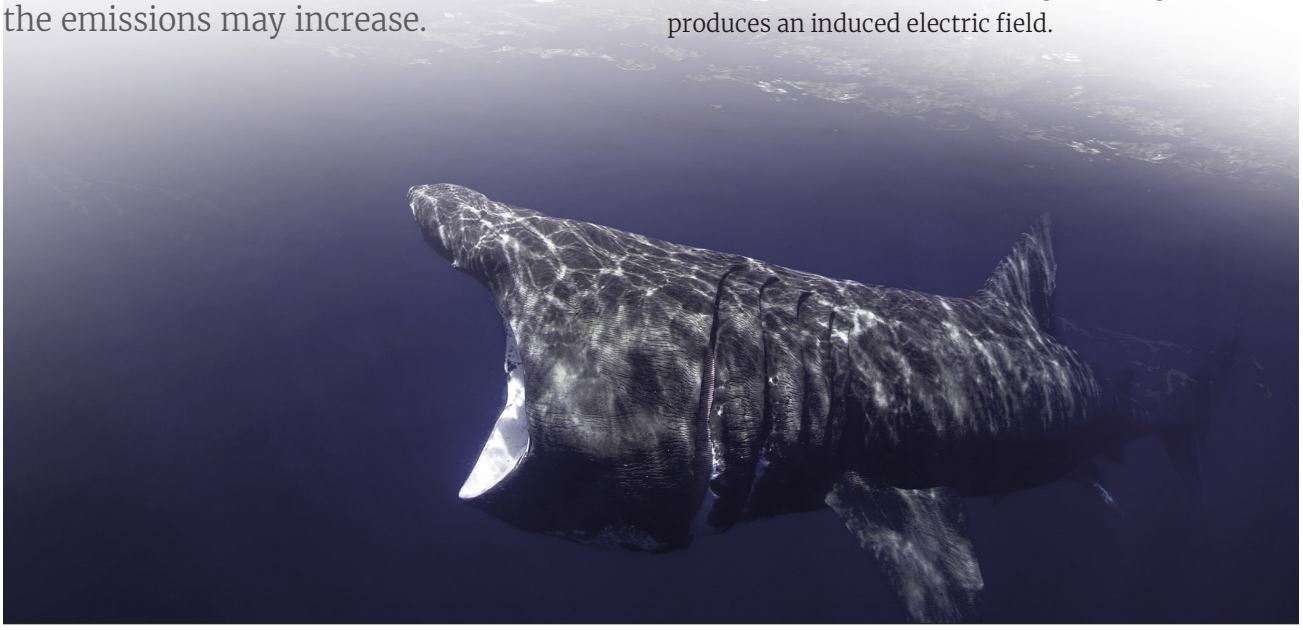
Electromagnetic Fields

RELEVANCE TO MARINE RENEWABLE ENERGY

Certain marine animals, such as certain elasmobranchs (sharks, skates, rays, etc.), marine mammals, crustaceans, sea turtles, and other fish species, can sense electromagnetic fields (EMFs). These species use EMFs to navigate, orient, and hunt for prey. Cables from operational marine renewable energy (MRE) devices can add EMFs to the environment, on top of other anthropogenic sources such as underwater telecom or power cables, while also adding to the Earth's natural field. MRE devices can potentially alter the ambient EMF field, which may disrupt the animals' ability to detect natural signatures, potentially affecting their survival, reproductive success, or migratory patterns. With the advent of larger MRE developments, the intensity and range of the emissions may increase.

STATUS OF KNOWLEDGE

EMFs are generated by the movement of electrons along a surface and are composed of two components: an electrical field and a magnetic field. Within a cable, such as a power export cable from an MRE device, EMFs propagate perpendicular to the cable axis, dissipating with distance from the cable. The electric field from cables can be attenuated with cable burial or shielding, and therefore is not of concern in seawater, unlike the magnetic field emitted in the water or seabed. In addition, the movement of water and animals through the magnetic field produces an induced electric field.



Laboratory and field studies have shown that sensitive marine species may exhibit altered behavior in the presence of EMFs, but the level of disturbance appears to be too limited to affect migration patterns or to keep animals from their preferred habitats. In general, the EMF levels anticipated from small MRE arrays, and perhaps even larger commercial arrays, are likely to affect some sensitive species, but are not likely to cause harm. However, these power levels are small in comparison to those emitted by other cables at sea, including those from offshore wind and power cables carrying electricity to islands and isolated areas.

Understanding the amount of EMF likely to be generated by MRE cables is not straightforward. The EMF emissions from some electrical cable configurations have been measured, but other configurations have only been estimated using computer models. The estimated EMF emissions must be correlated with the natural fields to understand their likely effects on marine animals. Satellites launched by the European Space Agency (*https://www.swarm.space/*) measure electric currents in the world oceans and may help to predict likely effects on marine life.

REMAINING UNCERTAINTIES

Present studies have shown demonstrable changes in sensitive marine animals in response to the EMF emissions of MRE devices, but these findings are based on a small number of tests reflecting the few MRE devices deployed. The full extent of the effect of EMF on sensitive animals has not been established, nor has the effect of EMF from the increasing number of energized cables along the seabed been estimated as the MRE industry builds out. Field and laboratory studies have generally been of short duration, not allowing for insight into cumulative effects on animals over time. Models of EMF emissions in seawater and within the seabed are fairly well developed but few have been validated with field data.

RECOMMENDATIONS

It is important moving forward that additional marine species be screened for EMF sensitivity, particularly those that are likely to spend time in the vicinity of energized power cables, including sedentary and mobile invertebrates as well as benthic fish species. The mix of species around MRE devices will differ by countries and region; species that are important commercially, recreationally, or culturally, or whose populations are depleted, should be screened for EMF sensitivity within local areas, if little is known about their sensitivity based on laboratory EMF studies. In addition, as large MRE projects are planned, the cumulative EMFs from multiple export cables and underwater substations must be measured and these levels of EMF evaluated relative to what is known about marine animal sensitivities.

A library of MRE cable capacities and configurations (twisted versus non-twisted, shielded versus non-shielded, etc.) should be developed to approximate EMF emissions by cable type. This library could be a resource for MRE developers in planning for project effects and enabling adequate mitigation measures, if they are needed. As MRE projects grow in size, the cumulative effects on areas of the ocean will need to be examined.

There is a need to collect field data on EMF emissions from cables to validate emission models, and to allow modeling estimates from single MRE cables to be extrapolated to large developments carrying higher power loads.

REPORT AND MORE INFORMATION

OES-Environmental 2020 State of the Science full report and executive summary available at:
https://tethys.pnnl.gov/publications/state-of-the-science-2020

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

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