New insights into helping marine species cope with climate change

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Stephen Palumbi's team has found that some species of coral are better able to adapt to higher temperatures than others.

(PhysOrg.com) -- Climate change is forcing marine plants and animals to move, adapt or die. Stanford biologist Steve Palumbi has found a coral species that is coping surprisingly well, and his analysis of the effectiveness of different size reserves suggests bigger isn't always better.

Move, adapt or die. Those are the options marine plants and animals have in the face of climate change, said Stanford biologist Steve Palumbi, who has been exploring how to help them go with the first two options, rather than the third. He's come up with some surprising answers.

Palumbi will be discussing the results of his research in two talks at the annual meeting of the American Association for the Advancement of Science in San Diego.

How to design marine protected areas to best benefit a wide variety of plant and animal species is the focus of a talk he'll give on Saturday, Feb. 20. The most practical kind of natural reserve is one that benefits species and local human populations, but Palumbi said striking that balance isn't always easy. Many people have argued that bigger is better when it comes to marine reserves, but Palumbi has data suggesting that is not always the case.

In a separate Topical Lecture he'll give on Sunday, Feb. 21, Palumbi will present his findings on how marine species are reacting to climate change, including new work on coral species in the Pacific that have poor powers of dispersal but a surprising ability to cope with higher temperatures.

Palumbi is director of Stanford's Hopkins Marine Station and a senior fellow at the university's Woods Institute for the Environment.

If you can't move, then you'd better adjust

Many species, such as those along the west coast of California, can simply migrate north to colder waters. But other animals, such as the coral that Palumbi's team has studied in Fiji and American Samoa, won't be moving anytime soon.

"Each coral population is trapped on its own island, and as global climate changes around them, the populations are essentially stuck where they are. They have to go to the second stage, which is to adapt," Palumbi said.

Marine scientists have predicted that coral reefs will be at risk of extinction due to high ocean temperatures caused by climate change, but Palumbi has found a species of coral that may have a better chance of adapting.

Palumbi's team studied corals growing in shallow lagoons that face intense heat during noontime summer low tides. The team knew these corals were resistant to brief heating but were surprised to find that the corals survived five to six days of high water temperatures. Baking in the tropical summer sun at low tide for 4 to 6 hours a day seems to have better prepared these corals for global warming temperatures.

"When we tested these corals against high temperatures for extended periods of time, they showed all the evidence of having higher resilience," Palumbi said. "It looks like the corals have adapted or acclimated to that stress and have a better chance of resisting high global warming temperatures." How long this resilience will last, and whether all corals can do this, are remaining questions.

Does size matter for marine reserves?

A major response to climate change is to protect reefs from other human-caused stresses such as overfishing. And as a result, a large number of Marine Protected Areas have been implemented in the Pacific. Some are the size of a football field. Some are the size of California. Is bigger better?

To determine how much difference the size of a protected area might make, Palumbi analyzed data from a set of small reserves in Fiji, from the Phoenix Islands and from the Papahanaumokuakea Reserve in Hawaii, the largest marine reserve in the world. All three areas are set aside by government agencies.

The Papahanaumokuakea Marine National Monument covers 360,000 square kilometers (139,000 square miles) in Northwest Hawaii and is a "no-take" reserve, which means nothing may be removed, including fish.

The Phoenix Islands Protected Area, which lies in the central Pacific Ocean between Hawaii and Fiji, is over 408,000 square kilometers (158,000 square miles). There are seven no-take reserves in this area, each about 39 kilometers (24 miles) across.

However, in densely populated areas, smaller reserves are more common. Fiji has 246 such protected areas, each averaging about 2 to 3 square kilometers (about a square mile).

"Small sets of marine protected areas are much more convenient: People can fish in between them or go around them easily. Species found within the marine protected areas easily spill out into the surrounding areas, potentially increasing fishing productivity," Palumbi said.

However, wide stretches of protected ocean allow species to spread more easily than small areas, where they risk being caught by fishermen between the reserves. Therefore, small reserves must be well matched to the plants and animals they are protecting because each species spreads at different rates, Palumbi said.

"Species have lots of different dispersal abilities, so it's very hard to have a marine protected area network that works equally well for all different species. You have to tailor the network of reserves to the species," he said.

Though small reserves meet the needs of fewer species than those of larger reserves, setting aside enormous areas of ocean is not that simple. Scientists and policymakers must consider local residents who depend on fisheries for their well-being.

"With heavy human populations, the political, social and economic problems of a big marine protected area are paramount and you've got to go to another strategy. But it's a strategy with limitations because it's hard to design an area perfectly for all species that need protection," Palumbi said. The most effective reserve is one that balances preservation of species with human needs, he said. Finding that balance is the challenge.

Provided by Stanford University

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