

# Coral Reefs: A Model for Restoration Management



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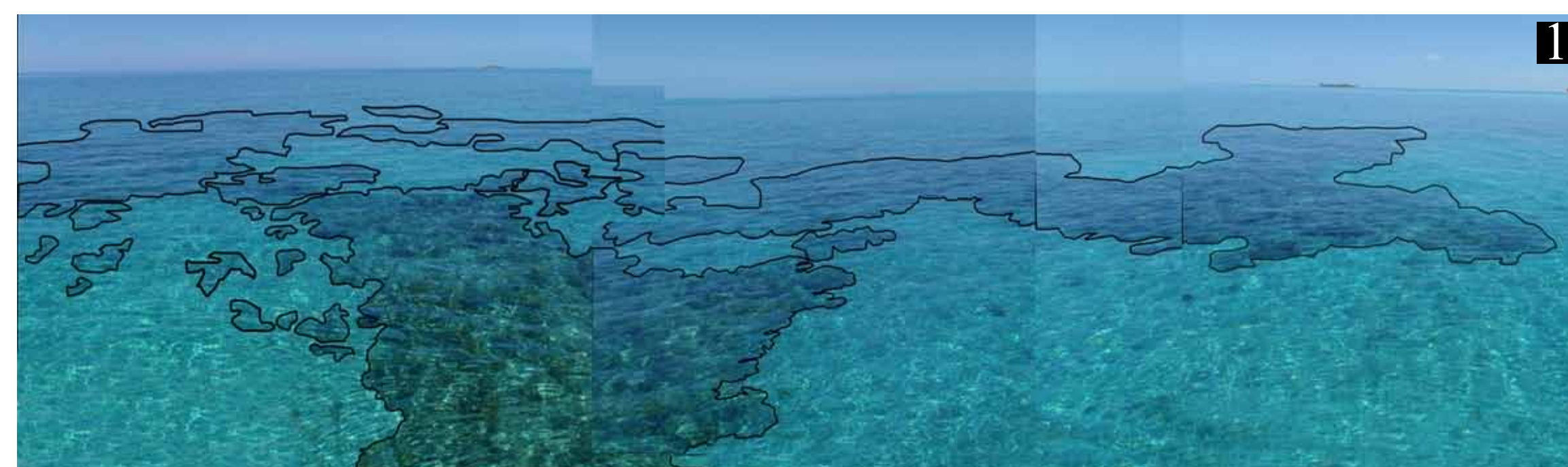
## Abstract

The coral reefs around southern Abaco, Bahamas have been affected by a number of natural and anthropogenic stressors that have led to their decline. This decline is evident in terms of their low coral cover and scarcity or absence of key reef building corals and other ecologically and economically important species. This project uses an ecosystem approach and incorporates adaptive restoration methods aimed to rectify the situation. This includes the translocation of key grazers on coral reefs, the long-spined black sea urchin, *Diadema antillarum* and maximizing reef recovery through transplantation of healthy reef-building coral fragments, such as *Acropora palmata* and *Acropora cervicornis*, collected opportunistically from broken colonies. Yearly monitoring of reef sites from 2008-2010 showed that fish and benthic communities remained fairly stable. Throughout the study *D. antillarum* has been increased by 30% and over 70% of transplanted corals are healthy and showing positive growth. Increasing the baseline knowledge, encouraging eco-friendly actions, and changing the way Abaco communities view their environment is critically important for protecting and restoring coral reefs. Activity booklets, environmental summer camps, restoration workshops and opportunistic community education have been implemented as successful community outreach programs and have shown to raise awareness of the importance of coral reef ecosystems.

## Background

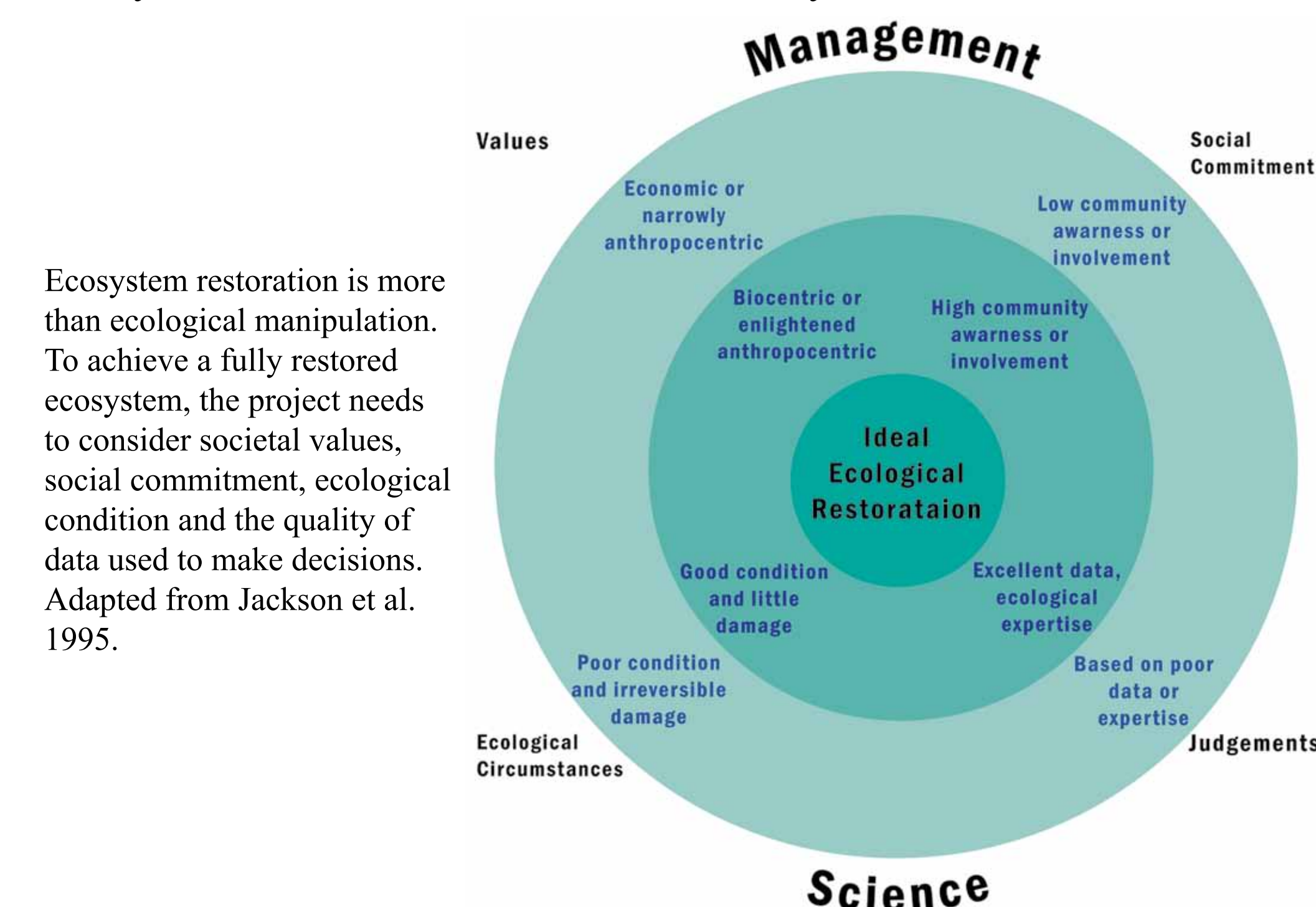
### Site Description:

Small, shallow, low profile reef (<1.5m) with high algal coverage and low coral coverage along the southern edge of the Little Bahama Banks. Natural abundance of urchins is low, but fish diversity and abundance, including the abundance of parrot fish, is typical of the region.



### Project Goals:

1. Determine baseline health of patch reefs surrounding Castaway Cay through fish and benthic surveys and establish an experimental site.
2. Investigate whether the introduction of *Diadema antillarum* on certain patch reefs would decrease algal cover and in turn increase coral diversity and abundance.
3. Use coral transplanting to accelerate coral repopulation.
4. Encourage environmental responsibility and knowledge of coral reef ecosystems within the local community.

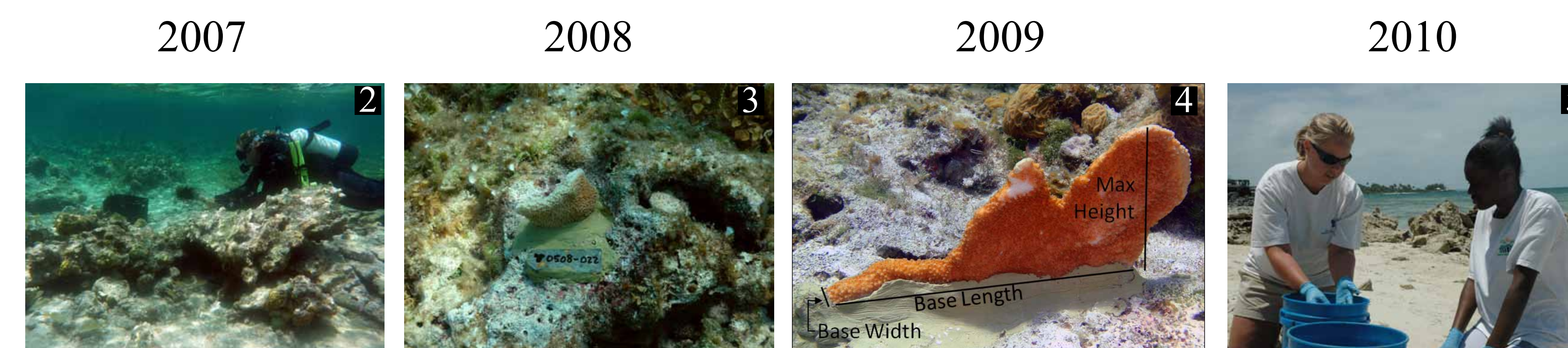


Ecosystem restoration is more than ecological manipulation. To achieve a fully restored ecosystem, the project needs to consider societal values, social commitment, ecological condition and the quality of data used to make decisions. Adapted from Jackson et al. 1995.

## Adaptive Restoration Plan

The future of restoration is adaptation. The need to adapt current restoration and management plans to fit the changing environment, climate and economy is pressing. Taking time to examine and evaluate methodology in the context of success and failure to meet goals is vastly important. Pinpointing areas for improvement at the end of each year (see lists below) can have a dramatic effect on restoration success. Challenging the perception that restoration is "strictly ecological" is necessary. Components of community education, societal attitudes, intrinsic value and economic dependency should be included in a comprehensive restoration plan.

Since 2007 69 coral fragments have been transplanted onto Glassbottom reef. Through our adaptive restoration techniques we have been able to track 73% of transplanted corals and have documented positive growth for 67% of transplants over the last three years. Translocation efforts have increased *Diadema* 30% from baseline data.



After each field season lessons were learned, these were incorporated into the next year's plan

### Lessons Learned

- Ecosystem approach crucial
- Begin transplanting coral fragments
- Conduct annual biodiversity surveys
- Monitor urchin retention
- Use rugosity as indicator for good urchin habitat
- Increase awareness of coral reef ecosystems through local high school summer camps

### Lessons Learned

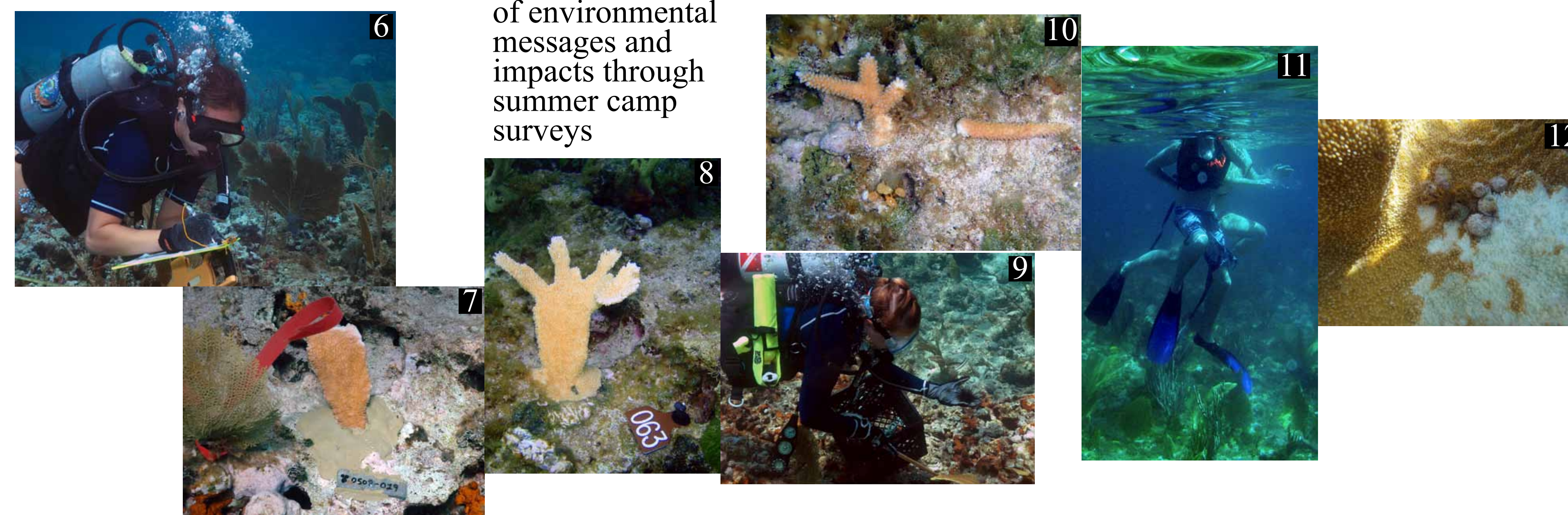
- Decrease number of coral species transplanted
- Improve transplant process
- Implement the use of PIT tags for coral identification
- Determine method to track coral growth
- Mark transects on experimental reef for consistent annual surveys
- Increase *Diadema* donor sites
- Evaluate success of environmental messages and impacts through summer camp surveys

### Lessons Learned

- Focus on transplanting historical reef building coral species
- Use photo documentation to track growth
- Simplify tagging method for individual coral fragments
- Use permanent transect markers
- Compare urchin behavior among sites
- Increase restoration efforts to other sites

### Lessons Learned

- Evaluate genetic diversity of corals and urchin at all reefs
- Compare restoration efforts across many sites
- Determine benefits of using coral nursery
- Improve existing summer camp curriculum
- Expand community education and outreach



Images: 1) Surface view of study site Glassbottom reef, 2) Collection of keystone species *Diadema* from donor site, 3) *Acropora Palmata* coral fragment transplanted with epoxy and concrete ID tag, 4) Standardized method for measuring coral growth, 5) Workshop held for high school students to promote coral reef conservation, 6) Biodiversity surveys conducted annually, 7&8) Transplanted *A. Palmata* in 2008 (7) and its dramatic growth by 2010 (8), 9) Adding key grazers like, *Diadema*, supports the ecosystem approach, 10) Broken transplanted *A. cervicornis* likely due to tourism pressures, 11) Example of snorkelers using poor technique at study site, 12) Predatory snails destroying live tissue of transplanted *A. palmata* 13) Abaco summer camp kids using activity booklet provided by Disney Cruise Line, 14) High school students helped Disney researchers transplant coral fragments during workshop, 15) Summer camp participants posing with conservation puzzle created by Disney

## Education Efforts

We believe education to be one of the most important components of an adaptive restoration plan. The ultimate goal of our education efforts are to promote environmental awareness, increase baseline knowledge, inspire society to take conservation action, increase environmental responsibility and encourage pride in their natural environments.



- Contribute to annual summer camps throughout The Abacos for school age students. Camps are intended to increase exposure to the environment and promote positive attitudes and behaviors towards the environment.
- Conduct pre and post camp surveys to evaluate effectiveness of messaging, experience and absorption of material.
- Host a coral transplanting workshop with local environmental group, FRIENDS of the Environment, to teach students how to and why to protect coral reefs and to demonstrate restoration.
- Promote intrinsic environmental value and awareness using an educational activity booklet on The Bahamas' natural environments: coral reefs, mangroves and pine forests.
- Develop an instructional poster on coral reef etiquette for snorkelers, anglers and boaters.
- Host a seminar for local fisherman encouraging sustainable fishing practices.

## Conclusions

- Collaboration between scientists, management and community is critical to a comprehensive restoration plan.
- Restoring historical conditions and ecological functions of a reef can only be achieved using an ecosystem approach.
- Evaluating environmental changes, especially biodiversity, on an annual basis will provide valuable information when adapting restoration plans.
- Modifying methods, materials and goals post field season can drastically improve restoration success.
- Education, education, education! Inspiring change, commitment, action and respect for the natural resources that support their community.

## Acknowledgements

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