

Introduction to the Special Issue on

Understanding the Effects of Offshore Wind Development on Fisheries

By Emily Twigg, Susan Roberts, and Eileen Hofmann

The United States is entering a new era of energy development with the emergence of offshore wind energy as part of the nation's energy portfolio. Across the country, states have developed Renewable Portfolio Standards for energy utilities that can be supported by the introduction of offshore wind. In 2020, two pilot wind turbines were installed off the coast of Virginia through a partnership among Commonwealth of Virginia (lessee), Dominion Energy (operator), and Ørsted (installer). With the passage of the Virginia Clean Economy Act of 2020, the Commonwealth is dedicated to achieving a 100% renewable energy supply by 2050. These are the first new offshore wind turbines in the United States since construction of the Block Island Wind Farm off Block Island, Rhode Island, was completed in 2016. Plans for utility-scale wind farms in waters of the US Atlantic outer continental shelf are expected to be approved by the Bureau of Ocean Energy Management (BOEM) starting in 2021, with more to follow in the next three to five years.

The projected development of US offshore wind energy resources will change the ocean landscape. Commercial and recreational fishing, industries with significant economic and cultural value in the United States, will be particularly affected by offshore wind energy development. Avoidance and mitigation of potential impacts on marine resources and maritime economies from offshore wind construction and operation will require evidence-based planning for the effects that might be expected to occur at an individual site. At the same time, there is an opportunity to take a comprehensive approach to understanding how localized changes within wind farm footprints will affect fisheries on regional scales and across projects.

This special issue of *Oceanography*, Understanding the Effects of Offshore Wind Development on Fisheries, provides an overview of what has been learned from research and monitoring of offshore wind farm impacts on fisheries resources. Much of the current understanding of these impacts and the lessons for monitoring them that are synthesized in this issue are based on experiences from European wind farms. Monitoring around the five turbines in the Block Island Wind Farm provides insights into changes that may be expected in the US Atlantic. The US Northeast and Mid-Atlantic will be the focus of offshore wind development activity in the near future because there are abundant wind resources in these areas, and many leases are in place already. Planning for offshore wind energy development along the US West Coast and Hawai'i is also underway (BOEM, 2020). This special issue stems, in part, from a workshop conducted by the National Academies of Sciences, Engineering, and Medicine and sponsored by the Bureau of Ocean Energy Management to plan research and monitoring for fisheries impacts from offshore renewable energy installations that are projected for the US Atlantic outer continental shelf (NASEM, 2018).

While it is important to build on what has been learned so far, the physical environments and biological resources of each US coast are very different from each other and from Europe, and extrapolation is not straightforward. Additionally, new energy technologies and a changing climate will drive a need to adapt monitoring strategies. For example, continuing innovations in wind turbine technology that allow them to increase in size—potentially provid-

ing up to 15 GW per turbine in the next decade (Musial et al., 2018)—mean that wind farms on the horizon in the United States will look unlike those that came before. Further, innovations in floating turbines will open up new and deeper areas to offshore wind development, with very different impacts.

PLANNING FOR CRITICAL AND RELEVANT RESEARCH AND MONITORING

With a wide array of fisheries species and environmental variables, the potential targets for research and monitoring are broad. Workshops and consultations with scientists, fisheries managers, and the fishing industry have helped to identify potential monitoring targets and initiate prioritization of these targets (e.g., Petruny-Parker et al., 2015; NASEM, 2018). Additionally, insights gained from research programs in Europe, and early studies of changes around Block Island Wind Farm, provide a starting point for planning monitoring programs for the US Atlantic outer continental shelf.

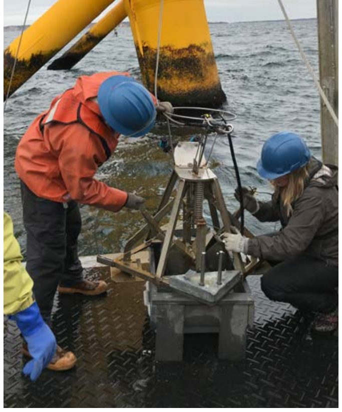
Offshore wind turbines introduce new habitat for colonization by benthic organisms and fish. **Degraer et al.** (page 48) document this artificial reef effect. Benthic monitoring at Block Island Wind Farm has shown initial colonization of the wind turbine foundations similar to what has been seen in Europe (**Hutchison et al.**, page 58). With this high-level knowledge as a starting point, these authors recommend focusing future monitoring on developing a deeper understanding of how changes in benthic ecology will affect functioning of the broader ecosystem.

Carey et al. (page 70) describe the monitoring of hard bottom habitat, demersal fish, lobsters and crabs, and recreational boating activities before and after construction of Block Island Wind Farm. These studies were designed in consultation with fishing and boating stakeholders and were adapted throughout the course of their implementation to be responsive to stakeholder concerns and new information. These authors discuss the challenges of monitoring the abundance of fish and invertebrate species that are already highly variable year to year. For this reason, the demersal fish study described in the article included multiple reference areas and comparability to regional studies. Among their recommendations for future monitoring, they suggest considering other metrics in addition to catch rates for identifying effects on fisheries species.

The construction and operation of wind turbines may also impact fisheries species through the introduction of noise (**Mooney et al.**, page 82) and electromagnetic fields (**Hutchison et al.**, page 96) in the environment. These impacts are highly dependent on the physiology and behavior of the resident species. The various stages of wind farm siting, installation, operation, and decommissioning generate noise with different characteristics and hence different potential impacts. A substantial body of research has examined the effects of noise on a variety of fish species, but gaps remain for understanding the susceptibility of resident fish species to noise at various life stages and the potential for population-level impacts. Similar concerns arise for electromagnetic fields generated by energy transmission cables that may affect fish species using naturally generated fields as behavioral cues.

The near-field and far-field effects of wind turbines on the hydrodynamics of surrounding waters are complex (**van Berkel et al.**, page 108). The wind turbine foundations impact mixing, turbulence, and stratification in the near field, and the direct extraction of wind energy by the farms affects wave and current distributions in the far field, both modifying the hydrodynamics in and around wind farms. The impact of modified local circulation on fisheries is limited; regional far-field impacts are unknown. **Van Berkel et al.** recommend integrated modeling analyses that combine near- and far-field circulation with life stages and habitat needs of key species to assess long-term effects on fisheries of the hydrodynamic changes due to wind farms.

What do these changes mean for fisheries? **Gill et al.** (page 118) highlight a critical gap—the need to understand how changes at local scales may impact productivity at regional scales. The authors suggest that regional, integrated monitoring programs that cross political boundaries (i.e., state, national) will be necessary to fill this gap. Such programs are important for determining whether, for example, fish are merely attracted to wind turbines and redistributed from other areas or whether there is a net benefit to production from wind farms located in a region. Evaluating the impacts of these changes will also require under-


standing how changes in fish communities will affect the human communities that rely on them.

INCLUSION OF THE FISHERIES

Many of the potential benefits from offshore wind energy development will apply to the general public through decreased consumption of fossil fuel and employment opportunities in various sectors of the economy involved in the design, construction, and maintenance of these facilities. Although coastal communities may benefit from new economic opportunities associated with the offshore energy sector, they also stand to be disproportionately affected by potential negative impacts. These communities have the greatest dependence on traditional uses of the ocean such as tourism, transportation, commerce, and recreational and commercial fishing. In particular, commercial fishing is associated with valued cultural traditions and contributes to the economic vitality of these communities. Offshore wind energy and its infrastructure is a relative newcomer in this environment, and as **Haggett et al.** (page 38) note, this development raises concerns about disturbance or loss of traditional fishing grounds and "industrialization" of this otherwise open space.

Methratta et al. (page 16) explain that the Energy Policy Act of 2005 only calls for consideration of fishing activities but sets no threshold for impacts on fisheries that would mandate a change in offshore wind planning. The level of consideration is at the discretion of the US Department of the Interior, an agency not generally involved in the management of these fisheries, which falls under the purview of NOAA Fisheries in the Department of Commerce. Hence, offshore wind energy development requires significant interagency coordination regarding the conduct of fisheries in federal waters as it relates to offshore renewable energy.

Conflicts between fisheries and offshore wind energy development have also arisen in Europe, and some of the strategies used to resolve conflicts there have been adopted in the United States. These approaches may include various types of compensation funds, participatory decision-making, and cooperative research strategies. With involvement of multiple state and federal agencies, community organizations, offshore wind developers, and both recreational and commercial fishing industries, a significant amount of time and effort is required for effective engagement in decision-making across sectors. Organizations such as the Responsible Offshore Development Alliance (RODA) and Responsible Offshore Science Alliance (ROSA) have been formed to provide opportunities for information sharing among government, industry, fisheries, and other stakeholders, as well as collaborative development of research and monitoring programs. **Haggett et al.** (page 38), **Methratta et al.** (page 16), and **Perry and Heyman** (page 28) discuss various aspects of these organizations.

As **Haggett et al.** (page 38) state, a just energy transition will require consideration of the effects that offshore renewables will have on fishing. While the spatial conflicts between energy and fishing present challenges, through coordination and cooperative research, there is precedent for and progress toward an inclusive approach to planning a new energy future.

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