

## A tale of two atolls: Researchers study the impact of fishing on remote coral reefs

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Tabuaeran elders fish from their reefs for dinner. Isolated from the outside world, harvests from the ocean sustain the atoll's residents. Credit: Kevin McLean

Coral reefs - kaleidoscopes of pink anemones and silver sharks - are the planet's most colorful ecosystems and among its most endangered, say marine scientists.

As global warming raises [ocean temperatures](#), many corals blanch and die, a phenomenon called "[coral bleaching](#)." And pumping large amounts of carbon dioxide into the atmosphere could make the ocean more acidic, further decimating corals and the [fish](#) that depend on them for food and shelter.

Millions of people inhabit coral reefs around the world, putting additional pressure on reef menageries. Establishing sustainable fisheries, even at remote islands and atolls, could significantly slow the decline of many reefs, say marine ecologists.

"We know that fishing can dramatically change the composition of a reef ecosystem," said Fiorenza Micheli, a professor of biology at Stanford University's Hopkins Marine Station. "By confronting overfishing immediately, we may increase the resilience of [coral reefs](#) to global warming and other threats."

To gain new insights on the ecology of reef fishing, Micheli and a team of Stanford researchers are taking advantage of an ongoing "natural experiment" at two isolated Pacific atolls - Palmyra and Tabuaeran (or Fanning Island) - located about 1,000 miles south of Hawaii. The project is funded by Stanford's Woods Institute for the Environment.

Separated by just 250 miles of ocean, the two atolls are worlds apart in terms of fishing pressure. Palmyra, a protected U.S. wildlife refuge, is virtually uninhabited and bars fishing along its shores. But Tabuaeran, part of the island nation of Kiribati (pron. "kee-ree-bahs"), is home to about 2,500 people who depend on the reef for food and income.

With support from a Woods Institute Environmental Venture Projects grant, a team of marine ecologists, oceanographers and anthropologists has been working alongside residents of Tabuaeran to better understand their fishing techniques and priorities. At the same time, the researchers are conducting underwater surveys to assess the populations and diversity of marine life at both atolls.

"By contrasting near-pristine Palmyra with inhabited and fished Tabuaeran, we are in a unique position to gather data that will ultimately help reef managers protect these vibrant and vulnerable habitats,"

Micheli said.

## **A tale of two atolls**

Fieldwork at Palmyra and Tabuaeran began in 2007. On one trip, researchers -including several Stanford undergraduates - donned snorkeling gear and counted the number and variety of fish species along sample areas at various reefs. Preliminary results from the underwater census suggest that the two atolls host very different communities of animals, in part because of the impact of fishing.

"Palmyra has some of the highest densities of sharks and other large fish of any coral reef in the world," said Douglas McCauley, a graduate student working with Micheli. "That's clear within seconds of jumping in the water there."

But at Tabuaeran, where fishing is a way of life, sharks and other large species are in short supply, McCauley said. "That was surprising, because Tabuaeran is a somewhat lightly populated island," he explained. "Most people arrived only a few decades ago, and fishing there is still very artisanal in nature."

Big fish grow and reproduce slowly, so their populations take longer to recover, he added. "It appears that it takes very little harvesting to reduce populations of these sensitive, large reef fish," McCauley said.

Trophy catches like sharks and the 100-pound bumphead parrotfish were the first to decline, he said. Highly prized by Tabuaerans, parrotfish have bottomless appetites that can alter the architecture of their coral homes. "The parrotfish's large size allows it to break off and crunch up whole branches of coral," McCauley said. "It plays a unique and important role in reef ecology that's simply not achieved by other fish species."

By spending hours in the water making detailed observations of bumphead parrotfish eating habits, the team is trying to piece together what a reef without these heavy eaters would look like.

## **Shark ecology**

Sharks are also important for healthy coral reef [ecosystems](#). For decades, conservationists have tried to protect reef sharks by setting aside reserves like Palmyra that provide a safe space to grow and reproduce. But sharks tagged at Palmyra have been caught by fishermen at reefs hundreds of miles away, McCauley said.

Shark tissue also contains unique ratios of carbon and nitrogen isotopes that identify its reef of origin. By sampling shark tissue, Stanford marine scientist Rob Dunbar confirmed that these top predators have been straying far from their home reefs.

"At Palmyra, we're finding that some sharks don't stay at home like we thought, so managers can't protect them outside the sanctuary borders," McCauley said. "It seems that effective management strategies for gray reef [sharks](#) and other similarly wide-ranging species will need to be thought out at much larger scales."

Shark meat is an important part of local diets, and shark fins garner large sums of money from traders who re-sell them to soup manufacturers. In 2009, Stanford anthropologists Bill Durham and Doug Bird, along with graduate student Eleanor Power, monitored the activities of Tabuaeran fishermen on daily forays for reef animals and conducted interviews with atoll elders on the history of local fishing. The results of these surveys will be used to assess fishing patterns and provide information to Tabuaeran leaders looking to achieve sustainable harvests.

## Sustainable future

Because the livelihoods of so many Tabuaerans depend on healthy fisheries, locals are eager to preserve fish numbers, McCauley said. "Those who depend most on the environment can and should be its best stewards," he added.

To engage the next generation of Tabuaerans, researchers taught science classes at local schools three times a week on topics such as reef ecology and genetics. The Stanford team also conducted town hall meetings at every village on the atoll.

To broaden the scope of the project, team members have shared their results with Kiribati government officials, who face the twin challenges of geography and poverty. With a population of about 100,000, the Republic of Kiribati is one of the least developed countries on Earth, consisting of more than 30 atolls spread across about 1.3 million square miles of open ocean. In 2006, the government established one of the world's largest and most isolated marine reserves - the Phoenix Islands Protected Area, a chain of virtually untouched atolls west of Tabuaeran.

"The government has been an ally in our work," Micheli said. "We hope our efforts will assist them in ensuring the long-term sustainability of their reef fisheries and will be a source of information and inspiration for other tropical Pacific communities as well."

Provided by Stanford University

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