Conservation Law Foundation ● Environmental Defense Center ● Humboldt Baykeeper
National Audubon Society ● National Wildlife Federation ● Natural Resources Defense Council
Southern Environmental Law Center

Recommendations to Reduce the Potential Risk of Entanglement of Marine Life During Floating Offshore Wind Energy Development

Advancing Responsible Development of Floating Offshore Wind

Floating offshore wind technology has immense potential to provide clean energy to millions of Americans, while helping the nation meet greenhouse gas emission reduction goals necessary to prevent the worst impacts of climate change.[1] Floating offshore wind will make renewable energy accessible to new areas of the United States. The ability to construct floating platforms in waters as deep as 1,000 meters or greater will allow for the expansion of offshore wind into areas like California, Oregon, and Washington, where the continental shelf and slope are steep and close to shore, the Gulf of Maine, as well as areas far offshore where the seascape experiences fewer competing human uses.

Like any energy infrastructure, floating offshore wind developments will have some adverse impacts on the surrounding environment. Because we also face a biodiversity crisis and healthy marine ecosystems are essential for reducing climate change impacts, we must appropriately site and develop floating offshore wind in a manner that protects local and regional biodiversity and abundance of marine life. As we establish America's new offshore wind energy industry, we must follow the principles of the mitigation hierarchy and avoid, minimize, and mitigate impacts.[2]

Floating Offshore Wind and the Potential Risk of Entanglement

Floating offshore wind platforms have unique environmental considerations compared to fixed platform turbines.[3] One notable difference is that they are moored using anchors, meaning installation of floating platforms will be significantly quieter than for foundations that are pile-driven into the seafloor. To advance floating offshore wind responsibly, however, the adverse impacts unique to this technology require proactive management action.

One unique risk factor associated with floating offshore wind is the potential entanglement of marine wildlife caused by its extensive underwater mooring and cable system (Fig. 1). Typical spacing of turbines is expected to be approximately 1 mile apart.[4] The mooring lines and dynamic array cables between the turbines therefore represent a sizable physical and ecological footprint, particularly for a utility-scale project.

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1 https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/.

2 *See*, *e.g.*, CSBI (2015). "A cross-sector guide for implementing the mitigation hierarchy." Prepared by the Biodiversity Consultancy on behalf of IPIECA, ICMM and the Equator Principles Association: Cambridge UK. http://www.csbi.org.uk/wp-content/uploads/2017/10/CSBI-Mitigation-Hierarchy-Guide.pdf.

3 Maxwell, Sara M., et al. "Potential impacts of floating wind turbine technology for marine species and habitats." *Journal of Environmental Management* 307 (2022): 114577. https://www.researchgate.net/profile/Sara-Maxwell-2/publication/358107242_Potential_impacts_of_floating_wind_turbine_technology_for_marine_species_and_habitats/links/61f05a65dafcdb25fd501ba7/Potential-impacts-of-floating-wind-turbine-technology-for-marine-species-and-habitats.pdf.

4 Typical spacing varies between 6x and 8x the diameter of the rotor. For example, a GE 12-MW Haliade-X turbine array with spacing 8x the diameter of the rotor would lead to turbines being spaced over 1 mile apart. Maxwell, Sara M., et al. 2022. *id*.

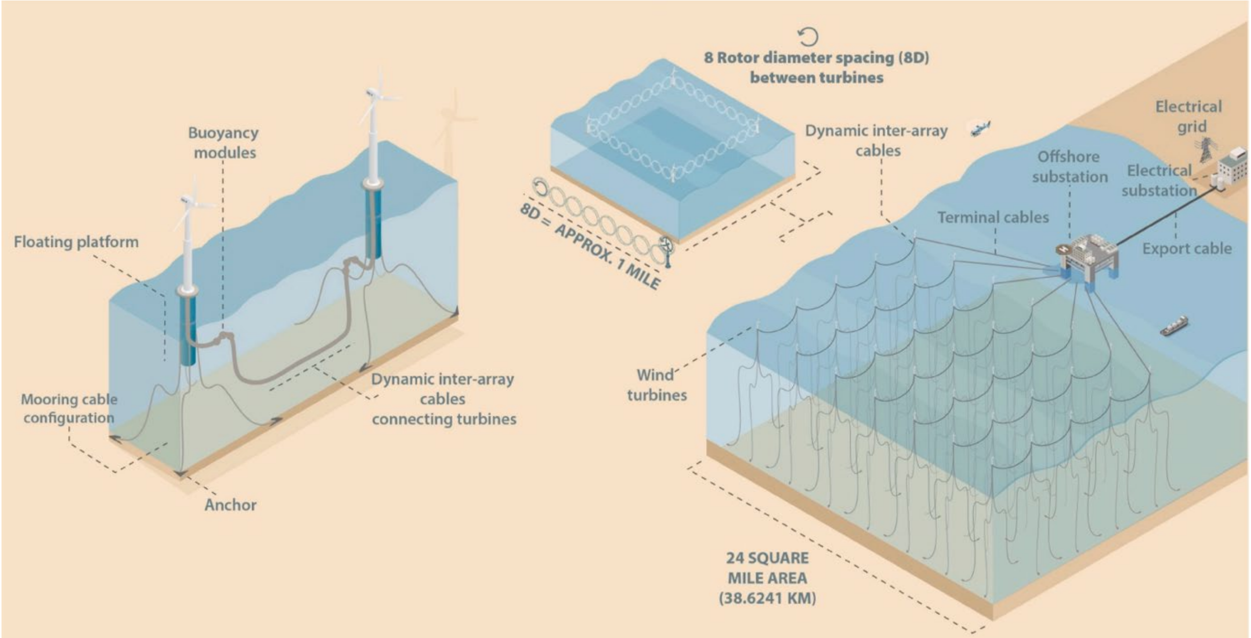

Fig. 1. Schematic of a commercial scale floating offshore wind energy development, including underwater mooring and cable system. Source: Maxwell, Sara M. et al. 2022.

“Secondary” entanglement is presumed to be the main entanglement-related concern for multiple species. This form of entanglement could occur if marine debris became ensnared around mooring lines and/or mid-water (*i.e.*, inter-array) cables, or other infrastructure, and subsequently entangled marine wildlife. “Primary” entanglement, where an animal becomes directly entangled in the lines and cables, and “tertiary” entanglement, where marine debris or active fishing gear already entangling an animal becomes ensnared on the infrastructure and anchors the animal, are additional potential concerns that warrant monitoring as floating offshore wind development proceeds.

To advance floating offshore wind responsibly, it is necessary to develop and implement methods to monitor for and avoid and minimize the risk to marine species most susceptible to entanglement including marine mammals, sea turtles, sharks, and diving or plunging marine birds, from secondary entanglement in marine debris (including fishing gear) that becomes ensnared on project infrastructure (*e.g.*, platforms, substations, mooring lines, inter-array cables, and anchors, as well as monitoring technology docking stations or other infrastructure).

Recommendations to Reduce Risk of Entanglement of Marine Mammals, Sea Turtles, Sharks, and Diving or Plunging Marine Birds in Floating Offshore Wind Infrastructure

The recommended measures are designed first to avoid and then minimize and mitigate potential impacts because the impacts of floating offshore wind energy developments are not yet known. Siting offshore wind projects in areas that avoid sensitive habitats and biologically important areas is the crucial first step to protecting marine life. Also, the recommendations described in this document are focused on addressing the risk of entanglement only and do not represent the entirety of guidance that has been developed to advise responsible offshore wind energy development.[5]

Several science-based solutions and new technologies that can help monitor for and minimize the risk of secondary entanglement are now available or are on the horizon. The construction of floating offshore wind in the U.S. is approximately five years away,[6] which provides the time necessary to undertake research and development into the most effective and appropriate monitoring and mitigation systems and identify necessary cost efficiencies. The recommended measures are based on the most up-to-date scientific and technological information available. They include examples of the types of technologies (existing or currently in development) that may be useful to monitor and mitigate for secondary entanglement risk. However, the recommendations may change as new scientific and/or technological advancements occur and are validated, and as empirical data on the risk of secondary entanglement and the effectiveness of monitoring and mitigation measures becomes available and informs adaptive management (*e.g.*, monitoring frequency may increase or decrease). Investment and monitoring of floating offshore wind developments will be of crucial importance to gather information on the likelihood and type of interactions with marine debris and vulnerable wildlife, and to inform future monitoring needs.

A monitoring approach using multiple methods in parallel is recommended, especially as we build our understanding of entanglement risk associated with floating offshore wind infrastructure:

- Continuous monitoring of any unexpected weight or strain on mooring lines or cables can provide an early warning signal of the incidence and general location of an entanglement or ensnarement event, and monitoring data can be used to trigger additional management action.
- Studies indicate that buoyant plastic fishing gear is a type of marine debris that poses a high risk of secondary entanglement and tends to remain near the surface.[7] The risk of secondary entanglement may therefore be highest in the first few meters of the water column close to floating platforms. We recommend daily remote visual inspection of the mooring lines and cables close to the platforms in order to detect an entanglement event within at least a 24-hour period;

[5] For recommendations related to other aspects of offshore wind development, please see these white papers on site assessment and characterization (https://www.nrdc.org/resources/essential-mitigation-measures-protect-right-whales-during-all-phases-offshore-wind), and monitoring priorities (https://www.nrdc.org/resources/monitoring-marine-life-during-offshore-wind-energy-development-guidelines). We emphasize that, to adequately protect endangered whales and sea turtles, a 10-knot speed restriction is needed for all vessels in all industries operating in areas where and during times when those species are expected to occur, including offshore wind project-associated vessels from pre-construction through decommissioning.

[6] BOEM. Offshore Wind Leasing Path Forward 2021-2025. https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/OSW-Proposed-Leasing-Schedule.pdf.

[7] Of the megaplastics collected from the Great Pacific Garbage Patch using Manta trawls, 86 percent of their total tonnage contribution represented fishing nets. By far the most common polymer types found in those fishing nets were buoyant polyethylene and polypropylene (Lebreton et al. 2018. “Evidence that the Great Pacific Garbage Patch is rapidly accumulating plastics.” Scientific Reports, 8, art. 4666. https://doi.org/10.1038/s41598-018-22939-w). A separate study on microplastics found that lower density polymers, including polypropylene and polyethene, dominated sea surface samples and decreased in abundance with depth. (Erni-Cassola et al. 2019. “Distribution of plastic polymer types in the marine environment; A meta-analysis. Journal of Hazardous Materials, 369, 691-698. https://doi.org/10.1016/j.jhazmat.2019.02.067). The highest risk abandoned, lost, and discarded fishing gear to the marine environment (ghost fishing was one of several considerations) include set and fixed gillnets and trammel nets, and drift gillnets made of buoyant plastic (Gilman et al. 2021. “Highest risk abandoned, lost and discarded fishing gear. Scientific Reports, 11, art. 7195. https://doi.org/10.1038/s41598-021-86123-3). Trajectories of buoyant purse seine and gill nets were found to have drift trajectories of between 30 and 120 days based on a study in the Maldives, indicating that these buoyant gear types could potentially migrate into offshore wind development regions from distant fishing areas (Stelfox et al. 2020. “Minimum drift times infer trajectories of ghost nets found in the Maldives.” Marine Pollution Bulletin, 154, 1-13. http://dx.doi.org/10.1016/j.marpolbul.2020.111037).

this frequency of inspection may allow for a rescue attempt if a marine mammal or sea turtle is observed entangled but alive at the surface.

- Monthly acoustic or remote visual inspections of the full length of the submerged structures is recommended, at minimum, to inform our understanding of the types of marine debris that may become ensnared at different depths and from different types of marine debris. These monthly inspections may also be useful for validating continuous monitoring approaches by confirming the location of ensnarement or entanglement events detected by a continuous monitoring system, or identifying events that were missed, during early applications of the technology. If marine debris ensnarements or marine life entanglements are observed during these monthly inspections at the start of an offshore wind project's operation, the frequency of full-infrastructure inspections should be increased. As monitoring challenges and costs increase with depth, if monthly inspections detect no marine debris ensnarements or marine life entanglements during the first year of an offshore wind project's operation, the frequency of full-infrastructure inspections may be decreased.

I. Monitoring

A. Continuous monitoring for strains on mooring lines and inter-array cables resulting from ensnarement of marine debris or entanglement of an animal (*e.g.*, using load cells[8] or other appropriate sensor-types with proven sufficient sensitivity to model line and cable movements under normal conditions and to detect abnormal movement caused by a marine debris ensnarement or entanglement event).

B. Daily remote visual inspection of infrastructure for ensnarement of marine debris or entanglement of an animal[9] at depths where marine debris is most likely to occur[10] (*e.g.*, using cameras, remote aerial surveys, or other appropriate techniques).

C. Monthly inspection of the full length of submerged infrastructure (including platforms, substations, mooring lines, inter-array cables, and anchors, as well as monitoring technology docking stations or other infrastructure, as appropriate) for ensnared marine debris or entanglement of an animal (*e.g.*, using side-scan sonar, and/or underwater autonomous vehicles (AUV) or remotely operated vehicles (ROV) designed specifically for surveys of offshore energy infrastructure).[11]

[8] "…the Kincardine Floating Offshore Wind Farm in Scotland has integrated load cells with the mooring lines to periodically monitor line performance and potentially detect the entanglement of floating marine debris, including derelict fishing gear." SEER Educational Research Brief on Risk to Marine Life from Marine Debris & Floating Offshore Wind Cables Systems (p.5). https://tethys.pnnl.gov/sites/default/files/summaries/SEER-Educational-Research-Brief-Entanglement-Considerations.pdf.

[9] Visual inspection at least once during each 24-hour period may provide an alert of an entangled marine mammal or sea turtle or diving or plunging marine bird at an early enough point in time that rescue efforts can be made, and the animal can be released alive.

[10] This information will be based on data from other regions. Initial research and expert consultation indicate that marine debris ensnarement is most likely to occur at depths of 0-5 meters below the sea surface.

[11] ROVs may also be an important tool for marine debris removal at depth. The Kincardine Floating Offshore Wind Farm also "will use remotely operated vehicles and vessel-mounted sensors (such as multibeam sonar) to periodically survey floating cable systems, which could also monitor for the presence of derelict fishing gear." SEER Educational Research Brief on Risk to Marine Life from Marine Debris & Floating Offshore Wind Cables Systems (p.5). https://tethys.pnnl.gov/sites/default/files/summaries/SEER-Educational-Research-Brief-Entanglement-Considerations.pdf. *See*, *also*, Federal Energy Regulatory Commission (FERC) Environmental Assessment for Hydropower License for the PacWave South Project (April 2020) at p. xvi. https://www.boem.gov/sites/default/files/documents/regions/pacific-ocs-region/environmental-analysis/PacWave%20South%20EA.pdf; and "The Atlantic Testing Platform for Maritime Robotics." https://www.atlantis-h2020.eu/.

II. Avoidance and Minimization Measures

A. Design features:
   a. Mooring lines and inter-array cables should be designed and maintained in configurations that minimize the potential for entanglement of marine species (*e.g.*, lines and cables should remain under tension).[12]
   b. Infrastructure should be designed to facilitate visual or acoustic detection of ensnared marine debris at depths where marine debris is most likely to occur (*e.g.*, by using lighter coloration or, for acoustic detection, textures to contrast with marine debris at depths where light is limited).

B. Protocol when ensnarement and/or entanglements are identified:[13]
   a. If monitoring shows that marine debris has become ensnared on any project structure, or that sharks and/or diving or plunging marine birds are entangled in marine debris ensnared on any project structure, the lessee will notify the National Marine Fisheries Service (NMFS) or U.S. Fish and Wildlife Service (USFWS), as appropriate, the U.S. Coast Guard, and the relevant state agency as soon as possible and within 6 hours detection. After discovery, the lessee shall remove the marine debris and any entangled sharks or diving or plunging marine birds, or any other species not listed in Section II.B.b., as soon as is possible to do so, as determined by the appropriate federal and state agencies, in a manner that does not jeopardize human safety, property, or the environment.
   b. If monitoring shows that marine mammals or sea turtles are entangled in marine debris ensnared on any project structure, the lessee shall immediately follow the Reporting Protocol for Injured or Stranded Marine Mammals or the sea turtle reporting protocol developed by the Sea Turtle Disentanglement Network; and provide the federal and relevant state agencies with all available information on the incident.[14]

C. Return/recycle: The lessee shall report recovered fishing gear to NMFS and the relevant state agency. The lessee shall consult with those agencies to arrange for the return or disposal of the gear at a suitable location, prioritizing the physical recycling of materials (as opposed to incineration).

III. Data transparency

A. All incidences of observed ensnarements of marine debris on floating offshore wind infrastructure and entanglements of marine life shall promptly be made publicly available.

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[12] Marine species are more likely to become entangled in slack lines. "Taut mooring configurations are preferable because less slack in lines is likely to reduce entanglement potential (Benjamins et al. 2014). Highest relative risk may occur with catenary moorings given that the lines are not taut. Chains and nylon ropes are thought to have higher snagging potential, as do accessory buoys." Maxwell et al. 2022. "Potential impacts of floating wind turbine technology for marine species and habitats." Journal of Environmental Management, 307, 114577 (p. 10). https://doi.org/10.1016/j.jenvman.2022.114577. Burying inter-array cables, when possible, may also reduce entanglement risk. *Id.* at Table 2.

[13] Protocol is adapted from the Federal Energy Regulatory Commission (FERC) Environmental Assessment for Hydropower License for the PacWave South Project (April 2020). https://www.boem.gov/sites/default/files/documents/regions/pacific-ocs-region/environmental-analysis/PacWave%20South%20EA.pdf.

[14] *See* National Marine Fisheries Service Large Whale Entanglement Response Program for whale entanglement reporting protocol (Greater Atlantic region: https://www.fisheries.noaa.gov/new-england-mid-atlantic/marine-life-distress/marine-mammal-entanglement-greater-atlantic-region; West Coast: https://www.fisheries.noaa.gov/west-coast/marine-mammal-protection/west-coast-large-whale-entanglement-response-program#reports); Sea Turtle Disentanglement Network for sea turtle reporting protocol. https://www.fisheries.noaa.gov/new-england-mid-atlantic/marine-life-distress/sea-turtle-disentanglement-network).