



Weathering the Storm

The Fate of Coral Reefs Post Hurricane Dorian

By Angela Rosenberg, ANGARI Foundation and Craig Dahlgren, Perry Institute for Marine Science

On September 1, 2019, Category 5 Hurricane Dorian approached the Abacos of The Bahamas, making landfall on Elbow Cay as one of the strongest Atlantic hurricanes on record. The slow-moving storm continued west over Great Abaco and stalled on top of Grand Bahama Island. Days after its initial landfall in The Bahamas, Dorian finally departed as a Category 2 hurricane. The intense, sustained winds, heavy rainfall, and significant storm surge brought on by Dorian, along with the lengthy duration it sat over the northern Bahamas, left catastrophic damage onshore. And we could assume similar effects offshore.

Perry Institute for Marine Science (PIMS) Executive Director Dr. Craig Dahlgren thought, “We had a great data set from before the storm and a rare opportunity to conduct a comprehensive assessment of damage from such a major hurricane that caused so much damage on land. While Dorian’s impacts on infrastructure were tremendous and may require years to replace, the potential damage to reefs may have lasting impacts on critical ecosystem services for decades.” PIMS is a nonprofit organization committed to protecting the ocean and has dedicated decades to researching coral reef habitats, sustainable fisheries and marine protected areas in The Bahamas.

Over the past few years, PIMS has partnered with ANGARI Foundation to assess coral reef health throughout The Bahamas. ANGARI Foundation is a nonprofit dedicated to supporting and promoting marine science research and education. Headquartered in West Palm Beach, Florida, the Foundation owns and operates a 65-foot research vessel christened R/V *ANGARI*, which completed its 34th expedition in March 2020. Foundation Co-founder, President and Captain of R/V *ANGARI*, Angela Rosenberg, describes the vessel, “We designed a very comfortable and capable vessel to support research expeditions in remote locations, and meeting the needs of scientific divers and their research requirements was especially important to us.”

Together, PIMS and ANGARI have completed 90 comprehensive coral reef health assessments throughout The Bahamas. Serendipitously, about 10 months before Hurricane Dorian, the team had surveyed reefs off Grand Bahama and southern Abaco, and only two months before Hurricane Dorian, the team had spent two weeks collecting data on Abaco reefs. After Hurricane Dorian passed, they had a unique opportunity to revisit recent sites to discover the effects of a Category 5 hurricane on a variety of reef habitats and structures.

A 30-meter-wide coral head lays broken and exposed post Hurricane Dorian. Researchers observed various scales of reef destruction - from physical damage to bleaching to silt and sediment coverage - throughout the northern Bahamas. Photo credit: Will Greene/Middlebury College



Surveying a Disaster Zone

Surveying reefs in remote locations for two weeks straight can be challenging on a normal day, but after a catastrophic event, it can quickly become a logistical nightmare. The *ANGARI* crew had to prepare for the expected demands of this type of work, as well as the possibility of unanticipated needs that may not be easily met once offshore and operating in a disaster area. During the two-week expedition, R/V *ANGARI* only touched land twice - a quick stop in Port Lucaya to clear customs and immigration, and a few hours in Marsh Harbour to refuel. Both stops had been scheduled well in advance.

"Having done these types of survey trips with PIMS before, we prepared and provisioned for two weeks at sea. We knew that we would be asked to maneuver the vessel into shallow, uncharted waters and had a planned itinerary with weather options ready," explains Captain Rosenberg, "but you can't foresee everything."

Only a week into the project, a major failure on the dive compressor seriously threatened the expedition's success. With a little luck, perseverance and help from contacts back in Florida, replacement parts were acquired and flown in a day later. The dive compressor was quickly returned to full operation, and the team was back underwater later that same day.

Devastating Effects

We found that Hurricane Dorian had devastating effects on a few of the reefs around Abaco and Grand Bahama, but little impact on other reefs short distances away. Furthermore, the type of damage varied considerably from reef to reef. This is illustrated at the Mermaid Reef and Sandy Cay Reef, two sites PIMS scientists have been studying for nearly a decade. Before Hurricane Dorian, both reefs had the highest amount of live coral in The Bahamas with nearly five times the average.

Mermaid Reef, a popular shallow reef just a few hundred feet offshore from Marsh Harbour, saw some of the worst damage from Hurricane Dorian. The reef was composed of large mounding coral colonies that had proven particularly resilient to mass bleaching events over the past decade and survived major storms like Hurricane Floyd in 1999. This reef took a direct hit from Hurricane Dorian at its peak strength when it first made landfall. The majority of the homes nearby were destroyed, with some razed to their foundations, leaving pieces of houses, household contents and even whole trees scattered across the reef. Large coral colonies up to the size of small cars, were moved by the strong storm surge and waves. As a result, there was a reduction in live coral cover by about 40 percent, with up to 30 percent of the coral colonies on the reef rolled from their position or broken into smaller pieces. In

contrast, Sandy Cay reef just 11 miles to the south was close to the southern eyewall of Hurricane Dorian at its strongest. But this reef, dominated by much more delicate branching staghorn and elkhorn coral, saw minimal loss or breakage of corals, debris or other storm damage.

Farther away from where the hurricane made its first landfall and began to slowly move across east Grand Bahama and the northern Abaco Islands between little Abaco and Grand Cay, several reefs also saw severe damage. Off east Grand

Bahama, trees from shore, mostly invasive Australian pines which have shallow root systems, were uprooted and rolled across the reef, demolishing corals and anything in their way. In the northern Abacos, shallow patch reefs up to 100 feet across were pounded by waves and fractured, and in several cases, large chunks were calved from the main reef. Other reefs in the area had sand, silt and mud from inshore areas smother corals, burying them in up to three feet of sediment. At several of these sites, many corals were observed to be bleached.

Signs of Hope

There were signs of hope, however, in our assessments. Coral restoration sites off south Abaco saw minimal damage from the storm, and coral nurseries growing critically endangered staghorn and elkhorn corals (*Acropora cervicornis* and *A. palmata*) off Grand Bahama and Abaco, even those in the eye of the storm at its peak strength, survived. These nurseries can provide a means to restoring populations where they were damaged by the storm.

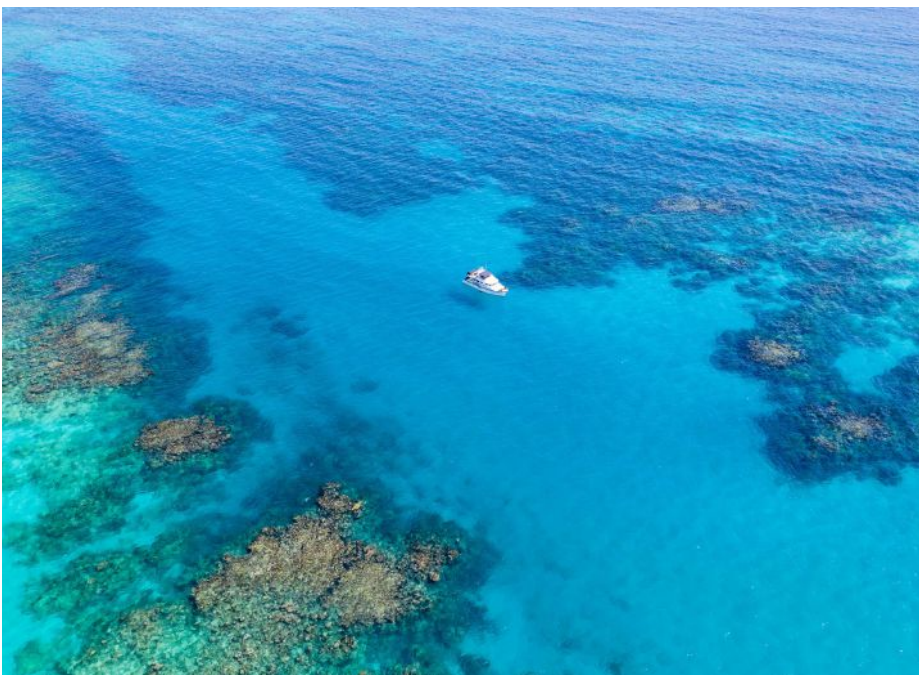
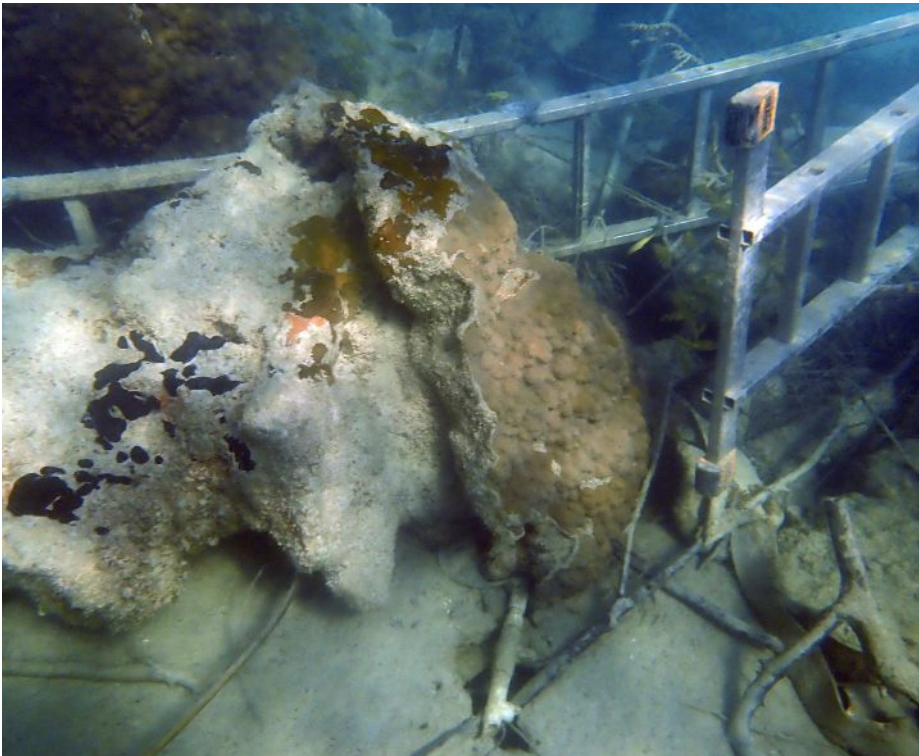
Our expedition was the first step in assessing impacts of Hurricane Dorian on the reefs of Abaco and Grand Bahama. It gave us a very broad look at what types of damage different reefs experienced across the full range of hurricane conditions encountered throughout the northern Bahamas. We are currently following up on this expedition by partnering with oceanographic modelers to gain a better understanding of the conditions experienced on the various reefs surveyed. Our hope is to better explain the damage that was observed and predict areas at risk from future storms. We are also planning more assessments for areas that received the most damage and monitoring many of the sites surveyed in October 2019 to determine the long-term impacts of the storm and track recovery. PIMS and ANGARI plan to return to the area to continue this work later this year.

For more information on ANGARI Foundation visit <https://angari.org/> and the Perry Institute for Marine Science visit <http://www.perryinstitute.org/>.

Researchers from the Perry Institute for Marine Science (PIMS), The Nature Conservancy, Middlebury College and Walt Disney World surveyed reefs around Grand Bahama and Abaco to assess the environmental effects of Hurricane Dorian. Credit: Kevin Davidson, ANGARI Foundation

Mermaid Reef, a shallow reef just a few hundred feet offshore from Marsh Harbour, saw some of the worst damage from Hurricane Dorian. Pieces of houses, household contents and even whole trees were scattered across the reef. Craig Dahlgren/Perry Institute for Marine Science.

R/V ANGARI squeezes in among the shallow reefs off southeast Abaco.. Photo credit: Will Greene/Middlebury College



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