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Coral reef study traces indirect effects of overfishing

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A study of the tropical coral reef system along the coastline of Kenya has found dramatic effects of overfishing that could threaten the long-term health of the reefs. Led by scientists at the University of California, Santa Cruz, the study was published in the journal *Coral Reefs.* The researchers found that the loss of predatory fish leads to a cascade of effects throughout the reef ecosystem, starting with an explosion in sea urchin populations. Excessive grazing by sea urchins damages the reef structure and reduces the extent of a poorly studied but crucially important component of the reefs known as crustose coralline algae. Coralline algae deposit calcium carbonate in their cell walls and form a hard crust on the substrates where they grow, helping to build and stabilize reefs. They also play a crucial role in the life cycle of corals.

"Some coralline algae produce a chemical that induces coral settlement, in which the larval stage in the water settles on the ocean floor to grow into an adult. This settlement must happen for reefs to recover after disturbance," said lead author Jennifer O'Leary, a research associate with the Institute of Marine Sciences at UC Santa Cruz.

The ability of coralline algae to induce the settlement of coral larvae has been well studied in the laboratory, but few studies have been done to investigate this relationship in the field. O'Leary set out to study the role of coralline algae in reef ecosystems as a UCSC graduate student working with Donald Potts, professor of ecology and evolutionary biology and a coauthor of the paper.

In Kenya, O'Leary teamed up with Tim McClanahan, a UCSC alumnus who now heads the Wildlife Conservation Society's marine programs in Kenya. The researchers compared the types of coralline algae and the number of juvenile corals on Kenyan reefs under three different management conditions: closed, gear-restricted, and open access. On fished reefs (both those open to all fishing and those with gear restrictions), sea urchin populations were much higher than on closed reefs, resulting in lower abundance of crustose coralline algae and lower coral densities.

"Outside the protected areas, we're seeing the ecosystem collapse," O'Leary said. "When you look at the effects of fishing, you can't just think about the species that are being removed. You have to look at how the effects are carried down through the ecosystem."

Most of the young corals found in the surveys were growing on crustose coralline algae. Juveniles of four common coral families were more abundant on coralline algae than on any other settlement substrate. The results suggest that fishing can indirectly reduce coral recruitment or the success of juvenile corals by reducing the abundance of settlement-inducing coralline algae.

"The loss of crustose coralline algae has huge implications for regeneration of coral reefs," O'Leary said. "In our surveys, we found no difference between gear-restricted areas and fully fished areas, so gear restrictions are not working to keep urchin populations down. We need to consider ecosystem-wide effects as we develop new management strategies."

Potts said he hopes the new study will raise awareness of the role that coralline algae play in the health of coral

reefs, especially in developing countries. "Most managers and conservationists, and even many scientists, are unaware of the existence, abundance, and importance of coralline algae, so management regimes intended to enhance the health of reefs may actually be detrimental," he said.

The coauthors of the paper include O'Leary, Potts, McClanahan, and Juan Carlos Braga of the University of Granada, Spain. Funding for this research was provided by UC Santa Cruz, Robert and Patricia Switzer Foundation, ARCS Foundation, Project Aware, and Wildlife Conservation Society.

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