UC SANTA BARBARA
THE Current

June 5, 2023
Harrison Tasoff

Lessons from ‘The Blob’ will help us manage fisheries during future marine heatwaves

In early 2014, a great anomaly descended upon the seas: A patch of warm water that manifested in the Gulf of Alaska. Scientists called it “The Blob.”

A strong El Niño prolonged this marine heatwave through 2016. It extended as far south as Baja California, Mexico, throwing marine ecosystems, weather patterns and fisheries into disarray. Now that the heatwave has passed, researchers have begun examining its effects and drawing insights that can help us prepare for a future where marine heatwaves are more common and more intense.

Marine scientist Chris Free, at UC Santa Barbara, led a network of colleagues along the West Coast to investigate how the 2014–2016 marine heatwave impacted the region’s fish, fisheries and fishermen. They documented The Blob’s diverse effects through a coastwide economic synthesis and a series of 10 case studies, finding that many fisheries suffered due to stock declines and shifting ranges. However, even some of the species that fared well caused management challenges. The study, published in the journal Fish and Fisheries, presents an outline for what to prioritize as scientists, fishermen and policymakers chart a path forward.

“Marine heatwaves have really emerged as possibly the greatest immediate climate threat to the oceans,” said senior author Lyall Bellquist, a fisheries scientist at UC San Diego and The Nature Conservancy. They’re already increasing in frequency, intensity and duration, he noted, causing profound impacts to ecosystems and economies, communities and cultures worldwide.

The Blob was the largest marine heatwave on global record, and impacted the entire food web between Mexico and Alaska, from plankton to whales. “Ecosystems are really complex and they’re really connected,” said lead author Free, “so a change in one place can just radiate and cause a surprising change someplace else.”

Winners, losers and headaches from both

To make sense of such a large disturbance, the team analyzed fishery revenues before, during and after the heatwave, which guided them to the case studies that highlight different responses to the event.

The ocean undergoes oscillations that shift the distribution of currents, temperatures and nutrients. Periodic events, like El Niño, mean that scientists, fishermen and resource managers are familiar with the effect warmer water can have on different species. But massive heatwaves like The Blob don’t always match our expectations.

Consider anchovies and sardines. The two species have a similar ecological niche, but sardines were thought to prefer warmer temperatures than anchovies. And yet, Pacific sardine populations collapsed before and during The Blob, causing a multi-year federal fishery disaster and closure from California to Washington. Meanwhile, anchovy began to increase during the marine heatwave, and exploded to near record levels in subsequent years. “You could hike up to the bluffs at Torrey Pines and see schools of anchovies from La Jolla all the way up to Del Mar,” Bellquist said.

Scientists at the National Marine Fisheries Service are working to understand what "went right" for anchovy during the warm years, and why they are continuing to increase, including studies of adult and larval diet and survival. Marine mammals and birds that consume anchovy have generally thrived since 2016. Surprises like these will become more common and more disruptive, the authors explained, so we need to figure out why we were wrong and what to do about it.

Climatic changes can also produce results that seem completely unconnected. For instance, the researchers found a spike in whale entanglements during The Blob. A heatwave can reduce the amount of cold, nutrient-rich water coming up from the depth. This depletes the amount of offshore krill, which large whales usually prey upon. The marine mammals likely moved inshore in search of booming anchovies, where they overlapped more than usual with the Dungeness crab fishery, leading to a rise in entanglements in commercial trap lines.

The study also highlighted that some fisheries will fluctuate as ocean conditions change. The distribution of market squid, usually a warm-water species, shifted toward Oregon during the heatwave, with activity as far north as Kodiak, Alaska. “For context, market squid is the single highest volume fishery in the entire state of California,” Bellquist said.

If properly managed, the squid could be a new, high-value fishery in these areas. But the development also presents challenges: The species could change the ecosystem, create bycatch issues, or alter the prey base available to other targeted species.

Even success stories can create management challenges. Shortbelly rockfish flourished in The Blob’s warm embrace. And while it isn’t historically a targeted species, it still impacted fisheries. The spike in abundance almost closed the Pacific hake fishery just two weeks into the season due to the increased amount of shortbelly rockfish bycatch.

But better monitoring prevented catastrophe. “Based on best available data, they were able to adjust the bycatch limit to allow the hake fishery to continue to operate,” Free said. “This is a nice example of management being really nimble and flexible and responding rapidly like we need to see more of in the future.”

Planning for the future

The case studies highlight what actions we need to take to prepare for a warmer, more volatile future. “Marine heatwaves are here with us to stay,” Free said. Even if we could predict and manage them perfectly, they would still impact fish and fisheries. “We need policies that bolster the resilience of fishing communities to

those negative impacts that we can’t mitigate.”

Improving fisheries monitoring will enable us to detect changes earlier and make decisions more quickly. “Without monitoring data, we wouldn’t have had any scientific justification to allow a higher catch limit for shortbelly rockfish, and the hake fishery would’ve closed,” Free said.

Management models should also include climate components, the authors stated. “Reactive management approaches that rely solely on historical fisheries analyses will only get us so far,” Bellquist said. Instead, we need to integrate forecasts of how fisheries might respond to both management decisions and climate change.

The authors also recommended easing access to permits so fishermen can target a more diverse portfolio of species. The more permits a fisherman holds, the better they can pivot toward a species that is doing well.

Innovation will also play a crucial role in the future of fisheries. Free and Bellquist spoke highly of exempted fishing permits, which enable fishermen to partner with scientists and legally operate under different rules or with different gear. “It could allow the fishers to try to solve the problem themselves,” Free said. The permits could spur innovation to reduce bycatch. One successful example of this was the recent federal approval of deep-set buoy gear, which was co-developed by fishers and scientists to reduce sea turtle bycatch in the swordfish fishery. Improvements like this show what is possible when stakeholders work together.

The authors are also evaluating fishery insurance as a possible tool for supplementing federal fishery disaster assistance. People primarily get their food from one of three sources — farms, ranches and oceans — and climate change has impacted each. But unlike for farming and ranching, there are currently no fisheries insurance programs in the U.S., Bellquist explained. Such programs could help alleviate the impacts of extreme events, and they were recently recommended by the National Oceanic and Atmospheric Administration.

Fortunately, the government is already updating the protocol for federal fishery disasters. At the end of 2022, Congress enacted the Fishery Disaster Improvement Act. The new legislation aims to streamline the process of determining disaster assistance. It also contains provisions to study the social impacts of disasters,

rebuild impacted fisheries and prevent future disasters, among other elements.

The authors are now working on step-by-step directions to navigate toward some of their recommendations. For instance, they are developing a computer model to simulate management strategies that prevent climate-driven whale entanglements in the Dungeness crab fishery. Tools to model biotoxins will also guide managers, fishermen and aquaculture growers during harmful algal blooms, which are likely to get worse under climate change. “We are also identifying fisheries that are good candidates for insurance programs,” Free said, “and designing programs that would be effective and affordable for fishermen.”

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Media Contact

Harrison Tasoff

Science Writer

(805) 893-7220

harrisontasoff@ucsb.edu

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