this question are summarized in Table 1. Respondents were mostly 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. The only disagreement was with the statement that validated numerical models are needed for environmental permitting.

Table 1. Perceptions of small array statements. (n = 7)

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

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 7 shows respondents' perceptions of the level of challenge posed by environmental effects when permitting large arrays, when asked to rank from most challenging to least challenging. The top-ranked challenges were calculated by Survey Monkey, such that the answer choice with the largest average ranking is the top challenge. In Canada, the top challenges for respondents in permitting large arrays are cumulative effects; collision risk; attraction, avoidance, and displacement; underwater noise; and changes to habitats.

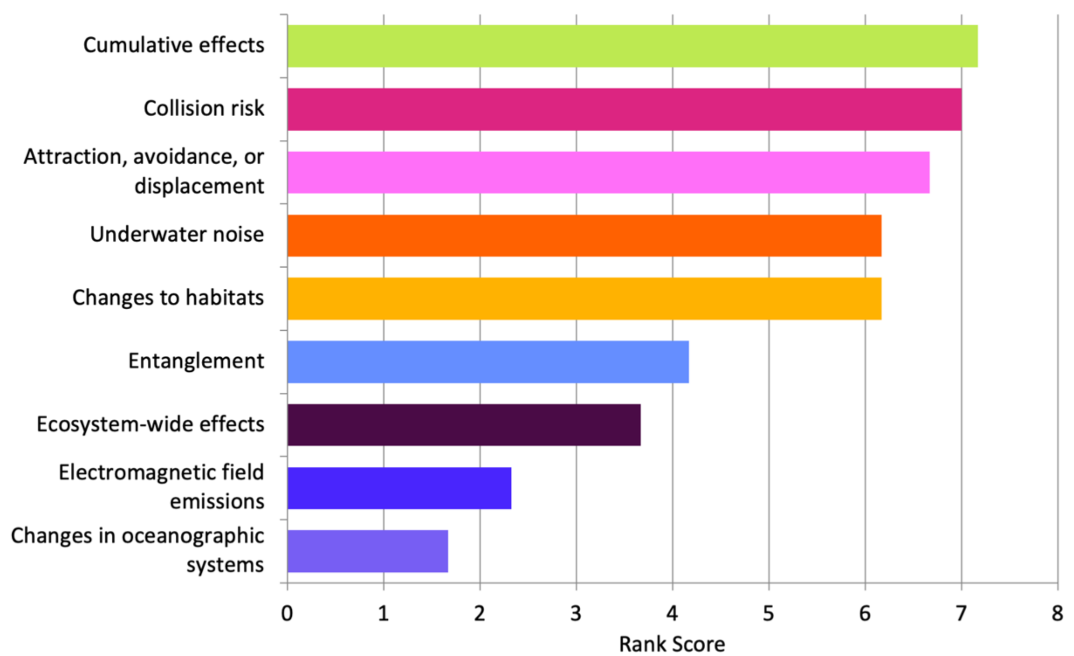


Figure 7. Ranking of challenges to permitting large arrays (more than 6 devices). (n = 6)

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 Table 2. Respondents were either neutral or in agreement (agreed or strongly agreed with all statements). The strongest agreement was with the statements that additional research/studies are needed to better understand the likely risk, regulators/advisors need to be knowledgeable and trained on MRE technologies, and field data are needed to determine the risk and uncertainty of an MRE project.

Table 2. Regulator perceptions of large array statements. (n = 6)

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

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 8.

In Canada, the top barriers to permitting based on the survey responses are scientific uncertainty regarding environmental effects; limited availability of environmental monitoring data; and insufficient guidance for managing environmental risks.

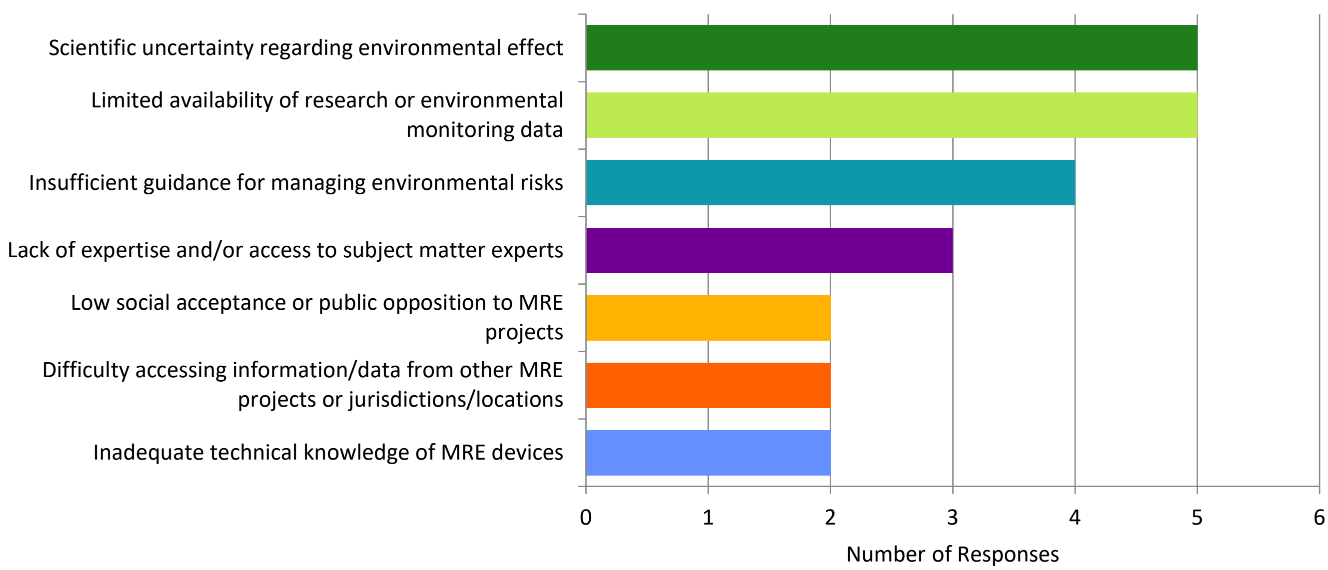


Figure 8. Barriers to permitting marine renewable energy projects. (n = 6)

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, regulators, and advisors 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, regulators, and advisors, 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 9 shows respondents' perceptions on retiring risks for small arrays. Most respondents agreed with retiring electromagnetic field emissions (86% strongly agree or agree) and changes in oceanographic systems (71% strongly agree or agree). All respondents disagreed with retiring collision risk (100% strongly disagree or disagree). Many disagreed with retiring entanglement (57% strongly disagree or disagree), attraction, avoidance, and displacement (57% strongly disagree or disagree), and underwater noise (57% strongly disagree or disagree).

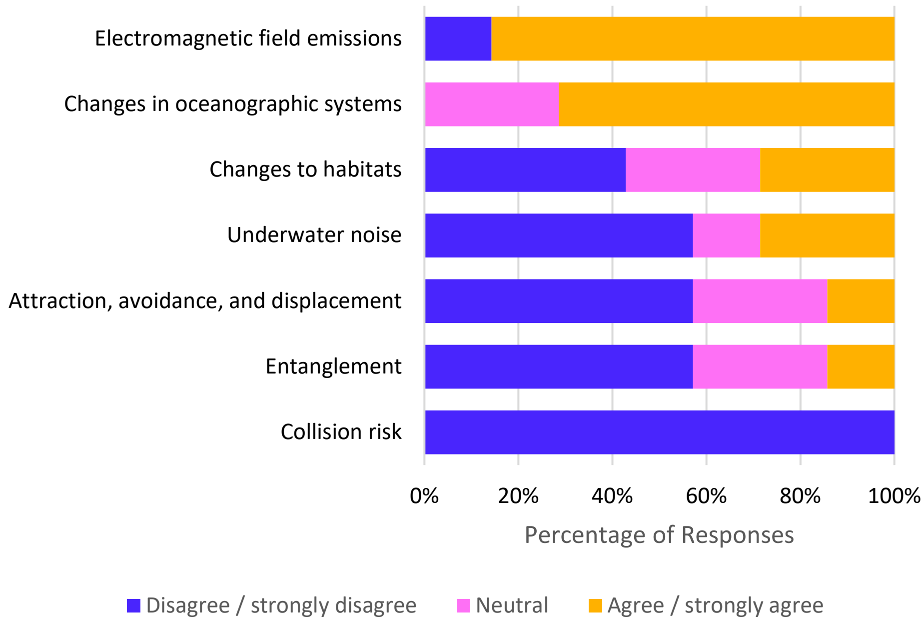


Figure 9. Ability to retire risks for small arrays (one to six devices). (n = 7)

Key additional comments left by respondents on risk retirement are included below.

- "The Bay of Fundy hosts diverse and sensitive marine species, including endangered whales. Collision risk remains a concern due to limited data and high ecological value."
- "Monitoring potential collision risk and avoidance behaviours is inherently challenging. Empirical information from operational projects to date is limited."
- "We cannot with certainty say that there will not be a blade strike from a tidal project. This is a concern of local First Nation's communities and government organizations that cannot be fully retired until we demonstrate data collection at projects on this scale for longer periods of continuous monitored operation."

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'. No respondents selected 'Never'.

One respondent selected 'Absolutely' and provided the comment included below.

- "Given the relatively small number of deployments and the cost in developing projects, even data collected from deployments on the other side of the world can and should be leveraged to support permitting decisions in different jurisdictions. Local ecology and site characteristics need to be considered in the interpretation or use of the data, but it is extremely valuable to evaluate risk."

Six respondents selected 'Maybe' and provided the comments included below.

- "Depends on where the data was obtained and applicability of data from another location to the area of interest and the species and habitat present there."
- "Transferability of data can help fill gaps in local knowledge, especially for emerging technologies. However, site specific conditions in Nova Scotia particularly in the Bay of Fundy, are unique and may not be accurately represented by data from other Jurisdictions."
- "Monitoring environmental variables in Nova Scotia, especially migratory fish and aquatic species at risk, is challenging due to the unique physical properties of the Bay of Fundy (e.g., fast tidal flows, high sedimentation, etc.) and biological and ecological characteristics (e.g., endangered species, high biodiversity). Analogous information from other jurisdictions is somewhat limited."
- "Depends on type of technology proposed and similarity with environmental conditions and species assemblage between the locations."

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 adaptive management (50% of respondents), followed by mitigation hierarchy (33% of respondents), and precautionary principle (17% of respondents) (Figure 10).

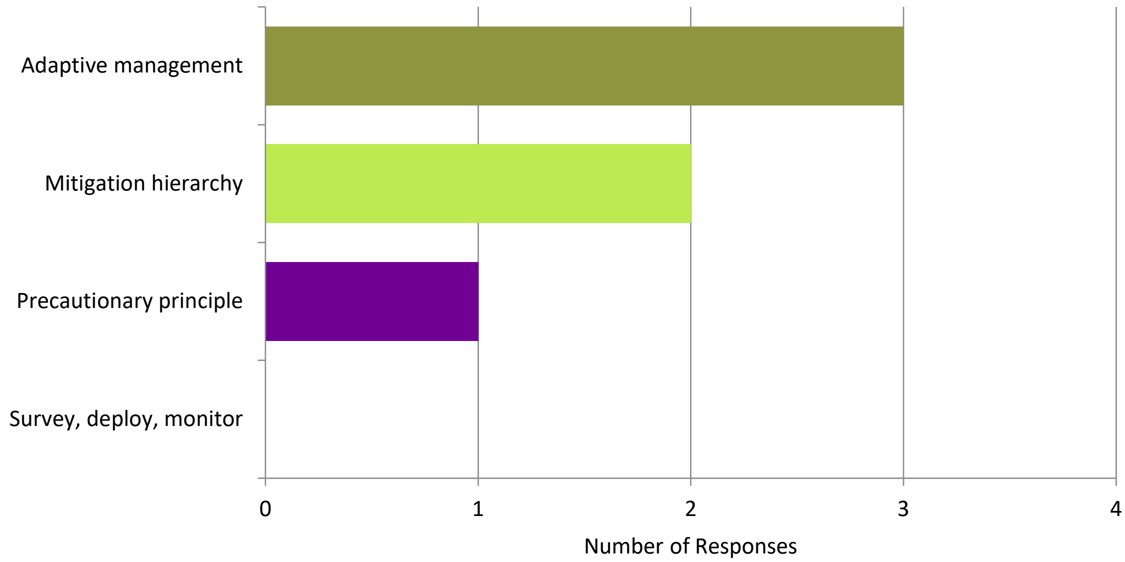


Figure 10. Strategy for managing environmental risks and uncertainties during the permitting process when moving from small arrays (one to six devices) to large arrays (greater than six devices). (n = 6)

Respondents provided additional responses, which are shown in Table 3 next to the management strategy selected. Open comment responses emphasized adaptive management as the preferred approach, citing the Bay of Fundy's unique environmental conditions, uncertainty surrounding tidal energy at larger scales of deployment, and the ability to facilitate ongoing data collection. One respondent noted that a survey, deploy, monitor approach may be used in conjunction with adaptive management, depending on applicable regulatory pathways. Additionally, one respondent noted that the precautionary principle serves as their department's default approach when scientific data is uncertain.

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 (more than six devices). (n = 6)

Management strategy selected	Additional Comment
Adaptive management	"The Bay of Fundy's powerful tides and diverse marine life require a flexible, responsive approach to environmental management. Adaptive management offers the most balanced and practical framework for scaling up tidal energy projects in a region with evolving knowledge and high ecological sensitivity."
Adaptive management	"Given the complexities and uncertainties associated with tidal energy development, and the scalability of projects, an adaptive management approach is appropriate."
Adaptive management	"Adaptive management using risk retirement as a guideline with a focus on getting small scale devices in the water thereby facilitating additional data collection. Lean into survey, deploy, monitor to an extent however

	not sure how that would align with current federal and provincial regulatory pathways."
Precautionary principle	"Default approach used by department when there is uncertainty in the scientific data"

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). All of the respondents indicated a potential (57% of responses) or known (43% of responses) difference between permitting processes for national grid-scale projects and smaller-scale MRE projects.

Selected responses are listed below:

- "Application and review requirements (including ESAs [Environmental Site Assessments]) are flexible and commensurate to the size, complexity, potential impacts and level of public interest"
- "The review process is similar but the outcome is likely to differ. Small-scale systems are the majority of systems submitted to date in this jurisdiction."
- "Permitting for smaller MRE projects would likely be more flexible and risk-proportionate compared to national grid-scale developments, while still ensuring environmental protection and regulatory compliance."
- "Sometimes these projects require less complex considerations but follow similar permitting processes nonetheless."
- "National grid scale projects are now (>40 MW) being fast tracked by a different agency provincially (BC [British Columbia] Energy Regulator) rather than through the Ministry of Water Land and Resource Stewardship. It also depends on whether the project is within provincial or federal Crown Land. I would further separate ocean observations and navigation projects as having far less scrutiny due to the size of devices and perceived proportional risk than community scale power projects. For ocean observation and navigation applications a proponent may (italicized) not require interacting with a provincial agency and could be facilitated through engagement with Transport Canada and the Department of Fisheries and Oceans Canada."

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)".

Figure 11 shows that respondents most frequently obtain information on the environmental effects of MRE from MRE project developers, followed by other regulators or colleagues, scientific journals, and conferences or workshops.

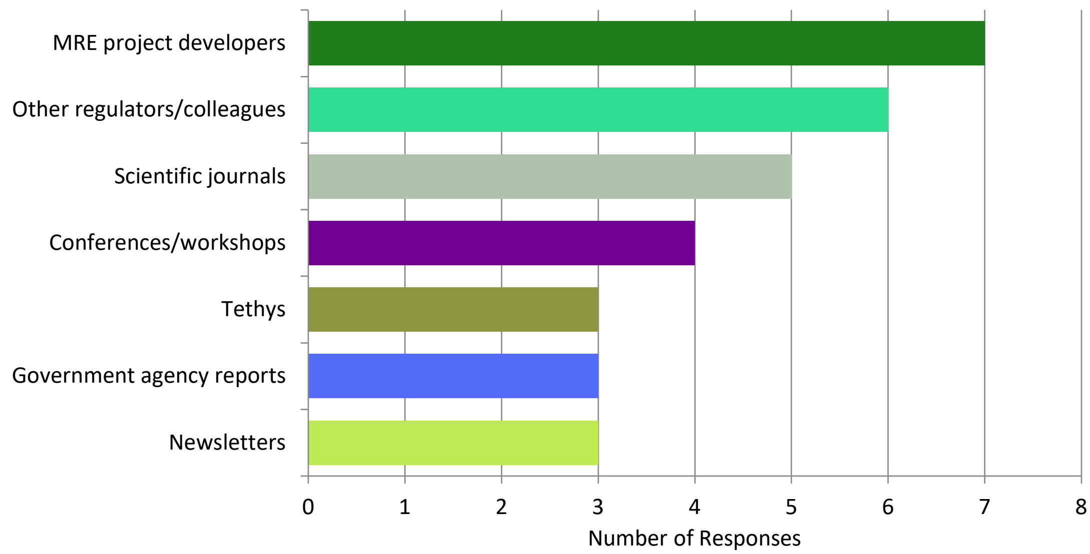


Figure 11. Resources and methods used to find information on environmental effects of marine renewable energy and support permitting. (n = 7)

Awareness, Purpose, and Usefulness

When asked if they had heard of Tethys, five respondents responded "Yes" and two responded "No". The two respondents unfamiliar with Tethys were asked a follow-up question, "After learning about Tethys, is it likely that you will explore it further?". One indicated clear interest in further exploring Tethys, selecting "Yes", while other expressed potential interest, selecting "Maybe".

The five 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 12, most respondents use Tethys to find papers and reports on environmental effects of MRE, receive the Tethys Blast Newsletter, and view live or archived webinars and expert forums.

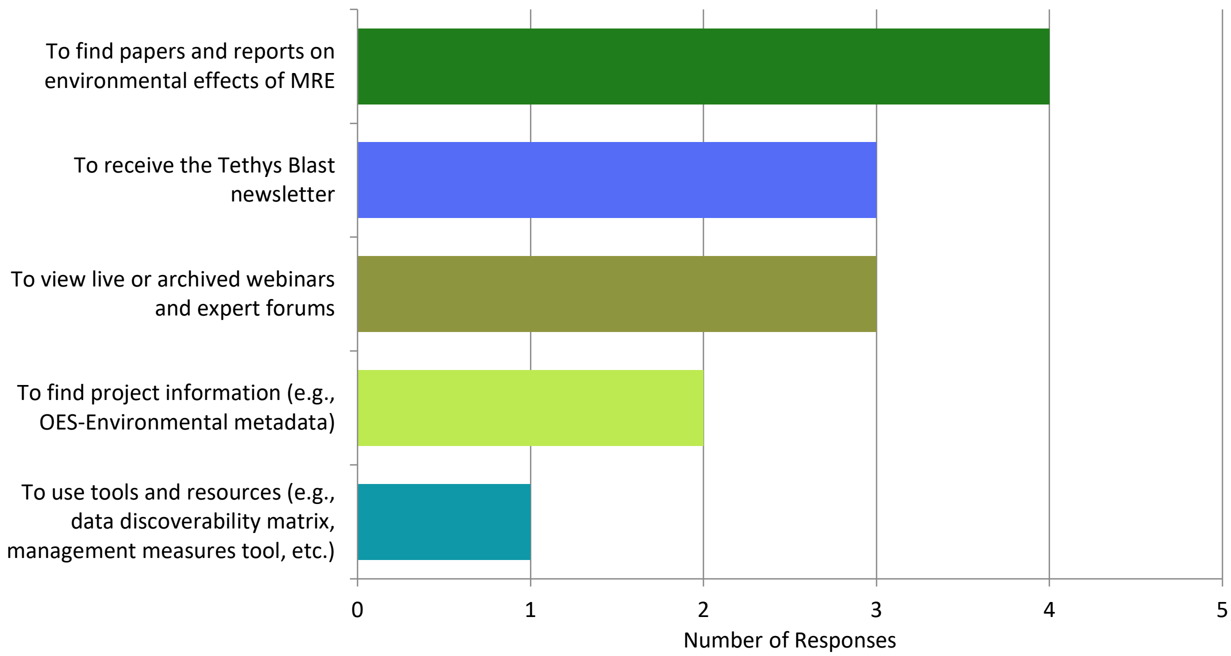


Figure 12. How do you use Tethys? (n = 5)

The five respondents familiar with Tethys were also asked how useful they find Tethys (not useful, somewhat useful, very useful). Three respondents indicated that they find Tethys very useful, one indicated that they find Tethys somewhat useful, and one indicated they find Tethys not useful.

Conclusion

Most survey respondents in Canada reported extensive experience with permitting processes for MRE projects, with high familiarity with tidal energy technologies and moderate familiarity with wave, ocean current, and riverine energy technologies. Familiarity was more limited for salinity gradient and ocean thermal energy conversion technologies. A majority of the respondents work for agencies focused on seabed and habitat, fish, and marine mammal considerations, while slightly fewer than half work for agencies addressing social and economic effects and energy production. One respondent works for an agency focused exclusively on water quality and birds.

Listed below are the key findings from the 2026 Canada Regulator Survey:

- The respondents perceived underwater noise as less challenging when permitting small arrays (one to six devices) and more challenging when permitting large arrays (more than six devices). Given that respondents perceived cumulative effects as the most challenging environmental effect when permitting large arrays, this suggests that regulators in Canada may have heightened concern regarding potential additive or multiplicative effects of underwater noise as additional devices are deployed within an array.

- Regional differences in risk perception and permitting barriers were evident among respondents. Respondents in Nova Scotia ranked collision risk as more challenging than those in British Columbia, while in contrast, those in British Columbia ranked underwater noise as more challenging. Notable differences in perceived permitting barriers also emerged. Both respondents working in Nova Scotia identified inadequate technical knowledge of MRE devices and low social acceptance or social opposition to MRE projects as barriers to permitting, however, none of the British Columbia or Alberta respondents selected either. While the small sample size limits broader conclusions, these differences may reflect a combination of regional variations in regulatory frameworks, local ecology, MRE development history, and the MRE resources present in each region. They may also reflect differences in perceptions held by local communities, First Nations, or other marine users (e.g., fishers) that can shape how environmental risks are prioritized by regulators and advisors during permitting processes. This suggests a potential need for community outreach and education materials, as well as tools and resources for regulators and advisors, that are tailored to the unique cultural, ecological, and MRE contexts of each region.

- The respondents indicated the need for knowledgeable and well-trained regulators and advisors as the greatest priority for MRE environmental permitting in Canada, regardless of project scale. This suggests that targeted engagement and outreach efforts to share relevant resources, tools, and educational materials with Canadian regulators and advisors could meaningfully support the environmental permitting process.

- The respondents indicated a greater need for field data and additional research when permitting large arrays (more than six devices) compared to small arrays (one to six devices). This suggests that as project size increases in Canada, so may regulatory uncertainty, highlighting the importance of targeted research and data collection and approaches that aid and streamline permitting by identifying low-risk interactions and enable the responsible use of pre-existing data and evidence.

- While respondents expressed openness to the concept of data transferability, it was noted that its applicability depends on similarity in technologies, species, habitat type, and site conditions. Perspectives on risk retirement varied. There was good agreement about retiring EMF and changes in oceanographic systems. However, they were more cautious of risk retirement for other environmental interactions. This distinction is most evident for collision risk, which respondents unanimously disagreed with retiring. Additional comments may explain this difference in perspective, with respondents citing limited empirical data, the unique ecological characteristics of the Bay of Fundy, and concerns raised by First Nation communities. Together, these responses suggest that while regulators and advisors in Canada are willing to use evidence from other jurisdictions to inform permitting decisions, additional site-specific evidence is likely needed to address remaining concerns of retiring some risks.

Similarities and differences were identified between the 2026 Canada Regulator Survey and the previous Canada Regulator Survey conducted by OES-Environmental in March 2020[2]. The most notable similarities between the two survey iterations were cautious openness to data transferability, and the need for additional evidence and capacity to support permitting decisions. Across both surveys, respondents emphasized the importance of field data, agency guidance, and knowledgeable staff to help reduce uncertainty in environmental permitting. However, differences between the two surveys suggest a shift from a conservative, stepwise approach to early stage MRE development in 2020 toward a flexible, differentiated, and scale-dependent regulatory perspective in 2026. In 2020, most respondents favored the phased approach and mitigation hierarchy for managing risk, while in 2026 the leading preference shifted to adaptive management. Similarly, in 2020 collision risk was identified as the top challenge for both single devices and arrays, while in 2026 cumulative effects ranked as the leading challenge for large arrays. These shifts point to a broadening of regulatory focus and increased emphasis on adaptive learning as the MRE industry progresses in Canada, moving from device-level environmental risks toward wider consideration of large-array and cumulative effects. It is important to note that these observations may not be representative of broad changes in regulatory approaches or perspectives in Canada as the 2026 survey introduced new response options, including cumulative effects and ecosystem-wide effects, and used different array scale categories than the 2020 survey, which compared single devices and arrays rather than small and large arrays. Additionally, broader conclusions about changes in perceptions over time cannot be drawn due to the low number of respondents.

---

[2] Rose, D.; Freeman, M. (2020). MRE Regulator Survey Report: Canada. https://tethys.pnnl.gov/publications/mre-regulator-survey-report-canada

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.

Appendix A

#	Question	Potential Choices
1	What level of government does your agency represent?	- National - County - Local - Other (please specify)
2	What country 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 agency 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)