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Red-footed boobies glide through air, manta rays through water—two very different species in very different elements and ecosystems. Or are they? On a recent trip to Palmyra Atoll, CORAL’s Executive Director, Dr. Michael Webster, was reminded of an interesting study showing how the charismatic red-footed booby (*Sula sula*) and the graceful manta ray (*Manta birostris*) are linked in a cycle that begins and ends in the sea.

This cycle, documented in *Scientific Reports* in 2012 by Stanford University’s Douglas McCauley, Paul DeSalles, and their colleagues, could have important implications for how scientists—and all of us—think about ecosystems. “People manage forests; people manage oceans,” says McCauley, “but they don’t talk much to each other.”

Humans often alter ecosystems shortening these ecological chains, says McCauley. The take-home message for conservation managers, says McCauley, is that “there are quite a number of these long interactions in nature; we need to recognize that they exist and talk more about how we can protect them.” He adds that while everyone pretty much agrees at this point that biodiversity is important, we need to value other attributes of ecosystem complexity as well: it is as important to protect the rich interactions between species as the species themselves. And while we don’t know what the impact on the manta rays would be if the native forests disappeared (surprisingly little is known about manta biology), says McCauley, we should act with caution.

Dr. Webster points out that the research by McCauley and his colleagues could even have economic implications. “Without research like this, people might never suspect that protecting trees could mean protecting mantas. Manta tourism brings thousands of dollars to communities near reefs each year and helps create an incentive for conservation.”

In Palmyra, red-footed boobies and other seabirds like terns, noddies, and tropicbirds, forage in the ocean, hundreds of miles offshore, consuming small fish and squid. At night, they fly to and roost in the native forests, depositing nitrogen-rich guano, which in turn is washed into the soil by rain, and eventually into the sea. On land, the nitrogen fertilizes the trees while in the sea it fuels the growth of the zooplankton manta rays like to vacuum up.

McCauley and his team compared bird populations in both native forests and non-native coconut palm forests on a number of Palmyra islets with offshore manta ray populations and nitrogen levels. Bird and manta ray abundance, as well as nitrogen, were far lower in the non-native systems; in fact, radiotagged manta rays were found to use only the coastlines associated with the native forests. McCauley says that even after years as an ecologist he found the results surprising. “It’s completely unintuitive to see this connection—from the offshore feeding by boobies to the roosts and forest to the plankton, all the way to a ray’s mouth.”

**Cool Science**

Uniting communities to save coral reefs.

**FROM RIDGE TO RAY**

Red-footed booby (*Sula sula*) in flight. Photo by Phil Haber

Manta ray (*Manta birostris*) in Palmyra. Photo by Gareth Williams
Diving in Fiji had long been a dream for me, my wife Jill, and her father, Bill Kerr, a long-time CORAL supporter and one of the first members of CORAL’s International Council—which Jill and I have also since joined. Over the years, we had heard about CORAL’s work in Fiji, including the marine reserve established at Namena several miles off the coast of Vanua Levu. So in September, when we finally had a chance to visit Fiji and see the results of CORAL’s work there, we were thrilled. One highlight of our trip was meeting Field Representative Didi Dulunaqio and his wife Salome in Savusavu. Didi’s passion for conservation was matched only by his pride in CORAL’s work and “his” reef. In Fiji, local villages have traditional rights to their offshore waters; so as Didi explained to us, if conservation projects are to succeed, the villagers and their chiefs must be included in the efforts.

In Kubulau, the district in which CORAL’s Fiji project is based, overfishing and runoff can threaten reef health, as in most populated areas near reefs. And because nearby Namena is a popular dive site, there was also a risk of damage to its reefs from untrained or poorly managed dive visitors. Working with villagers and their chiefs, CORAL helped members of the Kubulau community better manage and enforce a no-take reserve they had established, boost revenue from a fee system for divers visiting the reef, and address land-based pollution.

The community agreed to split the proceeds from the dive fees, using a portion to support conservation and enforcement activities on the Namena reef, and the rest to fill community needs, most notably education. The proceeds provide the villagers with the ability to send their children to secondary school, helping offset the loss of fishing income. Local villagers have begun to see other benefits as well. Now that the reef has become healthier, fishermen have observed better fishing in areas adjacent to the marine reserve. The villagers see firsthand the value of sustainable fishing, as well as how the income from tourism benefits their reef. Other districts in Fiji are considering using CORAL’s model to protect their reefs.

After meeting Didi and Salome and experiencing Fiji’s reefs and culture, I understand why CORAL’s approach to conservation is so successful. Nobody can know or love the reefs more than the people who have relied on them for generations. By embracing the local communities and providing them with the tools to own the conservation effort, CORAL has created a program that has preserved Namena’s reef and will be sustainable in the long run. – Alex Kreston
With their bright eyes and spiky “eyebrows” and whiskers (actually cirri, small skin flaps), blennies are undeniably cute. But their behavior isn’t always so cute—especially when they nip at divers’ ankles! Some blennies mimic cleaner fishes, tricking other fish into coming closer to have parasites removed, and then biting off pieces of their skin or fins. Others eat coral polyps—and even their own eggs. They also nibble on algae, plankton, and benthic invertebrates.

The tailspot blenny (*Ecsenius stigmatura*) steers predators toward its tail with a distracting fake eyespot. It can also change the color beneath its eyes to bright pink when threatened.
Female leopard blenny (*Exallius brevis*)

Leopard blennies prey on coral, feeding almost exclusively on polyps. Instead of scraping algae like many blennies, leopard blennies use their comb-like teeth to mine the surface of the reef, capturing pieces of polyp. Photo by Keoki Stender

Spinyhead blenny (*Acanthemblemaria spinosa*)

Spinyhead blennies are often found on elkhorn coral. They sometimes deposit their eggs in the vacated tubes of sea snails or tubeworms. Instead of actively foraging for food, spinyheads lie in wait in their hiding spots, then dash out to nab plankton and small crustaceans from the water column. Photo by Nick Hobgood

Secretary blenny (*Acanthemblemaria maria*)

Secretary blennies are two-inch-long tube-dwellers found in the western central Atlantic Ocean. They usually live on reef slopes (rather than reef patches) along with brain corals and sea fans, whips, and urchins. Photo by William Goodwin

Seaweed blenny (*Parablennius marmoreus*)

Look familiar? This charismatic fish won our October photo contest. Seaweed blennies are found in coral reefs in the western Atlantic Ocean; they are also found in the Gulf of Mexico. These tiny fish can change their colors to match the background, helping them foil predators. Photo by Rob McCall

Male leopard blenny (*Exallius brevis*)

The territorial male leopard blennies are brighter and larger than the females. Males prepare the nesting site by overgrazing a patch of coral to make a nice, smooth surface for the eggs. Photo by Keoki Stender
One might wonder what terra cotta tiles made in San Francisco (partly from recycled toilets) and the gorgeous green humphead parrotfish (*Bolbometopon muricatum*), swimming in azure waters off the coast of Palmyra in the Pacific Ocean, have in common. In a way, that is what some of the researchers in the Reefs Tomorrow Initiative are trying to find out.

“The thing that got us interested in the first place is these very large bodied parrotfish—they can be the size of a junior high school kid—and what the implications of losing these important ecosystem engineers might be,” says Doug McCauley with Stanford University. These fish, with their large bulbous heads striped with pink and their algae-coated beaks, are selectively fished—and sometimes overfished; the species has been proposed for listing under the Endangered Species Act.

Green humpheads (also commonly called bumpheads) make physical changes to their environment by grinding and biting on coral reefs, making small divots in the reef structure—sometimes thousands of divots every day. While humpheads eat both dead and live coral (having a possible negative impact on the reef), McCauley and his colleagues wondered if the divots they make might also have a positive effect, by providing hiding places where coral larvae can attach themselves and grow.

To test their hypothesis, the team had the tile company use spoons to scoop out artificial divots in 180 tiles to emulate the grazing scars made by humpheads and steepheads (*Chlorurus microrhinos*), the second largest parrotfish in Palmyra. Then, they installed the tiles on the ocean floor, half within cages (to keep them safe from coral predators) and half without.

While there is still much to be learned from the experiment, says McCauley, preliminary results show that the coral reef larvae are finding—and preferentially settling on—the divots rather than the flat tile surfaces.

“Parrotfish have long been known to help corals by controlling the algae that compete with the corals for space and light,” says McCauley. “Results emerging from this experiment will help shed light on a potentially new pathway through which parrotfish promote coral health and resilience.”

**Hawai’i**

“Hotel X” could save between $137,000 and $147,000 on its water bill each year by using recycled water while at the same time helping preserve Maui’s coral reefs, according to the results of a water-use
survey CORAL conducted recently. The survey was part of our campaign to assist hotel and condominium property managers as they prepare to access recycled (“R1”) water from the County of Maui’s new purple pipes; using recycled wastewater for landscaping and other purposes will reduce the amount of treated wastewater that ultimately reaches the reefs. The water-use survey results, plus tips for connecting to the recycled water system and navigating the permit process, were just published by CORAL in Recycled Water for Reefs/ A Guide for West Maui’s Resorts and Condominium Properties (downloadable at www.coral.org/hawaiiwater). The guide also includes information about using recycled water for landscaping, as well as how to get involved in the broader watershed stewardship movement, the West Maui Ridge to Reef Initiative, of which CORAL is a partner.

The County of Maui’s Steve Parabicoli says he’s excited to see Maui moving forward with recycled water use, not only for the benefits to reefs, but also because it will help extend Maui’s limited supply of potable water. “I’ve seen the need for years. We’ve looked at this as a wastewater disposal issue, but it should also be looked at as a drought-proof water supply issue.”

Lisa Paulson, Executive Director of the Maui Hotel & Lodging Association, says she sees recycled water use directly benefiting both reefs and the local economy. “Our reefs are integral to everybody’s visit. I would say ninety percent of the visitors who come here are in the ocean. We all realize that if we don’t maintain our island, we’re going to lose the main reason people come to visit us.”

Our New “Field” Team
While our direct conservation activities happen in coral reef destinations like Hawai’i, Honduras, Indonesia, and Fiji, much of our work to raise funds for and awareness about those initiatives takes place in the continental United States. A group formed earlier this year, the CORAL International Council, has begun putting boots on the ground to help make our efforts even more successful.

This past September, we held our first West Coast Council meeting in San Francisco. During the meeting, Council members established two significant goals for the year ahead—to collectively contribute and raise $100,000 to match your year-end donations, and to launch a CORAL prize. The prize will recognize significant contributions to coral reef conservation, and will be awarded next September during CORAL’s 20th anniversary celebration. Members are also creating local chapters of the Council in hubs like San Francisco, Washington, DC, Dallas, and Hawai’i.

During lunch, Council members had a chance to meet with our field team, who were in town for a week-long strategic planning meeting, and to hear firsthand how their support is helping our field work grow. At an evening celebration with our Board of Directors, staff, and local supporters, Council members were treated to a presentation by Dr. Stephen Palumbi, Director of Stanford University’s Hopkins Marine Station, about heat–tolerant corals and the role they might play in an ever-warming world.

We are thrilled that the leadership of these individuals is helping propel CORAL into a new era of impact. If you’re interested in learning how to get more involved with this passionate group of CORAL supporters, please contact Development Director Sarah Freiermuth at sfreiermuth@coral.org.
Triple Your Gift to CORAL!

In the past, we’ve been able to offer opportunities for you to double your contributions to CORAL through generous donor matches. And now, for the first time, we are able to offer you the benefit of tripling—yes, tripling!—your year-end gift.

Our newly formed CORAL International Council and a very generous couple have each pledged to donate $100,000 if we can raise that amount from you this holiday season. That means that all gifts made by January 17, 2014—if we are able to reach our $100,000 target—will be matched three to one.

Even if you’ve made a generous gift already this year, please consider contributing a fully tax-deductible gift now to help us capitalize on this amazing opportunity. Holiday gift memberships, donations in honor of someone or in memory of loved ones, and even matching gifts from your company all count toward the goal we need to reach.

To join your fellow CORAL donors in support of this important year-end campaign, please return the enclosed envelope with your contribution today, or make your gift online at www.coral.org/2013.

Thank you for your support!