



CAN-068-Protecting Coral Reefs- World's Oceans

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The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231

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Protecting Coral Reefs with Bubbles

Bubbles – yes, bubbles – could help protect coral reefs, oyster farms, and other coastal ecosystems from increasing ocean acidification, according to new research by Stanford scientists.

Credit: Shutterstock



Blowing tiny bubbles through seawater could help protect coral reefs and oyster farms from oceans turned increasingly acidic through human activities by stripping carbon dioxide (CO₂) from coastal marine environments and transferring it to the atmosphere, Stanford scientists say.



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The technique, outlined in a study published online in the journal *Environmental Science & Technology*, could provide a relatively inexpensive solution to one of the biggest threats facing coral reefs today. An estimated 30 to 60 percent of all the coral reefs have died since the Industrial Revolution as the oceans absorb more CO₂ and become increasingly acidic. Ocean acidification harms a variety of marine organisms, but especially those that use calcium carbonate to assemble their skeletons and shells, such as coral, mussels, and oysters.

"Ocean acidification is particularly troublesome for coral reefs because the entire structure of the ecosystems is built upon the calcium carbonate skeletal remains of dead coral," said lead author David Kowek, a doctoral candidate at Stanford's School of Earth, Energy & Environmental Sciences. "Ocean acidification makes it difficult for corals to calcify and makes it easier to erode these skeletal remains, threatening the integrity of the entire reef."

A further loss of coral reefs would be significant. Worldwide, coral reefs provide an estimated \$30 billion net economic benefit each year. A healthy coral reef provides a home to thousands of organisms, which island subsistence communities rely on for the bulk of their diet. A reef's mere presence can quell the waves whipped up by a surging storm, thereby guarding low-lying coastal towns from flooding.

In the new study, Kowek and his coauthors demonstrated that bubbling air through seawater for a few hours in the early morning can enhance the transfer rate of CO₂ between the ocean and the air up to 30 times faster than natural processes, resulting in a significant reduction in local marine concentrations of the greenhouse gas.

"The nice thing about the bubble pulse method is that it provides an engineering technique that can help bring us closer to conditions that coral reefs were used to 100 years ago, and to which they've been adapted for many thousands of years," said study coauthor Rob Dunbar, the W.M. Keck Professor of Earth Science at Stanford and Kowek's advisor.

An idea bubbles up

The idea to use bubbles to reduce localized ocean acidity arose from an observation that Kowek made while studying the natural chemical cycles of coral reefs and other shallow-water ecosystems. Kowek noticed CO₂ levels in these environments rise and fall in a predictable pattern throughout the day: CO₂ levels drop during the day as coral and other photosynthesizing marine organisms absorb the gas; when the sun sets and photosynthesis stops, plants and animals respire, and CO₂ levels rise again.

Kowek wondered if it might be possible to spur coral growth by reducing CO₂ levels in the water in the predawn hours – when the oceans are most acidic – by using air bubbles to draw the gas out of the seawater and transfer it to the atmosphere. If the bubbles have lower concentrations of CO₂ than the surrounding water, the gas will naturally diffuse into the bubbles.

The team set up a bubbling experiment in a sensor-laden water tank at Stanford's Hopkins Marine Station. Each night, they would fill the tank with bags of giant kelp. Throughout the night, the kelp would respire, adding CO₂ to the water, and thus acting to simulate the CO₂ buildup that occurs from respiration in coastal ecosystems at night. The team would then arrive the following morning, remove the kelp, and begin to bubble the high CO₂ seawater in order to test how bubbling lowers the CO₂ concentration. They found that just two hours of bubble-mediated ventilation could increase the transfer of CO₂ from the ocean into the air by 10 to 30 times.



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From tank to tides

The results from the water tank experiment closely matched the predictions from a computer model the team developed, giving the scientists confidence in the accuracy of their model. The scientists say that if timed correctly, bubble stripping could be an effective means of reducing extreme acidity in coastal ecosystems now and in the future. If ocean acidification continues to increase, the normal changes in ocean chemistry that occur overnight will pose a greater threat to marine organisms as concentrations of CO₂ reach harmful levels. A recent study by researchers at the Carnegie Department of Global Ecology at Stanford found that this is already happening in tide pools across California.

Koweeek thinks bubble stripping could prove useful for protecting small sections of shallow coastline that are ecologically, culturally, or commercially important. Because the operations would be small, the benefits to the marine environments from lowering ocean acidity levels would greatly outweigh the relatively small amount of atmospheric CO₂ generated by the bubbling process and by the compressors used to produce the bubbles.

"If this idea takes off, you could imagine people running these compressors on solar power," Koweeek said. "In the tropics, where there's a lot of sunlight, you could charge your compressors with solar energy during the day and then bubble at night."

A little bubbling could go a long way, if done strategically. "Many Pacific coral reef terraces have a mostly unidirectional water flow," said Dunbar, who is also a senior fellow at the Stanford Woods Institute for the Environment. "If you operate your bubbler in an area that is upstream of a large section of coral, you could reduce CO₂ levels for an entire reef."

Ultimately, bubble stripping could help protect more than just coral. "Many coastal ecosystems, including salt marshes, seagrass meadows, and mangroves undergo daily variations in CO₂ due to photosynthesis during daylight hours and respiration during nighttime hours," Koweeek said.

David Mucciarone, a science lab manager at Stanford, co-authored the study. Funding for the study was provided by the National Science Foundation and a McGee/Levorsen research grant from the Stanford School of Earth, Energy & Environmental Sciences.

[Source of Article](#)

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