Research Directions and Mitigation

To meet requirements of federal and state agencies, researchers at the Maine Offshore Wind Energy Test Bed south of Monhegan Island are undertaking wildlife-specific monitoring for fish, benthic invertebrates (such as crustaceans and shellfish), and marine mammals, focusing on both direct and indirect effects. The Gulf of Maine Research Institute and the University of Maine are looking at the impacts of "chronic" sounds to understand how they influence whale behavior. The monitoring program will collect data over a range of weather conditions near the test bed to gain a better understanding of turbine acoustics in water.

As for EMF emissions, researchers believe impacts can be reduced with better cable armoring, different cable designs and deeper cable burial (Petersen and Malm 2006). It is difficult to study EMF in the ocean, therefore the Pacific Northwest National Laboratory is working on a project investigating EMF sensitivity and the American lobster in a laboratory environment completed at the end of 2011 (Woodruff et al. 2011). However, more information is needed to determine the species that will potentially be affected by EMF, as well as the range of fields transmission cables will generate.

References

Bigelow, A.F., Schroeder, W.C., Collette, B.B., Klen-McPhee, G., and Bigelow, H.B. (2002). Fishes of the Gulf of Maine (3rd ed.). Washington D.C.: Smithsonian Press.

Boehlert, G.W. and Gill, A.B. (2010) Environmental and Ecological Effects of Ocean Renewable Energy Development: A Current Synthesis. Oceanography, 23(2), 68-81.

Gill, A.B., Huang, Y., Gloyne-Phillips, I., Metcalfe, J., Quayle, V., Spencer, J., and Wearmouth, V. (2009). COWRIE 2.0 Electromagnetic Fields Phase 2: EMF-Sensitive fish response to the EM emissions from sub-sea electricity cables of the type used by the offshore renewable energy industry.

Inger, R., Attrill, M.J., Bearhop, S. et al. (2009) Marine renewable energy: potential benefits to biodiversity? An urgent call for research. Journal of Applied Ecology, 46, 1145-1153.

Normandeau, Exponent, Tricas, T., and Gill, A. (2001). Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species (U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study BOEMRE 2011-09).

Pershing, A. (2011). "Marine Mammals". In Offshore Wind Feasibility Study (funded by the U.S. Department of Energy). Ed. S. Elston, P. Graham, E. Hedefine. Retrieved from http://www.deepcwind.org/offshorewindreport

Petersen, J. and Malm, T. (2006) Offshore Windmill Farms: Threats to or Possibilities for the Marine Environment. Ambio, 35(2), 75-80.

Schwartz, M., Heimiller, S., Haymes, S., and Musial, W. (2010). Assessment of Offshore Wind Energy Resources for the United States (National Renewable Energy Laboratory, Golden, CO. Contract nr DE-AC36-08-GO28308). Retrieved from http://www.osti.gov/bridge

University of Maine and James W. Sewall Company. (2011). Offshore Wind Feasibility Study (funded by the U.S. Department of Energy). Ed. S. Elston, P. Graham, E. Hedefine. Retrieved from http://www.deepcwind.org/offshorewindreport

Woodruff D.L., Schultz, I.R., Ward, J.A., and Cullinan, V.I. (2011). Effects of Electromagnetic Fields on Fish and Invertebrates, Fiscal Year 2011 Progress Report - Environmental Effects of Marine and Hydrokinetic Energy. PNNL-20813, Pacific Northwest National Laboratory, Richland, WA. Retrieved from http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20813.pdf

Image Sources

Breaching humpback: http://www.flickr.com/photos/pathawks/3840759913/sizes/l/in/photostream/

Turbine designs: http://www.renewableenergyworld.com/rea/news/article/2011/06/deepcwind-project-tirelessly-developing-floating-offshore-wind

Submarine cable: http://www.nsw.com/ProductsbrServices/Cable/PowerCables/SubmarinePowerCables/tabid/71/Language/en-US/Default.aspx

FAD: http://www.fao.org/DOCREP/005/Y4260E/y4260e0h.htm

Lobster: OAR/National Undersea Research Program: http://www.photolib.noaa.gov

Herring: http://www.gma.org/herring/biology/ecology/default.asp

Founded in 1983, the Island Institute is a membership-based nonprofit organization headquartered in Rockland, Maine, focused on helping to sustain the year-round island and remote coastal communities of the Gulf of Maine. As the Gulf of Maine increasingly attracts attention for its robust offshore wind resource, the Institute is working with island communities, fishermen, regulators, researchers, developers, manufacturers and others to enable them to effectively share information on ocean energy development with each other.

For more information on the Island Institute's ocean renewable energy efforts, please contact Heather Deese, vice president of programs, at hdeese@islandinstitute.org, (207) 594-9209 x 112 or Suzanne MacDonald, community energy director, at smacdonald@islandinstitute.org, (207) 594-9209 x 144.
The following web resources are also available:
http://www.islandinstitute.org/oceanrenewableenergy.php • http://www.islandinstitute.org/mappingworkingwaters.php

This fact sheet was reviewed by:
Andrew Gill, Ph.D. – Cranfield University
Aaron Rice, Ph.D. – Cornell University
Scott D. Kraus, Ph.D. – New England Aquarium
Bob Steneck, Ph.D. – University of Maine, School of Marine Sciences

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Interactions with Offshore Wind Energy: Marine Species

The Gulf of Maine (GoM) has been identified by the U.S. Department of Energy and offshore wind energy developers as an "outstanding" location for deepwater offshore wind energy development because of its strong, consistent winds (Schwartz et al. 2010). The GoM is also noted for its abundant marine life, which supports economically and culturally important fisheries. How might the introduction of floating offshore wind turbines impact marine species in the Gulf of Maine?

This fact sheet summarizes potential interactions of marine species with offshore wind energy developments off the Maine coast. Direct impacts, such as collisions with floating structures or service vessels, and indirect impacts, such as species avoidance or disturbance due to noise or electromagnetic field (EMF) emissions, can potentially have cumulative effects on populations of marine species.

Current research and proposals for commercial offshore wind energy projects in the northern Gulf of Maine are focused on floating structures, rather than the bottom-mounted turbine technology used at existing offshore wind farms in Europe and proposed elsewhere in the U.S. While there are currently no wind turbines installed at sea in the U.S., there has been research on wildlife and wind turbine interactions at land-based sites and at multiple existing ocean wind energy projects in European waters. This fact sheet is based on findings of those studies as they might apply to floating structures off the coast of Maine.

Marine Species of Conservation Concern

The GoM is extremely important to many species of temperate and subpolar marine mammals. Marine mammals are protected under the federal Marine Mammal Protection Act (MMPA) and many are listed as threatened or endangered under the Endangered Species Act (ESA).

Six species of baleen whales, 11 species of toothed whales, and two species of seals have been recorded in the GoM (Pershing 2011). These species are more common in spring, summer and fall when their prey is more plentiful. In particular, the GoM and the Nova Scotian Shelf are believed to compose the entire feeding area for the critically-endangered North Atlantic right whale from spring until fall. The northern Jordan Basin, approximately 60 miles offshore from the Downeast Maine coast, may be a winter mating area for North Atlantic right whales.

Many species of fish and invertebrates also inhabit the GoM, and sea turtles are occasionally found in the region (Bigelow et al. 2002). The ESA-listed Atlantic salmon, Atlantic sturgeon and shortnose sturgeon move through the GoM on their way to and from Maine's rivers (University of Maine 2011).

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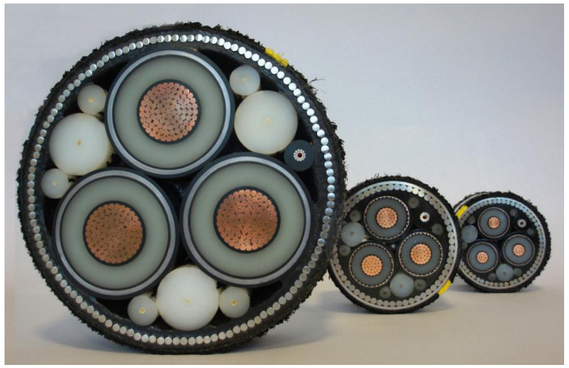
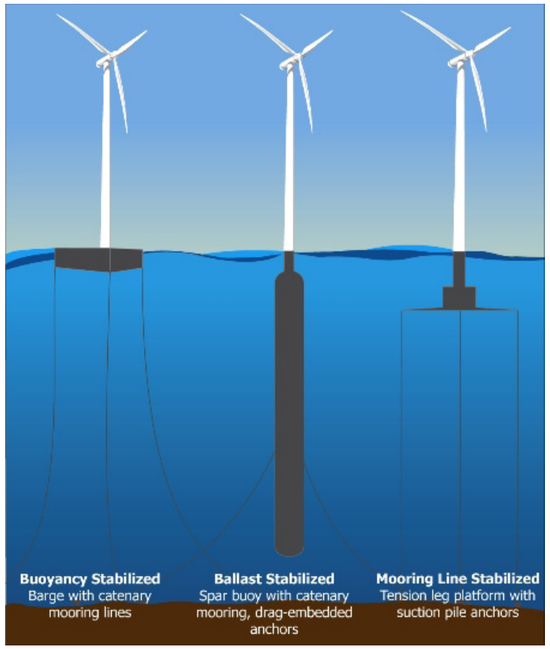
386 Main Street, Rockland, ME | www.islandinstitute.org | (207) 594-9209

Interactions with Platforms and Cabling

Direct effects to marine species are anticipated to be minimal as collision or entanglement with the floating platform and anchoring system is not expected. This is due to the stationary nature of the platform and the fact that cables will likely be relatively large in diameter (greater than 5 inches) (University of Maine 2011). However, wind turbine construction and maintenance activities will increase vessel traffic in and around wind-farm sites, which may increase the probability of collisions with marine mammals.



Cross section of submarine power cables

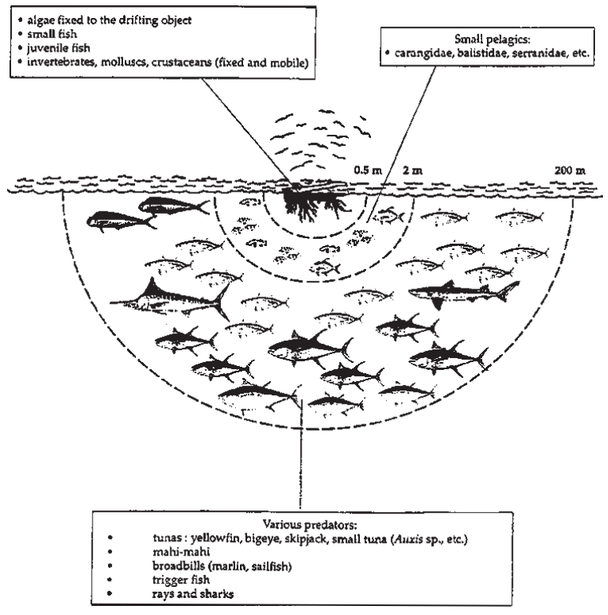


Floating turbine designs showing anchoring systems

Seals may interact with the platforms, as they are known to haul out on floating structures. Although this is not thought to cause direct harm to the seal, the platforms may be constructed in a manner that deters this behavior.

Aggregation and Avoidance

Turbine platforms, cables and anchoring systems may alter species behavior in multiple ways. Species may avoid the structures, and an array of structures could cause marine mammals and other migrating species to change their migratory routes. On the other hand, many species of fish tend to aggregate around floating structures at sea, a fact that fishermen have been using to their advantage for many years (Inger 2009). Similarly, offshore wind energy structures may act as Fish Aggregating Devices (FADs), which may affect the amount and diversity of prey. Arrays of offshore wind platforms would also likely impact fishing practices in the surrounding area, which will likely lead to changes in the diversity and abundance of species.



Species distribution around a Fish Aggregating Device (FAD)

Electromagnetic Field Effects

Electromagnetic Fields (EMFs) are caused by high voltage underwater cables that transmit power (Gill 2005). There are numerous submarine power cables in the GoM that are used to provide power to the offshore islands.

While effects can be reduced with cable armoring, EMF emissions have the potential to disorient many types of marine species. For example, major groups of bony fish and crustaceans (e.g., lobster, shrimp, sharks and rays) use the earth's magnetic field to aid in orientation and direction. To better understand this potential interaction, European researchers exposed sharks and rays to an EMF equivalent to emissions from industry standard cables and measured their responses (Gill et al. 2009). While EMF sensitive fish could respond to the EMF emitted by the cables and were attracted to it, they concluded that more research was needed to determine how the response may scale up to population level over the long-term (Ibid.). Several other studies have also found that marine animals are sensitive to EMF and display a range of behaviors when exposed to varying levels of EMFs (reviewed by Boehlert and Gill 2010).

American Lobster (Homarus americanus)

Sound Effects

Marine species rely on hearing in many ways, as visibility can be low in the marine environment and sound travels over four times faster in water than in air. Species therefore use sound to communicate with one another for feeding, mating and defense. Fish with swim bladders, such as cod and herring, are particularly sensitive as these bladders amplify a great range of sounds. While there is a great deal of diversity in hearing among marine species, many share the ability to hear human-made sounds.

Shipping, commercial fishing, ferries and other vessels in the GoM currently expose marine species to a noisy environment that is heavily influenced by humans, a factor that will make it difficult to estimate the noise impact of an offshore wind installation. In addition, while sound measurements have been performed in the waters around offshore wind turbines in Europe, the levels and types of sounds produced from floating structures in the GoM are likely to be different from these bottom-mounted structures.

Atlantic Herring (Clupea harengus)

Despite this uncertainty, it is anticipated that sounds during pre-construction surveys, construction, operation and decommissioning of floating turbines and their associated anchoring systems may have the potential to:

- mask species' communication and navigation vocalizations;
- damage hearing of animals that venture too close; and
- cause stress-related responses.