Dissolving the future of coral reefs

April 10 2014, by Erin Eastwood, Earth Institute, Columbia University

Credit: Erin Eastwood

Swimming through the liquid turquoise waters off the island of Viti Levu, Fiji, I am surrounded by iridescent fish of all colors, schooling around healthy branching corals. With a slight movement of my fins I propel myself towards two members of my research team, who are floating just above a steel structure built into the seafloor.

As I glide closer, I can see what look like hundreds of tiny bouquets attached to the structure, only instead of flowers they are made up of delicate, baby corals. This is a coral nursery, and we are snorkeling within one of Fiji's numerous marine reserves. These baby corals have been growing for a few months now, and will soon be transferred to nearby unprotected reefs with the hope that their continued growth will help restore these degraded habitats to their original splendor. Corals within the boundaries of protected areas are often pictures of tropical perfection – but all is not well in paradise.

Ocean acidification, the process by which the ocean's pH decreases as a result of the absorption of carbon dioxide from the atmosphere, is a threat that has the potential to obliterate all progress made in rehabilitating coral reef ecosystems. As more and more carbon dioxide is expelled into the atmosphere, at least a quarter of it is absorbed by the ocean every year. This causes a chain of chemical reactions in the seawater that result in the production of carbonic acid, increasing the acidity of the oceans at large. In 2012, a group of researchers lead by Bärbel Hönisch of Columbia University's Lamont-Doherty Earth Observatory found that our oceans are acidifying at unprecedented rates – occurring at least 10 times faster than the planet's largest acidification event, which happened 56 million years ago.

More acidic oceans mean less carbonate available – a mineral that is essential for building the hard structures that corals, oysters, lobsters, and other shelled creatures rely on for protection and support. Without adequate carbonate in the seawater, these animals grow more slowly, build brittle and breakable shells, and produce significantly less viable offspring. In some cases, organisms dissolve entirely. This spells disaster for coral reefs, where the intricate coral formations provide food and shelter for hundreds of species of fish and invertebrates like crabs, clams, sea stars, octopuses, and squid.

Because of this, ocean acidification is also a threat to humankind. The animals negatively affected by this process are a major source of food and income to countless people across the planet. Additionally, corals provide many coastal communities with protection from storm surges – when wave energy generated by offshore storms gets broken up over these underwater structures, the waves hitting land are less powerful than they would be otherwise. But corals grow weaker in more acidic conditions, and become less able to withstand storms and swells – possibly eliminating a crucial source of protection for coastal communities in the future.

Even without taking ocean acidification into consideration, coral reefs as they stand today face a bleak future. Overfishing, pollution, sediment runoff, and destructive fishing methods like trawling and blast fishing – a widespread practice in some developing nations where fishermen literally dynamite the reefs to more easily collect large amounts of fish and invertebrates – have brought many coral reef ecosystems to the brink of collapse worldwide.

One 2003 study, published in the journal *Science* by a group of researchers from institutions across Australia, the United States, and Panama, predicted that these vibrant underwater communities will not survive for more than a few more decades "unless they are promptly and massively protected from human exploitation". That's where marine reserves come in.

Marine reserves are protected areas that prohibit fishing and all the destructive practices that come with it over a specific patch of reef. When well planned and enforced, they can slowly but surely nurse a coral reef ecosystem back to health. Well-designed marine reserves have been shown to directly promote coral recovery, increase the size and abundance of fish within the reserve, and provide a "spillover" of fish into adjacent fishing grounds – enhancing human livelihoods while simultaneously protecting habitat. Marine reserves can provide a sanctuary, a reprieve, and a source of hope for the exploited and exhausted marine world.

However, they can't provide protection from ocean acidification, a threat that changes the very chemistry of the seawater itself.

Imagine putting a protective shield around a coral reef – a hard, explicit boundary that protects the precious and valuable community inside. You expend time, energy, the majority of your limited funds – and it's worth it, because you see results. Baby corals grow bigger as they build their fragile yet resilient structures. Larger, more abundant fish can be caught just outside of the shield's limits, and the strong, healthy corals protect your home from large, oceanic waves generated by offshore storms. But then, your protective barriers are breached by a sinister, sneaking threat, diffusing through the water like a poison gas, which begins to dissolve the life-giving coral reef before your very eyes.

This is the future of marine reserves if the slow creep of ocean acidification is not stopped. But there is still hope. While much more work is needed to understand the full ecological impacts of ocean acidification, it is now clear that increasing carbon emissions are the culprit. Quickly curbing these emissions will help prevent ocean acidification from disintegrating all progress made by marine protected areas and other conservation efforts. The task at hand is daunting, but that does not mean it's impossible. Many passionate and dedicated people like marine scientists, conservationists, and policy-makers are refusing to give up on the future health of our oceans, and so hope remains.

At the end of my trip to Fiji two years ago, I visited the marine reserve with the coral nursery one last time. Swaying in the current above those tiny buds of pink, purple, and yellow corals, I couldn't help but feel a swelling sense of hope, in recognizing the potential that remains for our ocean's restoration and protection. I pray that this potential is realized, before it too is dissolved by the silent threat of ocean acidification.

More information: "The Geological Record of Ocean Acidification." Bärbel Hönisch, Andy Ridgwell, Daniela N. Schmidt, Ellen Thomas, Samantha J. Gibbs, Appy Sluijs, Richard Zeebe, Lee Kump, Rowan C.

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