

Underwater Noise

RELEVANCE TO MARINE RENEWABLE ENERGY

Animals use sound in the marine environment like humans and animals use light (sight) on land. Underwater sound allows animals to communicate, navigate, interact, forage, and avoid predation. The extent to which marine animals detect and produce sound varies by species, covering a wide range of sound frequencies. Marine mammals and some fish species are the major animal groups of concern.

Marine animals are already subject to sources of human-caused noise underwater; the addition of sound from marine renewable energy (MRE) devices could induce stress, behavioral changes, a range of physical injuries, and a temporary or permanent reduction in hearing ability that can mask other sounds. The propagation of sound from devices dissipates with distance from the device, depending on ocean conditions and device sound level. Construction activities at sea can create loud underwater noise, while noise from operational devices is much quieter.

STATUS OF KNOWLEDGE

The underwater noise from MRE devices adds to other sound sources in the marine environment. It is necessary to properly measure those ambient noises to understand the additions from MRE devices. To date, there is no evidence that operational noise from devices harms marine animals physically or behaviorally.





Around devices, ambient noise consists of a combination of natural sounds such as animal vocalizations, tidal currents, wave sounds, wind, other weather conditions, and noise from anthropogenic sources such as shipping, boating, and other industrial activities. Generally, device noise appears to be lower than that of other anthropogenic sources and/or natural sounds. Areas with fast-moving tidal currents generate high levels of noise that make it very difficult to measure noise outputs from devices.

Measurements of the volume, frequency, and directionality of the noise emitted from MRE devices are needed to determine potential effects on marine animals. In the United States, there are regulatory action levels and guidance for determining levels of sound that may affect marine mammals and fish.

The MRE community has developed an international specification for measuring underwater noise from MRE devices, including how to properly calibrate instruments, data collection requirements, methods for data processing, and presentation of the results. This specification will ensure that underwater noise measurements are comparable and accurate.

In general, studies of underwater noise are aimed at changes in animal behavior, which is difficult and expensive to measure. There are many different methods used, none of which is solely effective. These methods include human observers from boats, aircraft, and shore; underwater cameras; and listening devices. The few studies available have concluded that MRE devices are unlikely to cause behavioral effects for marine animals at long distances, but some suggest the possibility of behavioral responses at close range.

Overall, the scientific community has reached a general consensus that underwater noise from operational devices within small-scale MRE developments does not pose a risk to marine animals and can be retired for small numbers of devices (one to six devices).

REMAINING UNCERTAINTIES

Despite the growing consensus in the scientific community, regulators remain concerned about the potential effects of underwater noise radiated by MRE devices. Distinguishing the sound of MRE devices from the ambient sound continues to be challenging, as taking accurate measurements in the high-energy environments is difficult, and understanding marine animal reactions and behavior is complicated. We have limited understanding of normal marine animal behavior, and less understanding of how marine mammals and fish may acclimate to underwater noise. Distinguishing whether changes in animal behavior may be due to noise from MRE devices rather than other stimuli is also challenging. While marine mammals and certain fish species are most susceptible to noise, there is a lack of information on how sea turtles, other fish species, and invertebrates might be affected. An additional aspect of noise emissions—particle motion—has been implicated in fish disturbance close to a source, but little is known about measuring and interpreting these results from MRE devices.

RECOMMENDATIONS

To understand the potential effects of MRE underwater noise on marine animals, noise from a range of device types must be accurately measured and distinguished from ambient noise. Methods to interpret effects on marine animal behavior over the range of frequencies and sound levels from single devices are not well developed. As noise effects from single devices are understood, the results will be used in computer simulations to scale the effects to MRE arrays; these models will need further development and validation. There is a need to continue to determine the noise outputs from each type of MRE device that is deployed in the ocean or large rivers, using the international specification.

OES-Environmental 2024 State of the Science report and executive summary available at:
<https://tethys.pnnl.gov/publications/state-of-the-science-2024>

Go to <https://tethys.pnnl.gov> for a collection of papers, reports, presentations, and other media about environmental effects of MRE.

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