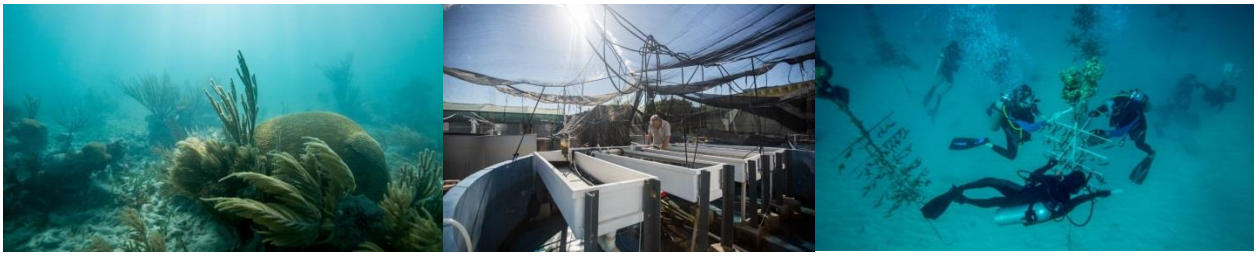
As Oceans Heat Up, a Race to Save World's Coral Reefs

Will efforts to save corals be overwhelmed by the quickening pace of climate change?



Laura Parker, National Geographic, PUBLISHED JANUARY 15, 2015

MIAMI—Early one December morning, Chris Langdon, a biological oceanographer at the University of Miami, zipped up his wet suit and dropped overboard just off Key Largo to inspect a section of Florida's ailing coral reef. His living "laboratory," 15 feet down, is the size of several football fields. Last summer a large bleaching event turned much of the coral white. Bleaching occurs when water temperatures rise or fall. Even a slight fluctuation can set it off. The result is dramatic and often fatal. The coral polyps expel their source of food—the algae that live within the coral and provide its vivid hues. Without food, the coral turns white and eventually dies. Langdon's morning dive was part of his continuing work to understand the effects of climate change in the oceans, such as rising water temperatures and rising levels of acidity. He has focused on coral reefs because of their critical role in feeding the world's populations. Reefs, known as the rain forests of the seas, occupy one-tenth of one percent of the ocean floor, but they provide habitat for a quarter of the world's fish. With the world so dependent on the oceans for food and natural resources, Langdon wants to understand how marine life could adapt to a changing environment. "When you talk to people about climate change, first there is denial," he says. "Once you convince them, most people snap straight to defeatism. They go from denial to defeatism without stopping at problem solving. Humans are natural problem solvers. It looks grim. But the future does not have to be. My question is, What can that future be for corals?"

Reef Biology 101

Coral reefs are built by colonies of millions of tiny coral polyps, animals that harbor algae-like organisms called zooxanthellae within their tissue. Coral and their zooxanthellae are mutually dependent. The coral provides a protective haven for the algae; the zooxanthellae provide essential nutrients to the coral.

Reefs grow in tropical waters. The largest is Australia's Great Barrier Reef, which stretches for more than 1,200 miles off the Queensland coastline. Florida's reef, the continental United States's only barrier reef, is modest by comparison, but its impact on the local economy is significant. It extends 300 nautical miles, from just north of Palm Beach to the Dry Tortugas below Key West, and it generates about $6.3 billionannually in tourism.

For the past 40 years, the news about coral reefs has been generally bad. Agricultural runoff, overfishing, coastal development, and overuse by tourists have damaged habitats and imperiled the corals' ability to survive. Because of climate change, ocean surface temperatures have been higher in the past three decades than at any other time since record keeping began in the 1880s, according to the U.S. Environmental Protection Agency.

As carbon dioxide accumulates in the atmosphere, the world's oceans, which cover 70 percent of the globe, absorb it like a sponge. Once in the sea, the carbon dioxide reacts with the water, raising the acidity of the ocean and threatening the ability of corals and other marine life, such as oysters, to form shells and skeletons. Last September, the National Oceanic and Atmospheric Administration (NOAA) listed 20 new species of coral as "threatened" under the Endangered Species Act, including 15 in the Indo-Pacific and 5 in the Caribbean. (Two other species were already on the list.) Staghorn and elkhorn corals, two of the most prevalent and sturdiest reef-builders among Caribbean corals, have been listed as "threatened" since 2006. Efforts to reverse the deterioration have met with some success. The reef surrounding Bermuda recovered after a 1990 government-imposedfishing ban on parrotfish, which provide essential support to reefs because they eat algae and seaweed that would otherwise overgrow and suffocate the coral. The Coral Restoration Foundation, a nonprofit group founded by conservationist Ken Nedimyer and based in Key Largo, raises coral in nurseries and transplants it to the Florida reef. On Summerland Key, the Mote Tropical Research Laboratory is working on ways to grow coral faster and larger. But the accelerating pace of climate change may overwhelm attempts to mitigate the damage. The rate of

warming and acidification is now faster than at any time in history, Langdon says. That spells trouble for corals, which often take 15 years to reach sexual maturity and reproduce only once a year. In 2005, according to a NOAA study, half the corals in the Caribbean died after warming waters triggered a massive bleaching. As ocean temperatures continue to rise, such events will occur more frequently. "Coral has been around for 200 million years," Langdon says. "They have survived huge extinction events. But the event that precipitated the last extinction happened a hundred times more slowly than the event that is going on now." By the end of the century, Langdon says, ocean acidity may increase by as much as 250 percent. "Every year is bigger than the year before, because it's exponential," he says. "We suspect coral reefs' rate of adaptation to climate change is going to be on the slower end of the species'. It is reason for concern that they may not be able to keep up with climate change."

Reef Research in the Desert

Langdon did groundbreaking research on coral reefs and ocean acidification, oddly enough in the middle of the Arizona desert, as part of a 1990s experiment to re-create the Earth's ecosystems in a three-acre enclosed facility known as Biosphere 2. Initially hailed as cutting edge science—one futuristic goal was to determine whether Biosphere 2's environment could be re-created on Mars—the experiment had run amok by 1995. Soaring levels of carbon dioxide and dropping levels of oxygen forced scientists to abandon the structure. Biosphere was then taken over by Columbia University, where Langdon was working as a research scientist. He was assigned to figure out what to do with the Biosphere's "ocean." "People were telling me that I was going to destroy my career," Langdon says wryly. "But I'm a risktaker, and I jumped at the chance." Langdon's work, detailed by *the New Yorker* in 2006, involved testing the impact of elevated carbon dioxide levels on the corals inside the Biosphere. He found that those levels harmed the corals' ability to calcify and grow. "So this started a whole new field of research—once I was able to convince people that tiny changes in pH did affect their ability to calcify," he says. In 2004 Langdon moved to the University of Miami's Rosenstiel School of Marine and Atmospheric Science, where the Florida reef provides better opportunities for research. On his December dive, Langdon was accompanied by several graduate students, who used numbered stakes to mark corals to be monitored and clipped small samples to study. Back in the lab in Miami, the coral samples were put in tanks of water of varying degrees, where they were fed, weighed weekly, and monitored for signs of recovery. This winter, Langdon and doctoral student Erica Towle will publish new findings showing that corals that adapt, survive and grow despite increasing ocean acidification—as long as the polyps are able to feed. Earlier researchers had focused primarily on the zooxanthellae that live inside coral polyps; Langdon and Towle looked at the polyp itself. "We're finding resilience in a critically endangered species," Towle says. "There is a glimmer of hope that this species, with exposure to natural food abundance, can continue to grow." That may not sound like much given the coming catastrophic change caused by warmer seas, but it could have huge implications for current reef recovery efforts. For example, coral nurseries could be established in areas where more food is available for coral polyps. That in turn could help coral grow faster to the size needed to reach sexual maturity. Langdon compares his research efforts to providing first aid to accident victims. "Can you keep the patient alive until the EMTs get there?" he says. "So a lot of our efforts are to give first aid to buy time until we can fix the big problem, like CO_2 [levels]. We can make a difference. It's not that hard."

Article Questions:

1. What is coral beaching? What causes it?
2. Describe the mutualistic relationship between coral and zooxanthellae.
3. What are some human impacts on coral reefs?
4. Name the two most prevalent corals in Caribbean reefs.
5. How long do some corals take to reach sexual maturity?
6. What is the impact of higher CO_2 levels on coral?
7. What is the key to coral survival despite increasing ocean acidification?