Collision Risk

RELEVANCE TO MARINE RENEWABLE ENERGY

The presence of marine renewable energy (MRE) devices—particularly the rotating blades of tidal and river turbines—is thought to pose a risk to marine animals. Animals might come into close contact with turbine blades in the course of their natural movements, because they are attracted to the device for purposes of feeding, shelter, or out of curiosity, or because they are not strong enough to avoid currents that might sweep them into the blades.

The concern is that a collision with moving device parts (e.g., turbine blades) or a moving device (e.g., tidal kite) could cause irrevocable injury or death. For animal populations that are under stress for other reasons, such as climate change or other human activities, the loss of even a few members due to collision might affect the survivability of the population. The greatest concerns are for marine mammals, fish, and diving seabirds.

STATUS OF KNOWLEDGE

Current knowledge about collision risk comes from empirical data and modeling studies around single turbine deployments and small arrays. During operational monitoring and laboratory experiments, fish were observed aggregating near devices and exhibiting avoidance and evasive behavior when the blades began to rotate. They have been seen to infrequently come into contact with turbine blades but did not appear to be injured. Marine mammals were observed avoiding a tidal array by moving away from the area when the turbines were operating. Seabirds have been seen near a tidal array when the turbines were not operating. No instances of marine mammals or diving seabirds colliding with an operational turbine have ever been seen.

Computer models are used to simulate collisions and encounters with turbines, based on the presence of marine animals. Recently these models have added some behavioral data and information collected in the field to more accurately estimate the probability of encounter or collision. Numerical models have been developed for collision risk with fish and marine mammals, but none have been developed recently for diving seabirds. Due to the challenges of collision risk data collection and modeling limitations, the use of frameworks to organize and evaluate datasets can help prioritize what information to gather for collision risk assessment. This kind of framework can help determine the probability of a collision event leading to a significant injury or death. This framework is based on a "bullseye" approach in which each concentric circle symbolizes the probability of an animal interaction with a turbine as it approaches a worst-case outcome (serious injury or death).

REMAINING UNCERTAINTIES

There remains the need for a better understanding of the likelihood of animals colliding with or avoiding turbines, the consequences of a collision on animals, and the overall risk to populations from potential losses of individual animals. There are few observations of marine animals interacting with MRE devices. Using underwater cameras in fast moving, often turbid water is difficult and results in very large datasets that are difficult to analyze. In addition, the probability of animals colliding with a turbine is likely extremely rare, so that capturing these events is unlikely. Models can help fill information gaps when field studies are not possible, but these predictions are sensitive to assumptions about marine animals' ability to detect, avoid, and evade a turbine. Finally, as the MRE industry moves toward commercial arrays, there is a need to understand how collision risk to animals might scale up from what we know about single devices.

RECOMMENDATIONS

Additional research and monitoring around MRE projects, field studies, and modeling are needed to advance our understanding of the risks of marine animal collision with a tidal or river turbine. Information describing the occurrence and behavior of marine animals at close range to devices is indispensable. Improvements in the methodologies and instruments used to collect, store, share, and analyze data about collision risk are needed, as are improved integration of algorithms and machine learning to decrease the labor of detecting images of marine animals around turbines. As collision risk models are improved, field monitoring data will be needed to validate these models. In addition to monitoring, regulators need to apply suitable frameworks that allow for the development of new projects, funding agencies need to provide support for both targeted research and dissemination of results, and developers need to provide access to their devices and increase collaborative data sharing.

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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