Institute of Marine Research, Norway

Atlantic cod larvae are attracted by the sound of offshore wind turbines

A unique first-of-its kind experiment revealed that, when exposed to simulated operational noise of an offshore wind turbine, Atlantic cod larvae alter their innate orientation and swim towards the source of the noise. This change in orientation behaviour has important implications for the dispersal of Atlantic cod larvae nearby offshore wind farms, and possibly also for their distribution as juveniles and adults.

Offshore wind is expanding rapidly and will become one of the most important sources of renewable energy. Large-scale offshore wind farms will occupy thousands of square kilometer areas along the coast. As such, they will be the most expansive industrialization of the ocean in history. The rapid development of expansive offshore wind facilities raises concerns about their possible effects on fishes.

Any effect of the turbines on the spatial distribution of fish stocks would have ecological, commercial, and societal impacts. If fish are attracted to reside within the wind facilities, they will become unavailable for fishers, who cannot operate safely inside a cluster of turbines. Fish spatial distribution starts to be determined from the earliest larval period, when millions of fish larvae swim while being transported by ocean currents. If wind farms attract or repel the fish larvae transiting through or nearby the facility, it would change their distribution at a large-scale, with potential consequences for the distribution of juveniles and adults.

Understanding the behavior of marine fish larvae in response to the signals emitted by the turbines (mostly noise and vibration) is a key research priority. When turbines operate, they introduce continuous underwater noise at low frequencies that propagates away from the facility. Marine fish are sensitive to underwater sound and some species respond to low frequencies such as those produced by a wind turbine. If and how marine fish larvae respond to the noise emitted by offshore wind farms is unknown.

To fill this gap, a team of scientists at the Norwegian Institute of Marine Research's Austevoll Research Station performed a first-of-its-kind experiment to explore whether larvae respond to the simulated sound of a wind turbine. Atlantic cod, a keystone species of the north Atlantic, is sensitive to low frequency sound. The team used a unique approach to recreate the scenario of cod larvae drifting in proximity of a wind farm. The experiment was designed to assess if swimming and orientation of cod larvae drifting at sea changed in presence of continuous low-frequency sound simulating that produced by an offshore wind turbine.

Cod larvae were videorecorded while enclosed in transparent behavioral chambers that were drifting in a Norwegian fjord. While the chambers were drifting, the team used a high-output, low-frequency speaker to reproduce continuous sound in the fjord at a very low frequency (100 Hz). The sound had an intensity comparable to that of real wind turbines. The team used also a state-of-the-art sensor to measure the directional component of the sound emitted by the speaker (the particle motion – oscillatory displacement of water particles around an equilibrium point caused by the passing of sound waves). Underwater particle motion is important because fish use it to locate the source of sound. The team tested around 90 cod larvae, half of which was videorecorded in the presence of the sound and half recorded with the speaker switched off (control).

In absence of the continuous sound, cod larvae oriented strongly to the northwest. When exposed to the sound, this innate orientation direction was less significant and less accurate. Rather, exposed

larvae oriented towards the direction of the speaker, that is, towards a simulated offshore wind turbine.

“These results indicate that cod larvae drifting through or near a wind farm will be attracted to the source of the sound. As thousands of wind turbines will be installed along the Norwegian coast, this attraction could affect the distribution of cod larvae at a large scale” says Alessandro Cresci, postdoctoral scientist at the IMR and first author of the article. “Such research is of crucial importance for the offshore wind sector, as it can help to identify possible impact mitigation measures. We plan to conduct more such experiments on other commercially and ecologically important fish species. “This approach could become a new standard in research on larval fish behavior in response to underwater sound” Cresci concludes.

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Contacts

Alessandro Cresci
Institute of Marine Research, Marine Ecosystem Acoustics Research Group
Austevoll Research Station, Sauganeset 16, 5392 Storebø, Norway
E-mail: alessandro.cresci@hi.no
Tel. +4748506296
Twitter: @alessandrocre90
Biography online

Howard I. Browman (Institute of Marine Research contact - English and French)
Institute of Marine Research, Marine Ecosystem Acoustics Research Group
Austevoll Research Station, Sauganeset 16, 5392 Storebø, Norway
E-mail: howardb@hi.no
Tel. +4798860778
Twitter: @HBrowman
Biography online

Guosong Zhang (Institute of Marine Research contact – English, Chinese, Norwegian)
Austevoll Research Station, Sauganeset 16, 5392 Storebø, Norway
E-mail: guosong.zhang@hi.no
Tel. +47 951 81 677

Caroline M.F. Durif (Institute of Marine Research contact - Norwegian, French and English)
Institute of Marine Research, Marine Ecosystem Acoustics Research Group
Austevoll Research Station, Sauganeset 16, 5392 Storebø, Norway
E-mail: caroline.durif@hi.no
Tel. +4797627269
Twitter: @durifcaroline
Biography online

Anne Berit Skiftesvik (Institute of Marine Research contact - English and Norwegian)
Institute of Marine Research, Marine Ecosystem Acoustics Research Group
Austevoll Research Station, Sauganeset 16, 5392 Storebø, Norway
E-mail: anne.berit.skiftesvik@hi.no
Tel. +4791866526
Biography online

Institute of Marine Research, Norway

Multimedia materials: Link and file description

LINK : multimedia

DESCRIPTION OF CONTENT

AlessandroCresci_chamber.png = Alessandro Cresci deploys a behavioral drifting chamber in the Bjørnafjorden, Austevoll, Norway

AlessandroCresci_SteveShema_Particle_Motion_Sensor.png = Alessandro Cresci and Steve Shema deploy a 3D acoustic vector sensor (M20-105, GeoSpectrum, Canada) to measure the directionality of the noise from the low-frequency sound projector (CBASS, M72-110, GeoSpectrum, Canada).

CBASS_speaker.jpg = High-output, low-frequency underwater sound projector used in the study (CBASS, M72-110, GeoSpectrum, Canada)

Chamber_deployment.JPG = A drifting behavioral chamber is deployed from the boat.

Chambers_boat.jpg = The drifting chambers used in the study are transported from the IMR Austevoll Research Station to the Bjørnafjorden

cod1.tiff = Cod larva (Gadus morhua)

cod2.tiff = Cod larva (Gadus morhua)

experiment_cod_larvae_bjørnafjorden.jpg = Anne Berit Skiftesvik (IMR scientist) and Glenn Sandtorv (IMR technician) on the way to the experimental location in the fjord.

particle_motion_sensor_2.jpg = Guosong Zhang (IMR engineer) sets up the 3D acoustic vector and sound pressure sensor (M20-105, GeoSpectrum, Canada) used in the experiments to measure the directionality of the simulated underwater noise from a wind turbine.

View_from_camera_chamber.JPG = view of the cod larvae swimming in a behavioral chamber drifting in a deep Norwegian fjord. The larvae were swimming while exposed to the simulated low-frequency noise from a wind turbine.

timelapse_cod.mov = Timelapse of the cod larvae swimming in a behavioral chamber drifting in a deep Norwegian fjord. The larvae were swimming while exposed to the simulated low-frequency noise from a wind turbine.