

California shellfish farmers adapt to climate change

May 23 2022



Shellfish growers at Hog Island Oyster Farm in Tomales Bay, Northern California. Credit: Remy Hale/Hog Island Oyster Co.

Because of their proximity to the ocean, Californians get to enjoy locally-sourced oysters, mussels, abalone and clams. Most of the shellfish

consumed here come from aquaculture farms along the coast—from San Diego to Humboldt County. And because the animals are filter feeders that siphon tiny plankton out of seawater, growing them is environmentally sustainable.

But due to rising [greenhouse gas emissions](#), the ocean has become more acidic, conditions hostile to shellfish growth.

"There have been calls across the state and across the U.S. to increase aquaculture output because it's so sustainable. But then at the same time, it's a very vulnerable industry," said Melissa Ward, a postdoctoral fellow at San Diego State University.

In a new study, SDSU and Oregon State University researchers interviewed California shellfish growers to find out how they perceive ocean acidification, and to learn what strategies they think will help their operations adapt to changing [environmental conditions](#).

"This study is fairly unique in that we're getting information directly from the people who are being affected by change and learning directly from their experiences," said geographer Arielle Levine, director of the sustainability program in SDSU's College of Arts and Letters..

Ward added that "they're on the front lines of observing [climate change](#) and they also are going to be most well-suited to describe what they think they need to adapt to those changes."

Growing threat

Burning coal, oil and [natural gas](#) emits [carbon dioxide](#) and other greenhouse gases into the atmosphere. About a third of that CO₂ is absorbed by the ocean, reducing pH levels.

As the water becomes more acidic, the calcium carbonate shellfish need for their shells is less abundant.

"And so they're basically running out of building blocks to build shell with," said Ward. "And that can be particularly challenging for a very very small shellfish that's just forming."

Most shellfish are spawned in land-based hatcheries. When they're about the size of a fingernail, they're moved to floating nurseries in the ocean.

"And at that point, they're just sort of subjected to whatever conditions and whatever food floats by in the water," said Ward.

If the water is acidic, the baby shellfish may grow more slowly, or even die, making it harder for [aquaculture farms](#) to remain viable.

Strategies for adaptation

Interviews with shellfish growers revealed that while they are concerned about the impact of ocean acidification on their operations, they often lack the scientific instrumentation to know when it's happening.

Growers also worry about other environmental threats such as warmer water, [heavy rainfall](#) and pollution—which all contribute to the spread of marine diseases—as well as toxic algal blooms.

"Sometimes, growers would lose 90, 100% of their shellfish in a given area, and they won't really know why," said Ward. "It's sort of a story of multiple stressors; you can imagine a time when the water is particularly warm or there's a rainfall event, and ultimately you may reach a tipping point that the shellfish in the water just can't remain resilient to."

Many growers said they need access to scientific resources to pinpoint

the environmental factors involved in large die-off events, and to potentially prevent them.

Policy change

All of the shellfish growers felt that regulatory and permitting requirements for shellfish operations need to be adjusted to respond to the rapidly changing environment. For example, it might be wise to diversify a shellfish operation by growing a [new species](#) that is better adapted to [ocean acidification](#). But obtaining the required permits for that can be onerous.

"California is likely the hardest state to get a permit for shellfish aquaculture, which is seemingly at odds with the messaging that's coming down from the top," Ward said. While state leaders recognize that shellfish aquaculture is sustainable and an opportunity for [economic growth](#), it can take years and hundreds of thousands of dollars for a grower to obtain a permit for a new species. "And they just can't afford that time and money," she added.

"We need to maintain the environmental protections that we have in California, but if we really want the industry to be resilient to environmental change, we have to kind of allow for flexibility in farm management."

Another adaptive strategy identified by [shellfish](#) growers was a need for more networking opportunities—not only with other growers, but also with managers, scientists and policymakers—to share information and best practices for adapting to environmental change.

The study is published in the journal *Ocean & Coastal Management*. The researchers hope it will serve as a roadmap for improving the resilience of the aquaculture industry in California.

"This work really draws a connection between environmental change that's happening and will continue to happen, and how that's not just affecting the species in the ocean, but also the people who rely on these species," said Levine.

More information: Melissa Ward et al, California shellfish farmers: Perceptions of changing ocean conditions and strategies for adaptive capacity, *Ocean & Coastal Management* (2022). [DOI: 10.1016/j.ocecoaman.2022.106155](https://doi.org/10.1016/j.ocecoaman.2022.106155)

Provided by San Diego State University

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