New research reveals ocean noise from shipping traffic reduced during COVID-19 pandemic

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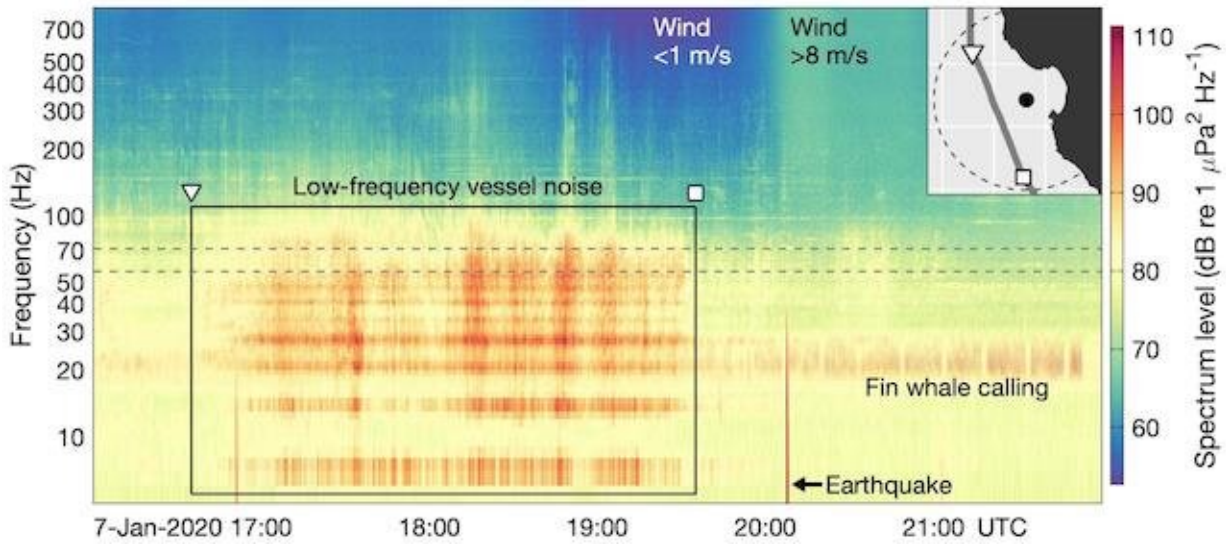
Shipping traffic generates low-frequency sound that permeates the underwater soundscape. An underwater microphone (hydrophone) on MBARI's MARS cabled observatory recorded a decrease in shipping noise in 2020 during the COVID-19 pandemic. Credit: Jess Morten, 2016 NOAA Channel Islands National Marine Sanctuary

The COVID-19 global pandemic upended life around the world and disrupted global economic activity. It enabled a rare opportunity to measure the relationship between shipping traffic and the underwater soundscape in the Monterey Bay National Marine Sanctuary.

A world of sound lies beneath the ocean's surface—the bellowing calls of gargantuan whales, the sharp clicks of dolphins hunting for squid, the deluge of rain on the ocean's surface, the rumble of an earthquake. While most of these sounds come from natural sources, like animals or geological processes, noise from human activities is present too. The deep growls from shipping traffic can permeate the ocean's soundscape. These thundering grumbles ebb and flow with pulses of vessel activity.

An underwater microphone (hydrophone) installed on MBARI's MARS cabled ocean observatory deep beneath Monterey Bay is constantly listening to the underwater soundscape, streaming sounds to shore year-round. Taking a closer listen to audio logged by MBARI's hydrophone in 2020 revealed a drop in low-frequency sound in the spring and summer—a change researchers attribute to a decline in shipping traffic during the COVID-19 pandemic.

"The sound of global trade is in the ocean, and that sound is noise. Ocean noise levels responded very quickly to economic impacts of the pandemic," said John Ryan, a biological oceanographer at MBARI and lead author of the study published in *Frontiers in Marine Science* this week.



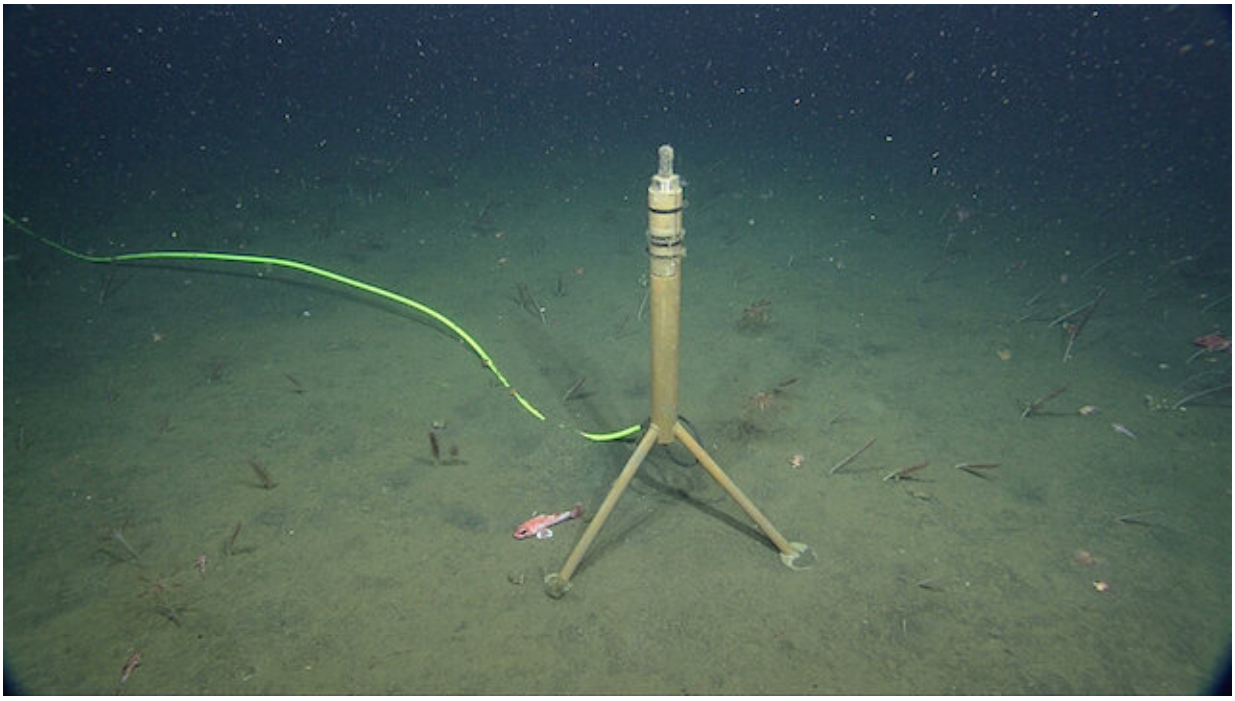
This spectrogram shows sound recorded by an underwater microphone (hydrophone) installed on MBARI's MARS cabled observatory over a six-hour period on January 7, 2020 during the start of the COVID-19 global pandemic. The southbound transit of a container ship is clearly evident from the low-frequency rumble (outlined in black). The hydrophone also logged natural sounds during this time period, including wind on the ocean's surface, an earthquake, and singing by a fin whale (Balaenoptera physalus). The vessel's noise apparently drowned out the vocalizations of the fin whale. Credit: MBARI

MBARI's hydrophone was uniquely suited to rapidly assess the impact of the COVID-19 pandemic on the ocean soundscape. "The cable connection is a great benefit because the data are available immediately," explained Ryan. "We can see the change happening when it's happening."

"We detected the changes by recording sound continuously through the cabled observatory and analyzing those recordings over not just 2020, but previous years too, so we could quantify how much quieter it was in 2020," explained Ryan.

The MARS cabled observatory sits approximately 20 kilometers (12.5 miles) from offshore shipping lanes, providing researchers the opportunity to "eavesdrop" on vessels as they pass through the Monterey Bay National Marine Sanctuary to ports to the north (San Francisco Bay) and south (Southern California).

Most marine acoustic recording systems can only be deployed for a relatively short period of time before battery and data storage capacity become depleted. MBARI's cabled observatory provides a constant connection to shore, removing the limitations on power and data to allow continuous listening to the ocean environment. MBARI installed a broadband hydrophone on the MARS observatory in 2015 and has collected a trove of acoustic data.



The hydrophone at MBARI's MARS ocean observatory has been instrumental for observing the soundscape of Monterey Bay and beyond. A cable runs from the instrument to the observatory and back to shore, providing power and a high-

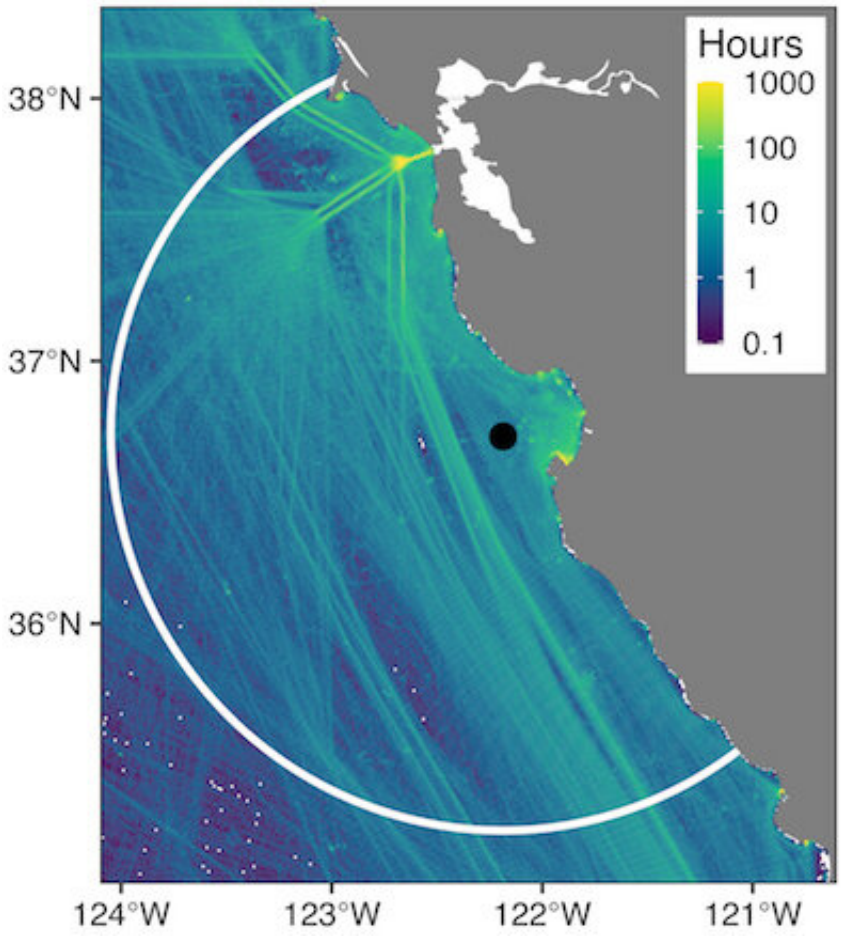
speed data connection to continuously record underwater audio and reveal trends over time, like the reduction of low-frequency noise during the COVID-19 global pandemic. Credit: MBARI

Examining data archived from the past three years proved critical for revealing how the marine soundscape off the central California coast changed during the COVID-19 pandemic.

"Between January and June, low-frequency noise levels decreased," observed Ryan. But was this a typical seasonal change or a phenomenon unique to 2020? The research team compared recordings for each month of 2020 to the same month in previous years. "If noise levels during 2020 were persistently lower than previous years, then we know 2020 was unusual."

Compared to 2018 and 2019, low-frequency noise was significantly reduced in 2020. "At its low point in June 2020, acoustic intensity was nearly halved," said Ryan. Noise levels began to rebound in July.

To determine if the drop in low-frequency noise evident in the hydrophone recordings was in fact caused by a reduction in ship traffic, researchers leveraged two independent data sets. Using data from U.S. Customs and Border Protection, personnel from the U.S. Maritime Administration (Department of Transportation) documented the total number of port calls for all ports along the California coast and the total gross tonnage that those ships were carrying. These data provided a statewide view of maritime shipping.



Mapping total hours of vessel presence using Automatic Identification System (AIS) records revealed the “arteries” of maritime shipping off the coast of central California. The black dot marks the location of the MARS cabled observatory, and the white arc represents a 165-kilometer (103-mile) radius around the hydrophone connected to the cabled observatory. (Data from San Francisco Bay were excluded from this map and study because this traffic is not relevant to sound recordings logged at the MARS observatory.). Credit: MBARI

To understand changes within earshot of MBARI's hydrophone, the research team leveraged Automatic Identification System (AIS) data from the U.S. Coast Guard. These data provided a way of tracking the movement of vessels, including their speed and their location, to focus on the Central Coast region specifically.

The port and AIS data confirmed that the significantly reduced low-frequency noise during February through June 2020 occurred alongside unusually low port activity across California and reduced transits by large vessels in the Monterey Bay region. "2020 had the lowest levels of shipping activity and the lowest levels of noise among all three years," said Ryan, "and as it grew quieter during 2020, that was clearly related to less shipping activity."

This research underscores how pervasive noise pollution in the ocean is. Sound travels further underwater than in air, extending the reach of anthropogenic noise. "Our noise can harm marine animals that rely on sound to live," emphasized Ryan. "They use sound to communicate, navigate, find food, reproduce, and survive."

The MBARI team is part of the SanctSound research collaborative spearheaded by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Navy to understand the soundscapes of national marine sanctuaries across the country. The four-year research project started in 2018 and brought together numerous scientific partners to study sound within seven national marine sanctuaries and one national monument in waters off the east and west coasts and Hawaii.

The Monterey Bay National Marine Sanctuary is home to at least 34 marine mammal species, including humpback whales (Megaptera novaeangliae), that rely on sound to communicate. Understanding the underwater soundscape—and how it changes with human activities—is critical to protecting these species of special conservation interest. Credit: Knute Brekke

"The SanctSound project was designed to show how listening in special ocean places all around the U.S. can help us to better understand and protect them," explained Leila Hatch, marine ecologist with NOAA's Office of National Marine Sanctuaries and co-lead of the SanctSound initiative. "The results of this study in the Monterey Bay National Marine Sanctuary provide an example of how underwater sound can be used to monitor the local implications of global-scale changes in human behavior, allowing us to further consider the implications of such

changes for the marine animals that call this place home."

SanctSound partners involved in this study are from NOAA, the Naval Postgraduate School, Southall Environmental Associates, Scripps Institution of Oceanography, and Moss Landing Marine Laboratories.

The recording location inside the Monterey Bay National Marine Sanctuary is far from major shipping lanes and from a major port, yet the sanctuary's soundscape responded rapidly to changes in offshore, large-vessel traffic, demonstrating how well sound carries and may impact sensitive marine wildlife, like whales. "We heard the changes in noise clearly even though we are not recording near a busy port or shipping lanes," said Ryan.

"Noise is an ephemeral pollutant," explained Ryan. "If we reduce the amount we put into the ocean, habitat quality improves immediately and there's an immediate benefit to animals that rely on sound for their lives."

Thanks to data processing by MBARI engineers, the hundreds of terabytes of acoustic data collected by MBARI's hydrophone are accessible to other research teams. MBARI also streams live audio from the MARS hydrophone to the Soundscape Listening Room. The listening room also includes archived sounds from marine mammals.

More information: John P. Ryan et al, Reduction of Low-Frequency Vessel Noise in Monterey Bay National Marine Sanctuary During the COVID-19 Pandemic, *Frontiers in Marine Science* (2021). DOI: 10.3389/fmars.2021.656566

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