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Coastal fisheries show surprising resilience to marine heatwaves

Researchers found that fish biomass often increased or was unaffected in the year following a marine heatwave

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SANTA CRUZ, CA—Prolonged periods of unusually warm ocean temperatures, known as marine heatwaves, can have devastating effects on marine ecosystems and have been linked to widespread coral bleaching, harmful algal blooms, and abrupt declines in commercially important fish species. A new study, however, has found that marine heatwaves in general have not had lasting effects on the fish communities that support many of the world's largest and most productive fisheries.

The study, published August 30 in *Nature*, relied on data from long-term scientific trawl surveys of continental shelf ecosystems in North America and Europe from 1993 to 2019. The analysis included 248 marine heatwaves with extreme sea bottom temperatures during this period. Trawl surveys, done by towing a net above the seafloor, assess the abundance of bottom-dwelling species that include commercially important fish such as flounder, pollock, and rockfish.

The researchers looked for effects on fish biomass and community composition in the year following a marine heatwave. To their surprise, they did not find evidence that marine heatwaves in general have big effects on regional fish communities.

"There is an emerging sense that the oceans do have some resilience, and while they are changing in response to climate change, we don't see evidence that marine heatwaves are wiping out fisheries," said lead author Alexa Fredston, assistant professor of ocean sciences at UC Santa Cruz.

Although declines in biomass did occur after some marine heatwaves, the researchers say these cases were the exception, not the rule. Overall, they found, the effects of marine heatwaves are not distinguishable from the natural variability in these ecosystems and in the sampling process of the surveys.

"The oceans are highly variable, and fish populations vary quite a lot. Against that background, we didn't see evidence of marine heatwaves dramatically reducing the abundance of fish in the temperate oceans," Fredston said. "Marine heatwaves can drive local change, but there have been hundreds of marine heatwaves with no lasting impacts."

In addition to assessing the impact on biomass, the researchers looked at whether marine heatwaves were causing changes in the composition of fish communities, such as a loss of species associated with cold water and an increase in species associated with warm water (known as "tropicalization").

"Tropicalization has been associated with long-term warming of the oceans, but we saw no consistent signature of that associated with marine heatwaves," Fredston said.

The researchers defined marine heatwaves as periods of more than five days with extreme sea bottom temperatures (above the 95th percentile) for that region and season. By subtracting out the effects of long-term ocean-warming trends, they were able to focus on episodes of extreme warming on top of those long-term trends.

The data set included some notable examples of marine heatwaves that did have profound impacts, such as the 2014-2016 marine heatwave in the Northeast Pacific known as “the Blob,” one of the largest on record.

“The magnitude of the impact for that one was very unusual,” Fredston said. “There were some really problematic outcomes, including huge declines in the Gulf of Alaska, where commercial fisheries really suffered, but other West Coast fisheries did well because a lot of species came up from the south.”

While “the Blob” led to a 22% loss of biomass in the Gulf of Alaska, a 2012 marine heatwave in the Northwest Atlantic led to a 70% biomass gain. The authors also noted that these were not large changes compared to natural variability in biomass, and similar effects were not seen after most other marine heatwaves.

The findings suggest that fish may be able to find safe havens by moving to areas with cooler water during these extreme events. Other factors besides temperatures may also be important in determining the response of an ecosystem to a marine heatwave, Fredston noted.

“I’m very curious to look at other aspects of this to see if we can predict the ecosystem response,” she said. “At this point, it will be hard to predict the impacts of the next marine heatwave."

This research was performed as part of FISHGLOB, an international consortium that has compiled a unique data set of scientific bottom trawl surveys from around the world. Their work was funded by the French Foundation for Biodiversity Research (FRB), Centre for the Synthesis and Analysis of Biodiversity (CESAB), the Canadian Institute of Ecology and Evolution (CIEE), and the French Embassy in Canada. The study was also supported by the Lenfest Oceans Program and the U.S. National Science Foundation.

Coauthor Malin Pinsky, currently at Rutgers University, will join the faculty at UC Santa Cruz in fall 2023 in the Department of Ecology and Evolutionary Biology. Other coauthors include William Cheung at University of British Columbia, Thomas Frölicher at University of Bern, Zoë Kitchel and Aurore Maureaud at Rutgers University, James Thorson at the National Oceanic and Atmospheric Administration, Arnaud Auber at the French Research Institute for Exploitation of the Sea, Bastien Mérigot at University of Montpellier, Juliano Palacios-Abrantes at University of British Columbia, Maria Lourdes ‘Deng’ Palomares at Sea Around Us - University of British Columbia, Laurène Pecuchet at The Arctic University of Norway, and Nancy Shackell at Fisheries and Oceans Canada.