



The point absorber wave energy converter on the picture has a surface float attached to a reaction ring by 3 vertical lines (i.e., tendons). It is secured in place by 3 mooring lines (that appear to run horizontally). The power export cable is supported by a series of floats in the upper section. Two scuba divers are added for scale. The mooring lines, tendons, and export cable are 10-20 cm thick. Lines and tendons are very taut (10- and 400-tons tension, respectively), and the cable has a multi-meter bend radius. These characteristics will prevent the lines and cable from looping around animal body parts. (Photo credit: Oscilla Power)

ENTANGLEMENT: A LOW RISK FOR MARINE ANIMALS AROUND MARINE ENERGY DEVICES

Marine energy devices can be secured to the seafloor by mooring lines, enabling them to remain in place on the sea surface or in the water column. In an array of devices, multiple underwater cables converge into a single power export cable installed on the seafloor. In some cases, oceanographic instruments are deployed alongside marine energy devices, but on separate mooring lines, to collect data like wave height and period. Some stakeholders have expressed concern that these mooring lines and cables may endanger marine animals by creating a risk of entanglement, though this risk remains uncertain.

STATUS OF KNOWLEDGE

- ▶ Floating marine energy devices, like wave energy converters, are held in place by mooring lines and have associated power export cables. While the possibility of entanglement risk remains uncertain, there are concerns that some marine animals may get trapped in these lines or cables and find themselves entangled.
- ▶ The presence of oceanographic instruments with surface lines near marine energy devices may increase the risk of entanglement to marine animals.
- ▶ Most available literature on entanglement is associated with lost fishing gear. Entanglement of marine animals in fishing gear can result in injuries, swimming difficulties, and/or drowning.
- ▶ No entanglement of marine animals in the mooring lines or cables of a marine energy system has been observed to date. However, on limited occasions, some marine animals have become entangled in the lines of oceanographic instruments.
- ▶ Mooring lines and cables from marine energy devices take up very little space in the water column and they are taut, preventing the formation of loops that could entangle marine animals.
- ▶ Entanglement that might happen from the interaction between marine animals and the mooring lines used to secure marine energy devices and oceanographic instruments is called primary entanglement.
- ▶ Secondary entanglement might happen in the unfortunate event that marine debris, such as lost or abandoned fishing gear, are caught on marine energy devices, oceanographic instruments, mooring lines, or cables, subsequently trapping marine animals.
- ▶ Because mooring lines and cables used in marine energy systems do not have loose ends or sufficient slack to create loops, the risk of entanglement for a small number of devices (up to six) is considered low by the scientific community.

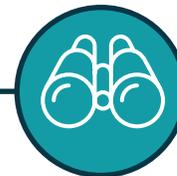
FACTORS INFLUENCING ENTANGLEMENT

- ▶ Entanglement risk depends on the configuration and characteristics of lines or cables, the depth, location, and type of marine energy device, as well as presence, behavior, and size of the animals at risk.
- ▶ The tension of a mooring line will affect the risk of entanglement, with tauter lines creating a lower risk.
- ▶ Large slow-moving marine animals, such as whales, sea turtles, and basking/whale sharks, have a greater risk of entanglement than smaller, fast-moving animals due to their body size, feeding habits, swimming behaviors, and migration patterns. Other animals possibly at risk of entanglement around floating marine energy devices include seabirds, manatees, and ocean sunfish.
- ▶ Biological characteristics and sensory abilities of specific groups of marine animals can have a significant effect on their entanglement risk, such as their ability to detect objects and colors, respond to acoustic deterrent devices, or swim swiftly around obstacles.



REMAINING UNCERTAINTIES

- ▶ The risk of entanglement remains unknown for large arrays with more than six marine energy devices and their associated oceanographic instruments. Currently, there are not enough devices in the water to learn about the effects of large arrays with multiple lines and the addition of dynamic cables draped between devices and connected to oceanographic instruments.
- ▶ As more arrays of marine energy devices are deployed, marine animal behavior might change; attraction to and aggregation around devices may increase the probability of entanglement of marine animals, although more lines and devices in the water may also lead animals to avoid an array.



LOOKING FORWARD

- ▶ In the absence of observation data around marine energy systems and associated oceanographic instruments, the potential entanglement risk for marine animals will need to be investigated with computer models, particularly to anticipate a scaled-up industry with larger arrays of devices.
- ▶ Once arrays of floating marine energy devices are deployed, it will be important to collect field observation data to better understand the risk of entanglement and consequences for marine animals.
- ▶ Implementing dedicated technologies to monitor changes in tension or failure of mooring lines, as well as regular visual inspections of lines and cables may help lower the risk of entanglement for marine animals.
- ▶ Understanding of entanglement and associated risks will improve with sharing of information, data, and research findings across the marine energy industry and other industries.

For more information, contact tethys@pnnl.gov, or visit:

Short Science Summary



Evidence Base



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