



CORAL REEF CONSERVATION

2016 STRATEGIC ACTIONS

Letter from the Executive Director

After 25 years of coral reef research, monitoring, and policy development, I have established a new charity that focuses on high impact research, restoration and education that contributes to the conservation of threatened species and habitats and helps the people dependent on these resources. This year's efforts have centered on the Maldives, where catastrophic changes to the reefs have occurred as a result of outbreaks of voracious coral-eating starfish and a particularly severe El Niño event. Our work has included the establishment of long-term monitoring sites; evaluation of the impacts of the 2016 mass bleaching event; removal of pest species, coral reef education for high school students, resort staff and guests, dive operators, and recreational divers; the introduction of novel coral gardening efforts, and the establishment of coral nurseries on two atolls. We have partnered with Anantara Resorts and Minor Hotel Groups for our work on South Malé Atoll and Baa Atoll, and with Carpe Diem Maldives Fleet for our country-wide conservation initiatives.

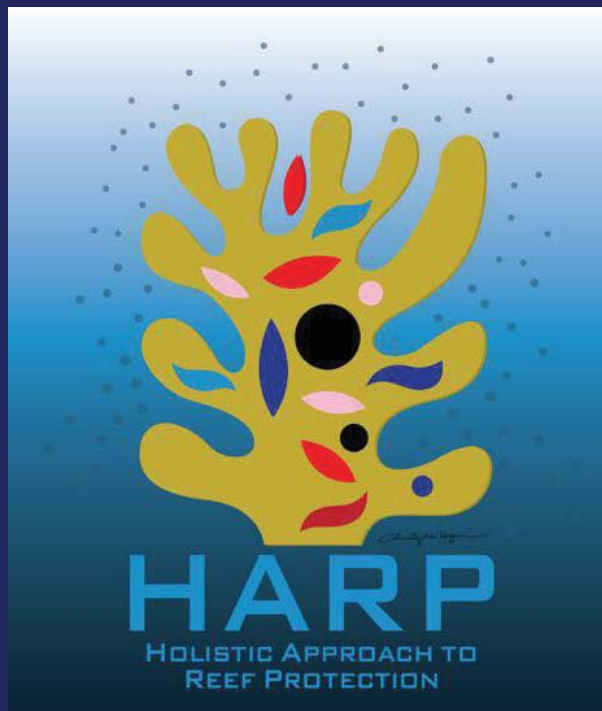




The Executive Director, Andrew Bruckner with survey gear in hand to assess severe coral bleaching on Mafushi Fore Reef, South Male Atoll in April 2016

MISSION

To understand and reduce threats affecting coral reefs, promote sustainable management of reef resources, and rehabilitate degraded reef ecosystems.



We are currently implementing the Holistic Approach to Reef Protection, HARP, in the Maldives through coral reef research, monitoring, reef clean-up and pest control, coral gardening, and education and training.

Spotted eagle ray swimming over bleached coral on reef Baa Atoll, Maldives, April, 2016



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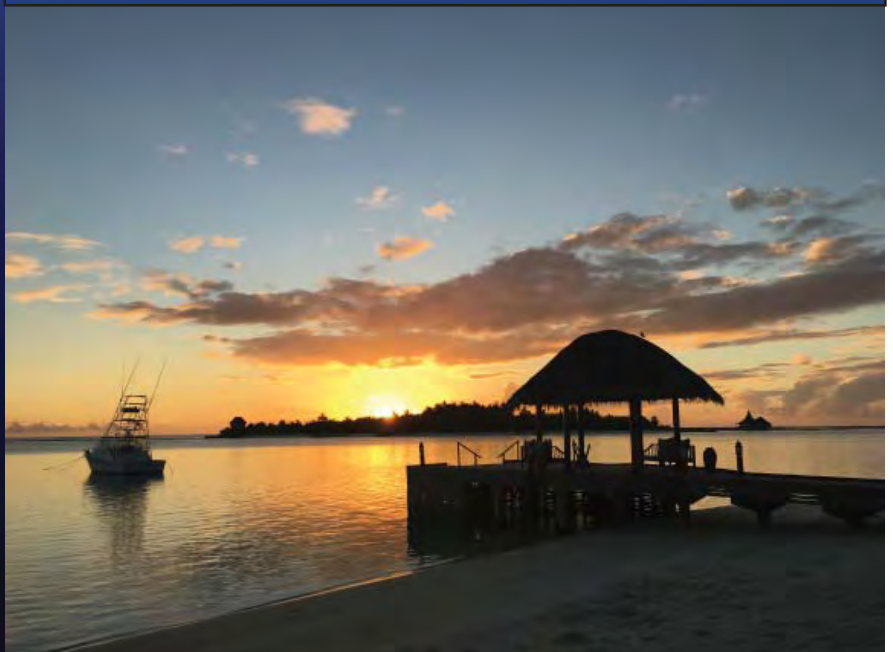


WHERE WE WORK





In 2016, we examined reefs located on 10 different atolls in the Maldives. We access the remote northern atolls on Carpe Vita (top left). Bleaching of staghorn coral surrounding water villas at Veli, South Malé Atoll (top right). The densely populated capital of the Maldives, Malé (center). Islands and reefs at the edge of Baa Atoll (bottom center). Sunset at Dhigu, South Malé Atoll (bottom right).



RESEARCH AND MONITORING

ESTABLISHING MONITORING SITES

In January, 2016, we established permanent monitoring stations on ten reefs off Baa Atoll and South Malé Atoll to determine the status of coral reefs and to document the impacts of the predicted bleaching event. Our sites include outer reefs, channel reefs, and lagoonal patch reefs and pinnacle reefs. Our stations include rebar marking the beginning and end of transects which allow us to photograph the same section of reef repeatedly. We also tagged coral of two genera (*Acropora* and *Pocillopora*) to allow us to collect tissue samples from the same coral each quarter.

This information will allow us to analyze seasonal and temperature-related changes in their symbionts and health status and will help us identify corals that may be adapting to climate change.



ASSESSING REEF STATUS

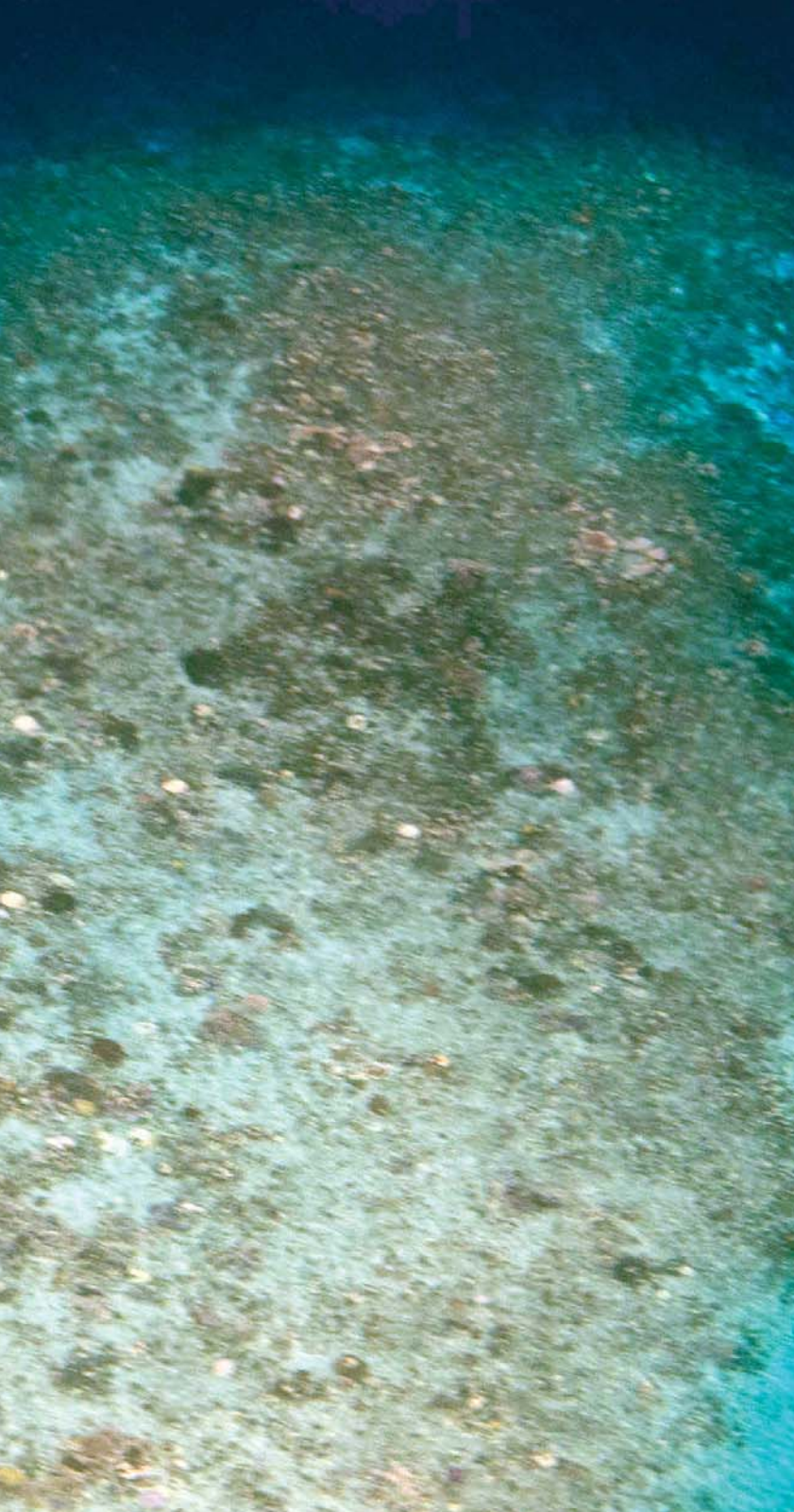
We use permanent transects at 5-10m depth supplemented with random transects at 3-20m depth to evaluate coral reef community structure. In addition to our ten permanent sites, we surveyed 12 other reefs on South Malé Atoll and Baa Atoll, and collected baseline data following the 2016 bleaching event from six other atolls. We determine how much of the bottom is covered with coral and other invertebrates, how much is algae, and how much is rock, rubble or sand. We also identify and measure the sizes of the corals and assess their health, characterize the algae into different groups based on their functional role, and record how much dead coral is on each reef. Our fish surveys provide us with information on the species diversity, abundance and size structure, allowing us to determine the biomass of different species and functional groups.

This information tells us about the amount of fishing pressure, severity of natural and man-made stresses, if the reefs have been damaged, and whether the reefs are recovering.



EVALUATING THE SEVERITY OF BLEACHING

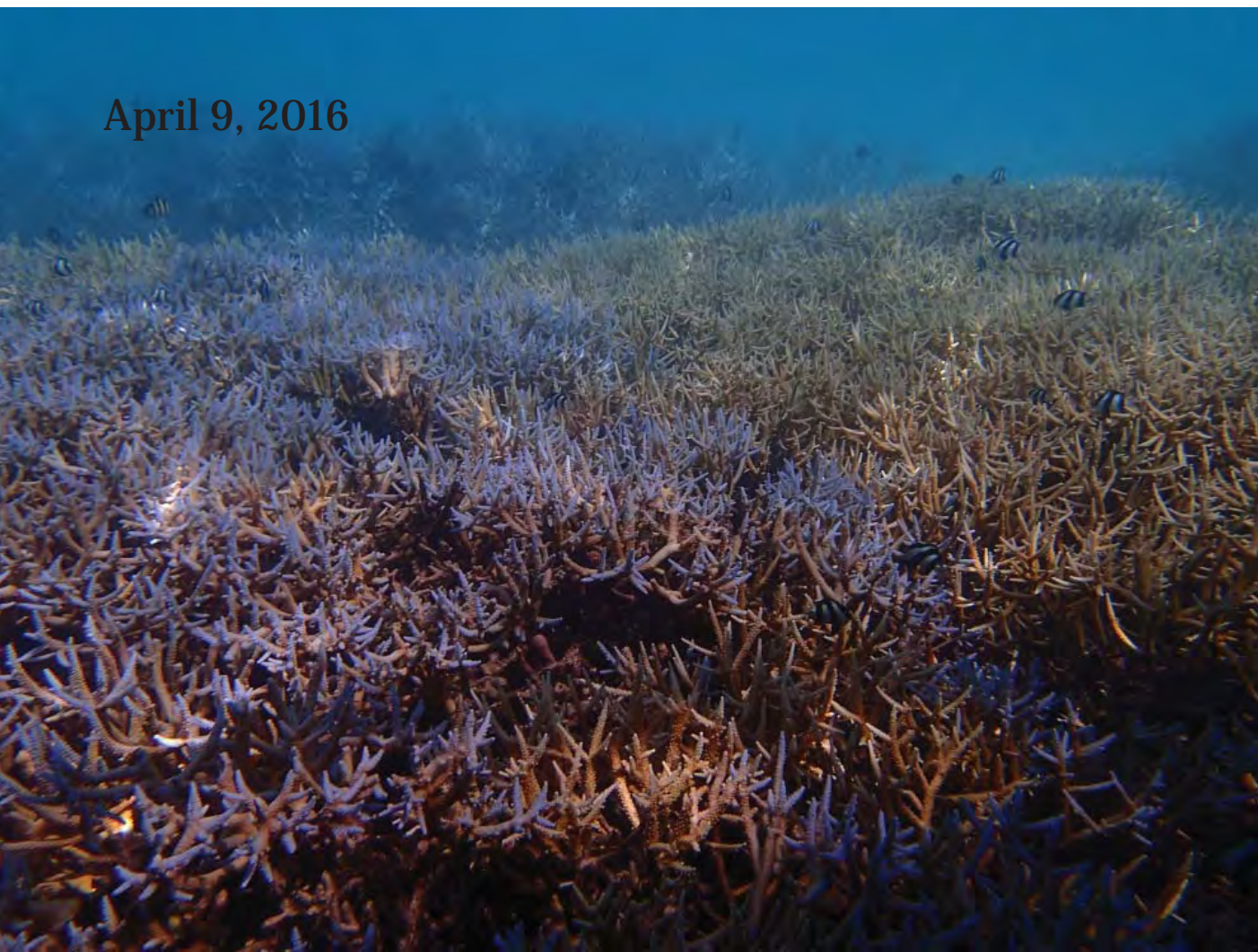




On over 95% of the reefs we examined, the majority of the table corals died during the bleaching event. Aerial photograph of a submerged patch reef on North Malé atoll in May 2016 with bleached table corals (*Acropora* spp.). Stages of bleaching, from pale (top), bleached (top middle), bleached and dying (bottom middle) and completely dead and covered with algae (bottom). Bleaching refuges were table corals survived included outer fore reefs and channel reefs where water flow was much higher.



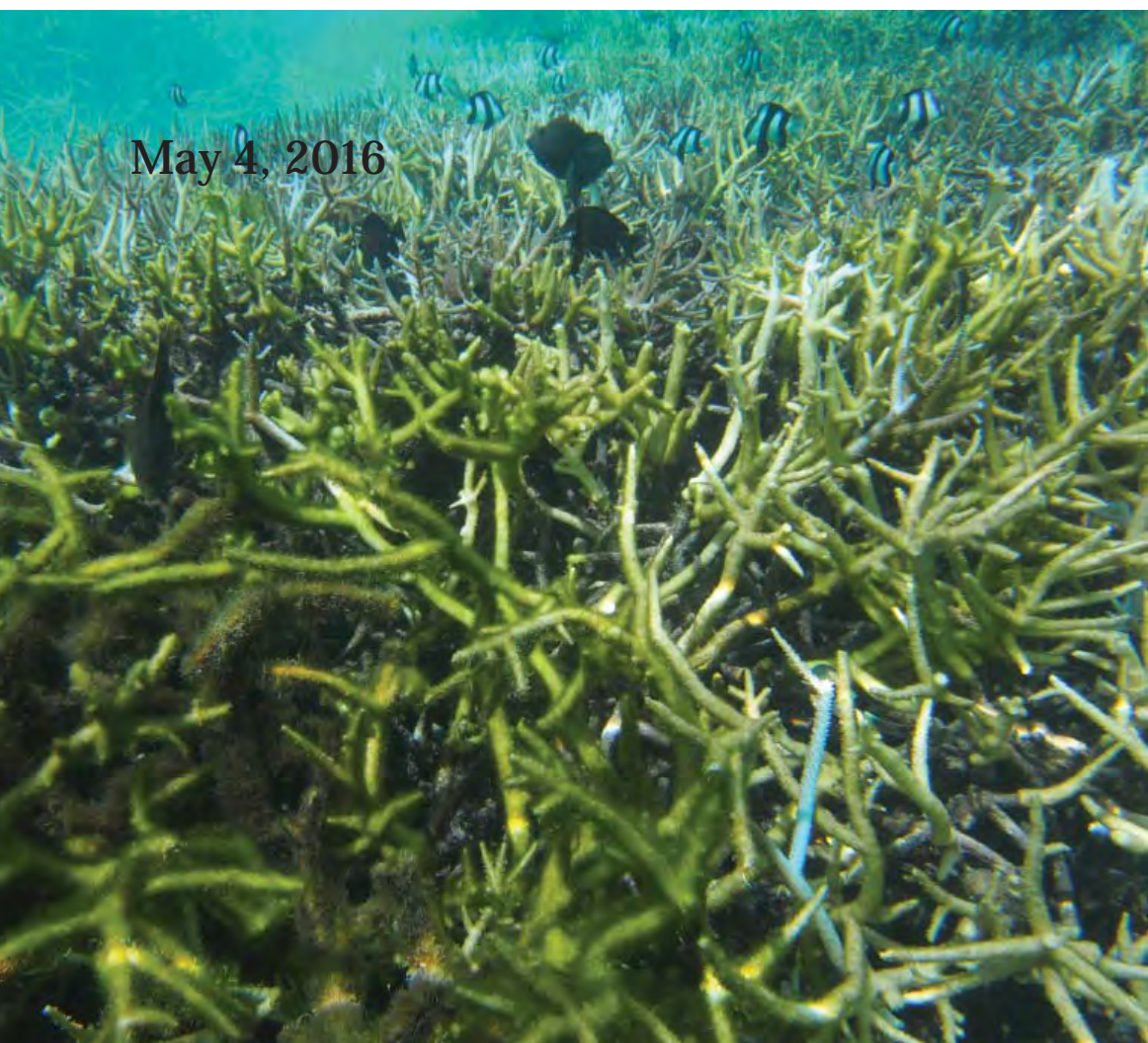
April 9, 2016



April 21, 2016



May 4, 2016



During the 2016 mass coral bleaching event, some reefs fared worse than others. In calm, protected lagoonal habitats with minimal water circulation, temperatures exceeded 34° celsius. One shallow snorkel area surrounding the water villas at Veli, South Male Atoll, had huge stands of staghorn coral. These quickly died. The photographs to the left show the stand when it was just starting to bleach (top left), two weeks later when it was completely bleached, (bottom left) and two weeks after that when 99.8% of the population had died and skeletons were covered in thick algae (top right).

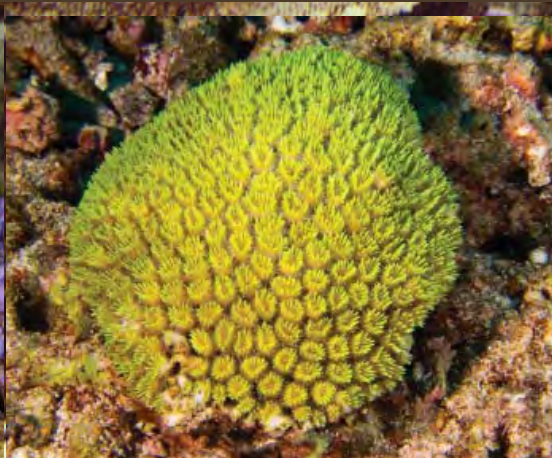


An aerial view of the staghorn population (dark spots is dead coral skeletons) is shown in the lower right.

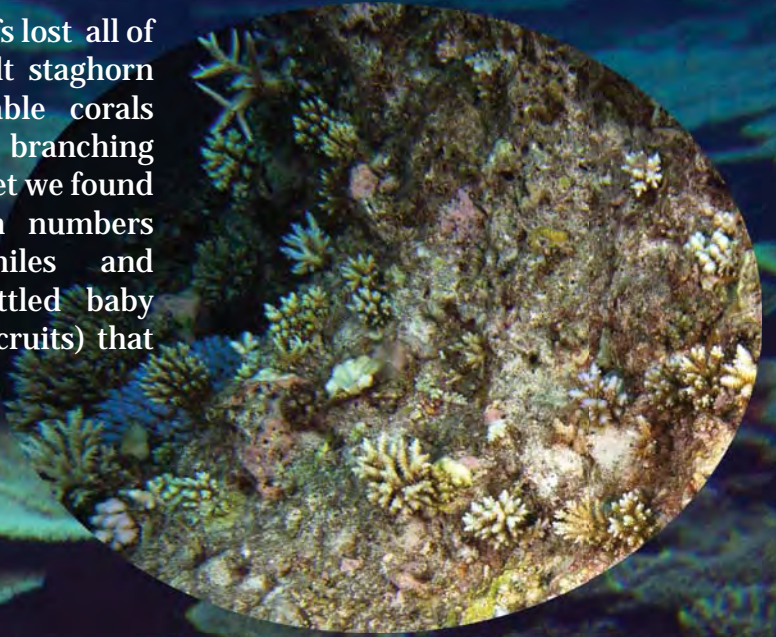
Coral Reef CPR has established a nursery here, with intention to restore this area within a few years, because of the critical importance of the site as a nursery area.

Adaptation, Bleaching Refuges and Survivors

We identified locations where bleaching did not occur or was less severe, such as channel reefs and outer fringing reef (background). We also identified some corals that did not bleach, even though neighbors of the same species remained brown (bottom center). We also identified a number of corals that bleached, but they produced fluorescent colors. Some of these, such as *Galaxea* (second from left) and *Lobophyllia* (second from the right) turned fluorescent and boulder coral (right).



Many reefs lost all of their adult staghorn corals, table corals and other branching species, yet we found very high numbers of juveniles and newly settled baby corals (recruits) that survived.



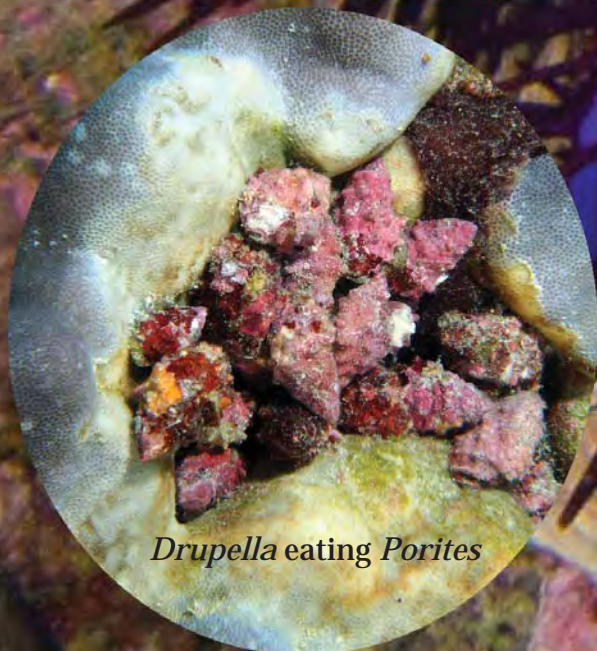
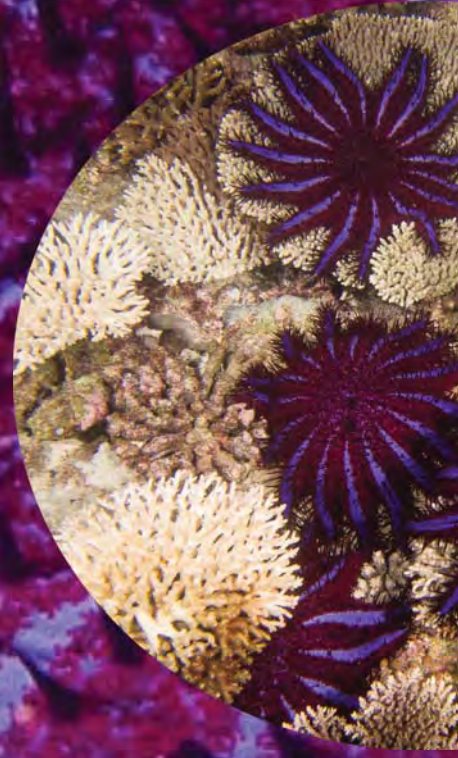
More reefs where there was greater water circulation and deeper, submerged thilas such as the Veli Channel the species did bleach. Two adjacent boulder corals (*Porites*), the left colony bleached and the right colony had fluorescent animal pigments which behave like sunscreen, protecting them from harmful UV radiation. One turned fluorescent yellow and survived the bleaching event. Others turned purple such as the digitate *Acropora* (left)



ELIMINATING CORAL REEF PESTS

Coral reefs in the Maldives have been under attack from voracious crown of thorns starfish (COTS) since early 2015. To date, outbreaks have been reported from six atolls. Hundreds of thousands of these starfish have been removed or killed by injection. Coral Reef CPR scientists have collected over 12,000 since October 2015. These starfish are a serious concern now, as coral populations have been greatly reduced due to the 2016 bleaching event, and starfish are consuming the survivors which are the strongest and most important corals for the recovery of these reefs.

Coral Reef CPR has also documented unusually large aggregations of *Drupella*, which are small coral-eating gastropods. These snails are found at a very high prevalence and large aggregation size, with up to 250 snails found on an individual coral and 60-80% of certain species being infested. We removed over 2,600 snails from four reefs near Dhigu, South Malé Atoll during August and October and continue to collect snails from affected corals.



Drupella eating Porites



Drupella removed from one coral



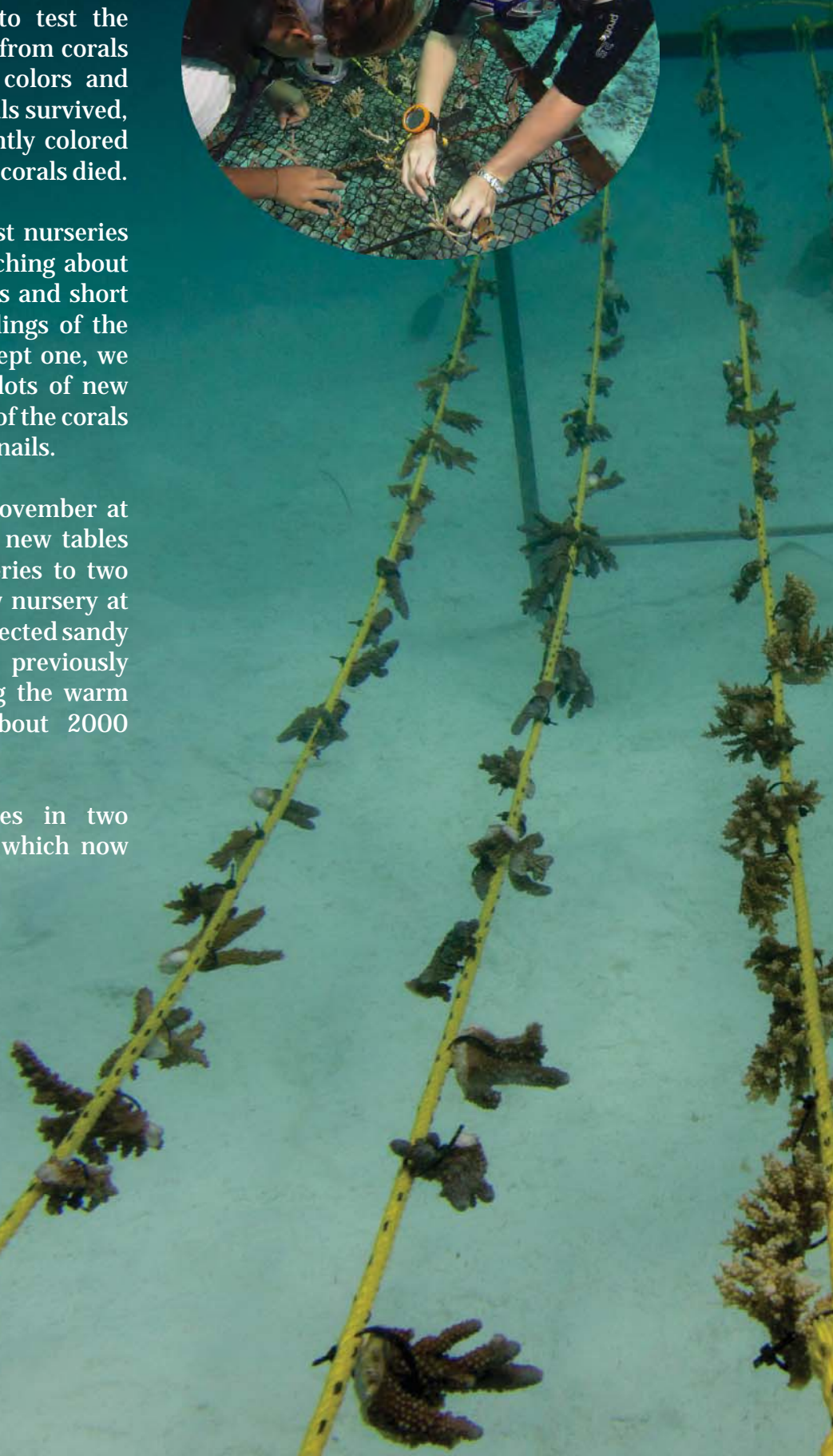
CORAL NURSERIES

At the peak of the bleaching event we conducted a small experiment to test the survival of small branches taken from corals that were bleached, fluorescent colors and unbleached. Our unbleached corals survived, while about half of the fluorescently colored colonies lived and all the bleached corals died.

In August, we established our first nurseries off Dhigu, South Malé Atoll, attaching about 900 corals to mesh covered tables and short ropes suspended between the pilings of the water villas. In all locations, except one, we had very high survivorship and lots of new growth. In one we lost about 50% of the corals due to predation by coral-eating snails.

We expanded our nurseries in November at Dhigu, South Malé Atoll, adding new tables to four locations and rope nurseries to two locations. We also created a new nursery at the “Advanced Snorkel Site” a protected sandy channel where corals had been previously planted (but they all died during the warm water period). We planted about 2000 fragments.

We created new rope nurseries in two locations at Kihavah, Baa Atoll, which now contain about 2000 fragments.



SOURCES OF CORALS

To minimize damage to reefs, we only use broken coral branches that were naturally detached by waves or diver contact, fragments from corals that have diseased or are under attack by coral-eating snails, and corals salvaged from sites of construction, dredging, sand extraction and burial for land reclamation.



Two scientists attaching fragments to a mesh table (top left). New growth on a staghorn coral attached to a rope (bottom left). A coral table with attached acroporids (right) and a close-up of fragments on table showing two months of growth (top right). A coral rope nursery at Dhighu (background).

EDUCATION

The most important way to achieve change is through education and community involvement in conservation actions. Coral reef CPR conducts seminars, workshops and in water training, and uses volunteers to achieve our conservation objectives. During 2016, we reached over 4000 high school students, resort guests, recreational divers, staff, and local community members through our presentations. Volunteers were integral in our crown of thorns clean-up efforts, and in assisting us with the establishment and amintenance of nurseries.





Images from our educational seminars, high school workshops, crown of thorns volunteer clean-up activities, coral nursery work and scientist volunteers that supported and participated in our educational programs.

OUR PARTNERS AND SPONSORS



CORAL REEF CPR PUBLICATIONS

The Magnificent Maldives conserving an underwater gem



In the center of the Indian Ocean, south of the equator, lies the Maldives, a nation of 1200 islands and 200,000 people. The world's largest atoll is a chain of islands that stretches for 1,100 kilometers. The Maldives is a unique country in that it is the only one in the world to be geographically aligned east-west, from about 10°N to 10°S. The Maldives is a unique country in that it is the only one in the world to be geographically aligned east-west, from about 10°N to 10°S. The Maldives is a unique country in that it is the only one in the world to be geographically aligned east-west, from about 10°N to 10°S.

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Culling Crown-of-Thorns Starfish (COTS): Can we salvage impacted reefs?

The crown-of-thorns starfish (COTS) is a voracious predator of coral. It is a major threat to coral reefs in the Indo-Pacific region. COTS are found in high densities on reefs that have been impacted by other factors, such as bleaching and overfishing. COTS are found in high densities on reefs that have been impacted by other factors, such as bleaching and overfishing. COTS are found in high densities on reefs that have been impacted by other factors, such as bleaching and overfishing.

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REEF NEWS

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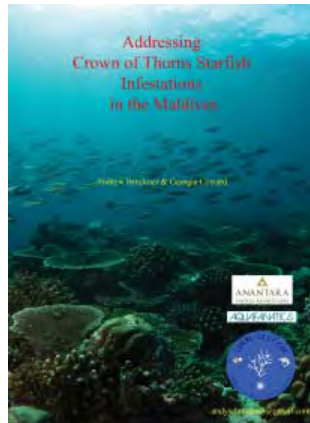
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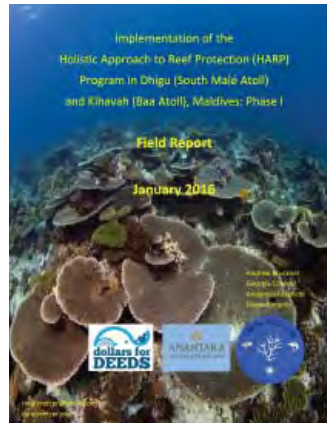
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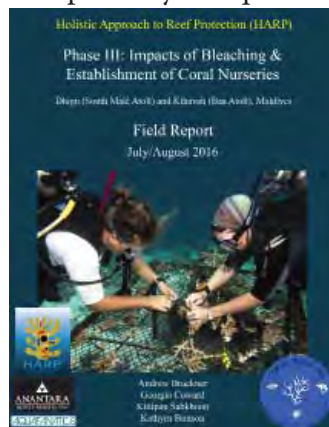
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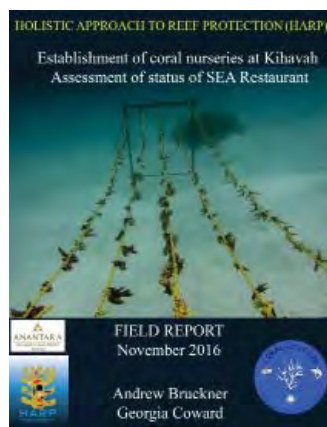
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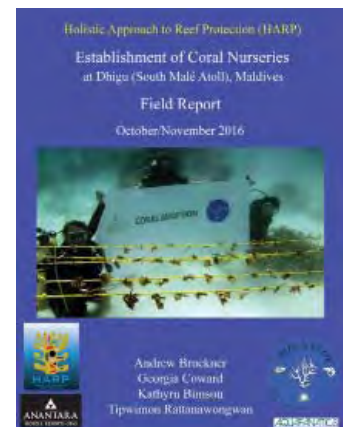
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