

Oceanographers produce first-ever images of entire cod shoals

November 6 2018, by Jennifer Chu



The RV Knorr, in Norway's Alesund harbor in February 2014, as the crew prepares to begin its Nordic Seas Experiment. Credit: Michael Collins, U.S. Naval Research Laboratory

For the most part, the mature Atlantic cod is a solitary creature that

spends most of its time far below the ocean's surface, grazing on bony fish, squid, crab, shrimp, and lobster—unless it's spawning season, when the fish flock to each other by the millions, forming enormous shoals that resemble frenzied, teeming islands in the sea.

These massive spawning shoals may give clues to the health of the entire cod population—an essential indicator for tracking the species' recovery, particularly in regions such as New England and Canada, where cod has been severely depleted by decades of overfishing.

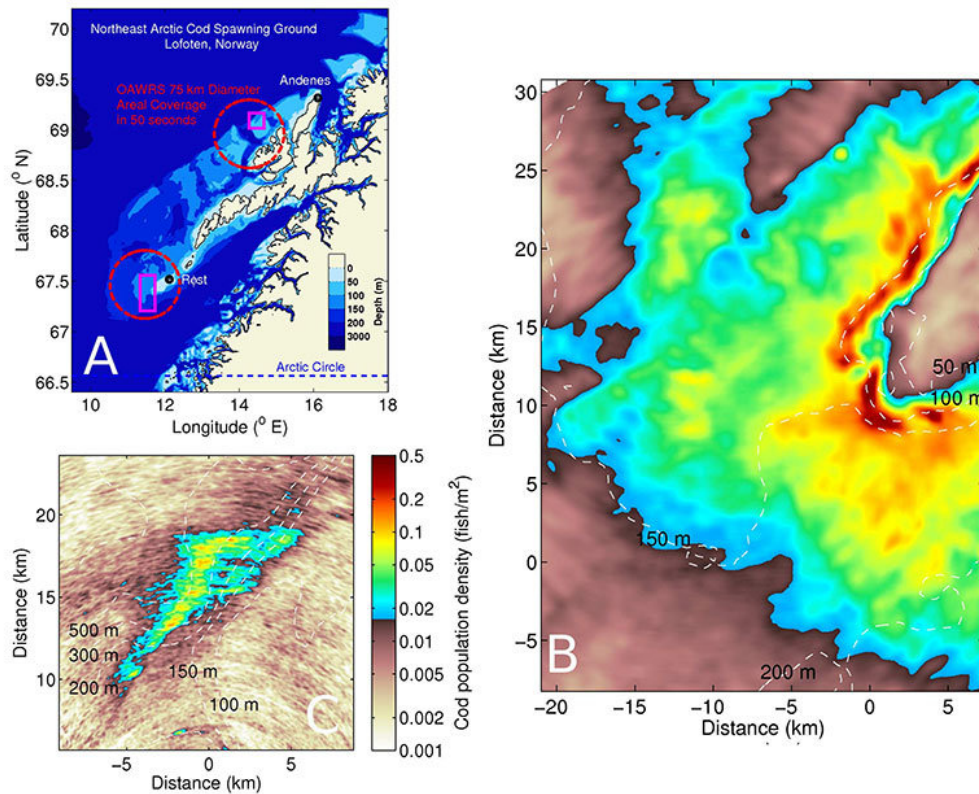
But the ocean is a murky place, and fish are highly mobile by nature, making them difficult to map and count. Now a team of oceanographers at MIT has journeyed to Norway—one of the last remaining regions of the world where cod still thrive—and used a synoptic acoustic system to, for the first time, illuminate entire shoals of cod almost instantaneously, during the height of the spawning season.

The team, led by Nicholas Makris, professor of mechanical engineering and director of the Center for Ocean Engineering, and Olav Rune Godø of the Norwegian Institute of Marine Research, was able to image multiple cod shoals, the largest spanning 50 kilometers, or about 30 miles. From the images they produced, the researchers estimate that the average cod shoal consists of about 10 million individual fish.

They also found that when the total population of cod dropped below the average shoal size, the species remained in decline for decades.

"This average shoal size is almost like a lower bound," Makris says. "And the sad thing is, it seems to have been crossed almost everywhere for cod."

Makris and his colleagues have published their results in the journal *Fish and Fisheries*.



Spatial population distributions of entire Atlantic cod spawning groups of the Northeast Arctic obtained by instantaneous imaging. Top left image shows, in red circles, areas where researchers imaged spawning grounds of Atlantic cod in Lofoten, Norway. Right image depicts a 40-kilometer-wide stable cod group containing about 40 million individuals. Bottom left image shows a 20-kilometer-scale cod group of about 1 million individuals near Andenes, Norway. Credit: Massachusetts Institute of Technology

Echoes in the deep

For years, researchers have attempted to image cod and herring shoals using high-frequency, hull-mounted sonar instruments, which direct narrow beams below moving research vessels. These ships traverse a

patch of the sea in a lawnmower-like pattern, imaging slices of a shoal by emitting high-frequency sound waves, and measuring the time it takes for the signals to bounce off a fish and back to the ship. But this method requires a vessel to move slowly through the waters to get counts; one survey can take many weeks to complete and typically samples only a small portion of any particular expansive shoal, often completely missing shoals between survey tracks and never capturing shoal dynamics

The team made use of the Ocean Acoustic Waveguide Remote Sensing, or OAWRS system, an imaging technique developed at MIT by Makris and co-author Purnima Ratilal, which emits low-frequency sound waves that can travel over a much wider range than high-frequency sonar. The sound waves are essentially tuned to bounce off fish, in particular, off their swim bladder—a gas-filled organ that reflects sound waves—like echoes off a tiny drum. As these echoes return to the ship, researchers can aggregate them to produce an instant picture of millions of fish over vast areas.

Making passage

In February and March of 2014, Makris and a team of students and researchers headed to Norway to count cod, herring, and capelin during the height of their spawning seasons. They towed OAWRS aboard the Knorr, a U.S. Navy research vessel that is operated by the Woods Hole Oceanographic Institution and is best known as the ship aboard which researchers discovered the remnants of the Titanic.

The ship left Woods Hole and crossed the Atlantic over two weeks, during which time the crew continuously battled storms and choppy winter seas. When they finally arrived at the southern coast of Norway, they spent the next three weeks imaging herring, cod, and capelin along the entire Norwegian coast, from the town of Alesund, north to the Russian border.

"The underwater terrain was as treacherous as the land, with submerged seamounts, ridges, and fjord channels," Makris recalls. "Billions of herring actually would hide in one of these submerged fjords near Alesund during the daytime, about 300 meters down, and come up at night to shelves about 100 meters deep. Our mission there was to instantaneously image entire shoals of them, stretching for kilometers, and sort out their behavior."

A window through a hurricane

As they moved up the Norwegian coast, the researchers towed a 0.5-kilometer-long array of passive underwater microphones and a device that emitted low-frequency sound waves. After imaging herring shoals in southern Norway, the team moved north to Lofoten, a dramatic archipelago of sheer cliffs and mountains, depicted most famously in Edgar Allen Poe's "Descent into the Maelstrom," in which the poet made note of the region's abundance of cod.

To this day, Lofoten remains a primary spawning ground for cod, and there, Makris' team was able to produce the first-ever images of an entire cod shoal, spanning 50 kilometers.

Toward the end of their journey, the researchers planned to image one last cod region, just as a hurricane was projected to hit. The team realized there would be only two windows of relatively calm winds in which to operate their imaging equipment.

"So we went, got good data, and fled to a nearby fjord as the eye wall struck," Makris recalls. "We ended with 30-foot seas at dawn and the Norwegian coast guard, in a strangely soothing young voice, urging us to evacuate the area." The team was able to image a slightly smaller shoal there, spanning about 10 kilometers, before completing the expedition.

On the brink

Back on dry land, the researchers analyzed their images and estimated that an average shoal size consists of about 10 million fish. They also looked at historical tallies of cod, in Norway, New England, the North Sea and Canada, and discovered an interesting trend: Those regions—like New England—that experienced long-lasting declines in cod stocks did so when the total cod population dropped below roughly 10 million—the same number as an average shoal. When cod dropped below this threshold, the population took decades to recover, if it did at all.

In Norway, the cod population always stayed above 10 million and was able to recover, climbing back to preindustrial levels over the years, even after significant declines in the mid-20th century. The team also imaged shoals of herring and found a similar trend through history: When the total population dropped below the level of an average herring spawning shoal, it took decades for the fish to recover.

Makris and Godø hope that the team's results will serve as a measuring stick of sorts, to help researchers keep track of fish stocks and recognize when a species is on the brink.

"The ocean is a dark place, you look out there and can't see what's going on," Makris says. "It's a free-for-all out there, until you start shining a light on it and seeing what's happening. Then you can properly appreciate and understand and manage." He adds "Even if field work is difficult, time consuming, and expensive, it is essential to confirm and inspire theories, models, and simulations."

Provided by Massachusetts Institute of Technology

Citation: Oceanographers produce first-ever images of entire cod shoals (2018, November 6)
retrieved 24 April 2024 from

<https://phys.org/news/2018-11-oceanographers-first-ever-images-entire-cod.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.