Noise

POTENTIAL CONCERNS

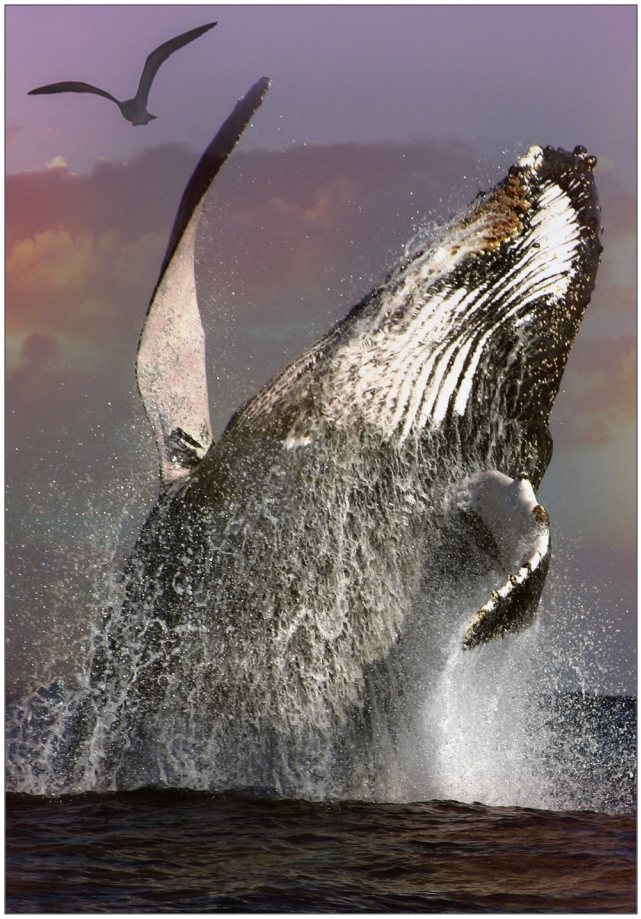
Animals use sound in the marine environment for communication, social interaction, orientation, predation, and evasion. The extent to which marine animals detect and emit sound varies by frequency and amplitude as well as species-specific characteristics.

The addition of anthropogenic noise sources from operational marine renewable energy (MRE) devices may induce behavioral changes and physical harm to marine animals. A plausible range of physical impacts includes temporary or permanent reduction in hearing ability, damage to nonauditory tissues, irregular gas bubble formation in the tissues of fish and marine mammals, and nerve damage. Underwater noise may also result in behavioral changes such as avoidance of/or attraction to the source and interference with communication, navigation, and detection of prey. The addition of underwater noise from MRE devices would mix with many other existing sources of anthropogenic sound in the oceans.

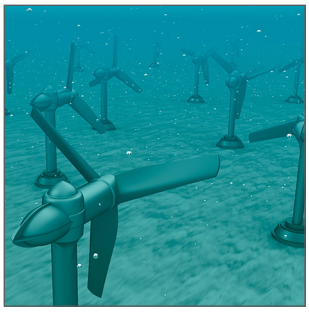
STATUS OF KNOWLEDGE

To date, there have been no observations of operational noise from MRE devices affecting marine animals.

Assessing the potential effects of underwater noise from MRE devices on marine animals requires that we understand the noise environment into which the devices are placed, be able to measure the sound from the device, and relate that sound to changes in animal behavior. This challenging process begins with the ability to accurately measure the background, or ambient, noise. Ambient noise consists of a combination of natural sounds like tidal currents, wave sounds, wind, other weather conditions, and calls from marine animals and birds, as well as noise from anthropogenic sources, such as shipping, boating, and industrial activities. Measuring ambient and MRE device noise



involves specialized underwater listening equipment. Documenting changes in animal behavior requires a combination of human observers and measurements by optical or acoustic instruments. Numerical models are useful as predictive tools for evaluating propagation of sound underwater and potential effects on the environment and marine animals.



Noise sources associated with MRE devices of greatest concern are those associated with construction activities; while operational noise is likely to be lower. Generally, it appears that MRE device noise is lower compared to other anthropogenic sources and/or natural sounds in proximity to the device. In particular, tidal races generate high levels of noise that interferes with the measurement of MRE device noise. The propagation of sound from MRE devices dissipates with distance from the device, depending on specific ocean conditions and the sound source from each specific type of wave or tidal device.

OUR UNDERSTANDING OF THE PROBLEM

With limited MRE deployment to date, little information is available to comprehensively determine potential effect on marine animals. Regardless, there is indication that some construction/installation activities may include harmful levels of sound that may cause marine animals to temporarily leave the location. Conversely, operational sounds from single devices do not appear to be of concern more than a few tens of meters from a device. Most sound measurements from MRE devices have been gathered for single devices; although we can bound the likely acoustic outputs from the cumulative impacts of arrays, few field measurements have been made to date.

FUTURE RECOMMENDATIONS

A number of approaches could be used to enhance the current understanding of potential noise impacts on marine organisms. For example, rigorous field investigations that focus on ambient noise characterization, accurate detection of sound generated from a device, and site-scale observation of organisms using multiple detection methods could be particularly useful. Furthermore, establishing dose/response relationships between organisms and various noise amplitudes and frequencies will help determine the levels that may impact different life stages of organisms. Understanding acoustic outputs from a range of tidal and wave devices will broaden the understanding of impacts and help quantify device-specific noise impacts. Finally, the cumulative impacts of arrays need to be understood to aid in impact assessments for larger-scale development activities.

Monitoring efforts at future wave and tidal energy sites should include site-based observations of marine animals to determine the behavioral responses of organisms of interest, coupled with noise outputs from devices over operational cycles. Collection of device-generated noise during various operating states for the purposes of evaluating potential noise impacts on marine organisms of concern will provide insight into the noise characteristics of different devices, operating states, and temporal variability. Research priorities include establishing methods and techniques to characterize ambient noise in marine environments and accurately detect device-generated noise. Laboratory studies aimed at establishing dose/response relationships by organisms with various amplitudes and frequencies of sounds will help advance field experiments that document behavioral responses of animals around MRE devices.

FOR MORE INFORMATION

Annex IV State of the Science full report and executive summary available at: *http://tethys.pnnl.gov/publications/state-of-the-science-2016*

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Go to *http://tethys.pnnl.gov* for a robust collection of papers, reports, archived presentations, and other media about MRE development.

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