Wind on the Water

WILL AN OFFSHORE WIND FARM AFFECT THE UNDERSEA SOUNDSCAPE?

by Kate Madin

An offshore wind farm, like this one off Copenhagen, Denmark, is slated for construction in Nantucket Sound off Cape Cod, Mass.

Over a decade, federal agencies examined and debated the nation's first proposed offshore wind farm, which would place power-generating wind turbines in Nantucket Sound off Cape Cod, Mass. Officials examined the likely effects on ocean views, airplane and boat navigation, air and water quality, fish populations, migrating birds and marine mammals, even electric and magnetic fields. They approved the project in August 2012. Still, two scientists at Woods Hole Oceanographic Institution (WHOI) thought another factor needed to be looked at—or listened to—more closely: sound.

Sound travels better than light through water, so "in the ocean, one of the main ways animals perceive their environment is by using sound," said WHOI biologist Aran Mooney. "We know that sounds we make in the ocean influence animals, and loud sounds may detrimentally affect animals."

In 2012 Mooney and biologist Laela Sayigh began recording underwater sound in Horseshoe Shoal, a 25-square-mile area in Nantucket Sound, where Cape Wind Associates plan to build 130 wind turbines, each 440 feet tall, to produce up to 454 megawatts of power at peak generation. Using anchored digital acoustic recording instruments, the scientists are measuring and identifying underwater sound before, during, and after turbine construction. They think the experiment, the first of its kind in the United States, could offer a template for assessing possible impacts, good and bad, of future offshore wind farms.

"When Aran suggested monitoring the Cape Wind site, I thought, 'That seems pretty basic—it's right in our backyard, and it's such an obvious way to get a sense of what's out there," said Sayigh, who studies how marine mammals vocalize and communicate. "We are looking not just at marine mammal sounds, but also fish sounds, boat noise, and more."

Collecting all frequencies

The U.S. Department of the Interior report approving the wind turbines stated, "Noise impacts are expected to range from negligible to minor for onshore and offshore receivers" during the construction phase. After construction, the report stated, "Operational noise impacts are expected to be negligible" for onshore, offshore, and underwater locations.

However, Mooney said, turbine construction, requiring seabed excavation and supports, could generate significant amounts of loud sound, and the metal turbines' operation will generate continuous sound, perhaps at frequencies used by marine mammals or fish.

"On the flip side," he said, "a lot of marine animals and larvae are attracted to sounds in the ocean. The turbines' operational sounds may be at low frequencies that actually bring larvae in. And the turbines themselves might provide structure animals can reside around as well—basically an artificial reef—so there's potential benefit there."

The scientists use two kinds of acoustic recorders—one commercially available type, and another, the DMON (digital acoustic monitor), made at WHOI by engineer Tom Hurst and colleagues.

"We can record anything that makes a sound out there, even weather sounds, like rain and storms," Mooney said. Calls from gray and harbor seals are generally below 5 kilohertz (kHz) or so, he said. Dolphins' sounds could be much higher—calls ranging from 5 to 30 kHz, and echolocation in the ultrasonic range with frequencies as high as 150 kHz. Sounds of fish, and sounds that humans produce from boats and construction, are lower frequency, essentially one kHz or below.

The DMON, 18 inches long and four inches across, continuously records all the frequencies Mooney and Sayigh want to capture, but only for a week. The commercial recorder is heavier and bulkier, and records frequencies up to only 40 kHz. But it can be set to record for one minute every ten minutes, spreading out battery power and hard-drive space and recording for two or three months before needing replacement.

"We're making the best of both worlds, putting one device in the water to get a really in-depth look for one week, then we continue with the other device to get a sampling period of several months, then we replace both," Mooney said.

In 2013 the researchers purchased two more acoustic recorders and put them in control areas at a distance from the Cape Wind site, which doubles their assessment ability and will let them compare areas.

> We can record anything that makes a sound out there, even weather sounds like rain and storms.
>
> —*Aran Mooney*

A model for future wind farms

The recordings reveal both familiar and unidentified sounds.

"We have fish called cusk eels whose sounds are really abundant, but we're getting a lot of sounds we haven't figured out yet," Mooney said. Even invertebrate animals make sounds. Certain shrimp, for instance, make loud snapping sounds and low rumbles. By listening in, the researchers anticipate learning more about what animals are in the turbine area, their abundance, and what they do.

"Animals make sounds when they attract mates or reproduce, and you can track those activities by listening," Mooney said. "I'd love to look at biological diversity with this project. In healthy habitats, you have a spectrum of sounds." An undersea area under environmental stress could sound different, and impacts might be gauged by the missing sounds.

Through the summer of 2013, the researchers have recorded large amounts of data.

"We're now in the phase of the study where, in addition to still collecting digital records, we are creating computer programs to identify sounds within the data," Mooney said. "Analysis is a slow process, but we're starting to see trends." For example, cusk eels' call levels reflect their activity cycles—higher at night, lower by day, and seasonal, as the fish migrate away in autumn.

Boat noise is extremely challenging, the researchers said. Vessels produce highly variable sound frequencies, time patterns, and sound levels, making it difficult to create an automated way to sort through data and identify them.

Cape Wind intended to begin construction in 2013. Mooney and Sayigh's study, funded by Woods Hole Sea Grant and the Island Foundation, with contributions from the WHOI Coastal Ocean Institute, will run at least two years, but the researchers hope to continue from Cape Wind's pre-construction through operational phases. Jordan Carduner and other visiting graduate students from Duke University's Nicholas School of the Environment are participating in the project, working with Mooney to outline methods to acoustically monitor wind farm construction, which has not happened at offshore wind farms elsewhere.

"We want to evaluate the importance of this kind of research for future offshore wind farm development, " Mooney said. "That will be valuable for industry, policymakers, and the public." ▲

Cape Wind Associates plan to erect 130 wind turbines, each 440 feet tall, in a 25-square-mile area of Horseshoe Shoal in Nantucket Sound. WHOI scientists are recording undersea sound in the region, before, during, and after.