# Coral Monitoring and Gardening in South Eleuthera

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## Introduction

An important issue in the field of tropical marine biology is the decline in abundance, health and biodiversity of coral reefs. Reef ecosystems yield food and shelter to one quarter of all marine species. In addition, they provide livelihoods for 30 million small-scale fishermen and support commercial fish stocks consumed by one billion people. The reef structure itself provides critical shoreline protection to coastal populations, particularly against wave action from storms (Goldberg and Wilkinson 2004). In recent decades, coral reefs have faced myriad threats leading to significant declines worldwide. These threats include bleaching, phase shifts to macroalgal dominance, disease, ocean acidification, increasing sea surface temperatures, overfishing, low coral recruitment rates and increased frequency and severity of storms (Goldberg and Wilkinson 2004). Commercial coral harvesting, recreational activities such as diving, and ocean pollution add to the increased amount of stress currently being placed on coral reefs (Kojis and Quinn 2001). Without reefs, a total of $375 billion in goods and services would be lost, in addition to biodiversity, coastal shoreline protection, fisheries and livelihoods.

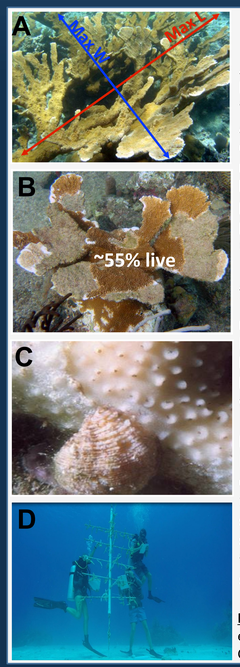
Acroporids are broadcast spawners which release eggs and sperm into the water column. Fertilization success relies on sufficiently large population densities, while dispersal is a function of ocean currents. As populations have declined, acroporid recruitment has been limited in certain regions, leading to a decrease in genetic diversity and ultimately leaving the species vulnerable to disease. Acroporids can also reproduce by natural fragmentation, though fragment growth produces clones of the parent colony. Now, due to the synergistic effects of low recruitment rates and other anthropogenic stressors, coral reefs are not as resilient to natural stochastic events such as hurricanes (Kojis & Quinn 2001).

Caribbean acroporid corals *Acropora cervicornis* (Elkhorn coral) *and A. palmata* (Staghorn coral) are important reef-building species with high growth rates. However, they have been slow to recover from a mass disease outbreak in the 1980s that killed off almost 95% of both species in the Caribbean (Kojis and Quinn 2001). In 2006, both *A. palmata* and *A. cervicornis* were listed as threatened under the Endangered Species Act. In 2008, they were categorized as critically endangered by the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. This study aims to monitor existing acroporids populations for the first time in South Eleuthera, Bahamas and to participate in ongoing acroporid gardening efforts.

## Objectives

1. Baseline assessment of wild *Acropora palmata* (Elkhorn coral)
2. Participate in *Acropora cervicornis* (Staghorn coral) gardening

## Methods




***Acropora palmata* baseline assessment**

Baseline *Acropora palmata* data were collected via snorkeling at four sites (Figure 1). Following Atlantic and Gulf Rapid Reef Assessment (AGRRA) protocols (www.agrra.org), morphometrics of each colony were recorded to the nearest 0.5 cm, including maximum length ($L_{max}$), maximum width ($W_{max}$) and maximum height ($H_{max}$). Colony depth was recorded to the nearest 0.5 m. The percent of live coral tissue on each colony was estimated, and presence/absence of disease and the corallivorous gastropod *Coralliophila abbreviata* was documented.

***Acropora cervicornis* coral gardening**

The Cape Eleuthera Institute's (CEI) *A. cervicornis* nursery was maintained throughout the semester. CEI's nursery trees, made of PVC piping, consist of a central trunk with ten perpendicular branches. *A. cervicornis* fragments are suspended from branches by zip-ties or monofilament. Algal growth was manually removed with brushes to prevent overgrowth of *A. cervicornis* fragments.

**Data analysis**

For size comparisons among sites, *A. palmata* measurements were converted to volumetric values ($L_{max}$ x $W_{max}$ x $H_{max}$) to indicate three-dimensional space occupied by each colony. This amount of space has implications for the amount of available habitat and reef structure itself. An analysis of variance (ANOVA) was used to test for significant differences in parameters measured among sampling sites.

**Figure 2**. *Acropora palmata* baseline assessment data included (A) colony size, (B) estimated percent live cover and (C) *Coralliophila abbreviata* presence/absence. Coral nursery maintenance (D) involved manual removal of algae with brushes .

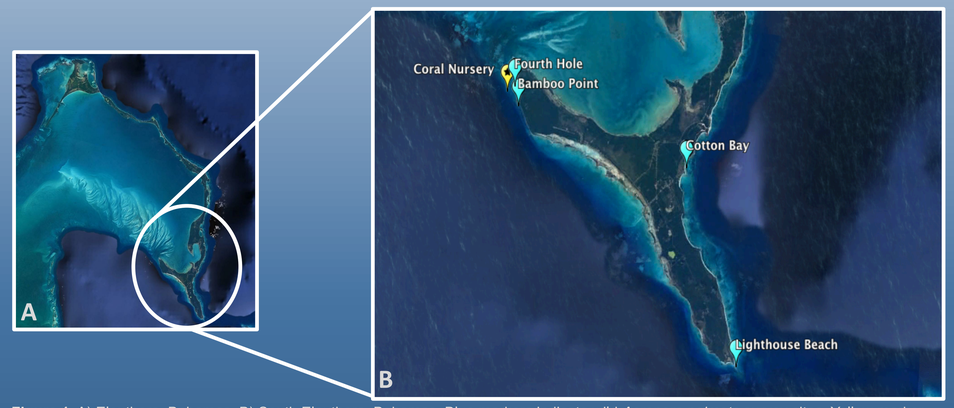



**Figure 1**. A) Eleuthera, Bahamas. B) South Eleuthera, Bahamas. Blue markers indicate wild *Acropora palmata* survey sites. Yellow marker indicates location of Cape Eleuthera Institute's *A. cervicornis* nursery.

## Results

A total of 29 *A. palmata* colonies was surveyed at four sites around south Eleuthera (Table 1, Figure 1). There were significant differences in the depths of the *A. palmata* colonies at the four sites (Figure 3). The deepest colonies were found at an average of 1.5 m in Cotton Bay, while the shallowest, at Lighthouse Beach, were at 0.5 m. Despite the difference in colony depth, there was no statistical difference in average colony size among the four sites (Figure 4). In addition, there was no statistical difference in the estimated percentage of live coral per colony among the four sites sampled (Figure 5), with a range of approximately 65 to 95% live tissue per colony. The predatory gastropod *C. abbreviata* was found on colonies at three of the four sites sampled. There were no signs of disease on any of the colonies surveyed.

**Table 1**. Summary of wild Acropora palmata survey data. Mean values are given with standard deviation. LC = percent live coral tissue per colony; CABB = corallivorous gastropod *Coralliophila abbreviata*.

| Site | n | Colony Depth (m) | Colony Size ($m^3$) | LC (%) | Disease | CABB |
|---|---|---|---|---|---|---|
| Bamboo Point | 1 | 1.40 | 2.70 | 98 | No | No |
| Cotton Bay | 14 | 1.79 ± 0.74 | 1.17 ± 4.12 | 70.3 ± 24.9 | No | Yes |
| Fourth Hole | 11 | 0.77 ± 0.26 | 0.07 ± 0.09 | 65.9 ± 33.8 | No | Yes |
| Lighthouse Beach | 3 | 0.50 ± 0 | 2.39 ± 1.03 | 76.7 ±32.1 | No | Yes |

**Figure 3**. Average depth of colonies surveyed at each site. Lower case letters indicate significant differences.

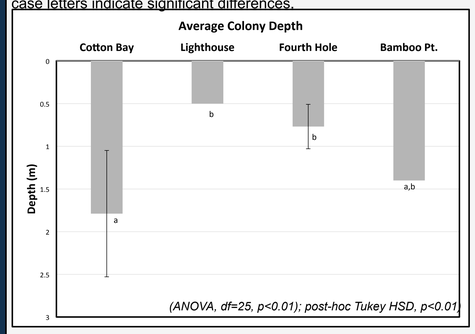



**Figure 4**. Average size of colonies ($L_{max}$ x $W_{max}$ x $H_{max}$) surveyed at each site.

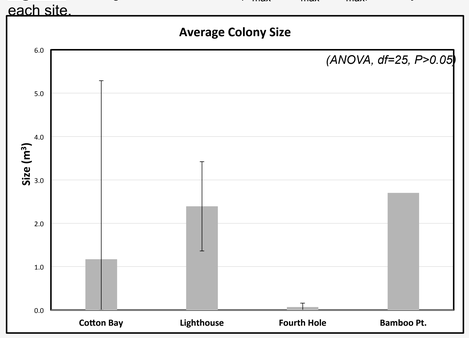
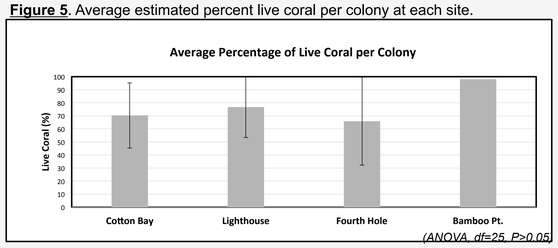



**Figure 5**. Average estimated percent live coral per colony at each site.




## Discussion

This study initiated the first baseline assessment of acroporid corals in south Eleuthera. While healthy colonies do exist, the prevalence of old, dead structure indicates populations were much healthier in previous decades. Colony size did not differ among sites sampled, but this result may be a function of low sample size and high variability within sampling sites. Cotton Bay, for example, was characterized by very large old, dead *A. palmata* structure that serves as evidence of a healthier past, while Fourth Hole, generally contained smaller, less rugose *A. palmata* structure. One of the most important ecological characteristics of acroporids is their ability to grow rapidly and contribute to reef size adding shoreline protection and three-dimensional space for habitat. As acroporids die, the calcium carbonate structure left behind from their skeleton erodes over time and key ecological benefits are lost.

While colonies were small, the percent of the live tissue was high among the four sites sampled. The amount of live coral is important for reproduction. As acroporid populations struggle to recover and dead colonies erode, reproduction has become less successful due to low population density. Because acroporids are broadcast spawners, high population densities are needed for successful fertilization and genetic variation, especially in isolated areas.

As populations have declined in number and health, it is even more critical that remaining colonies survive to reproductive age. Under normal conditions, a natural predator such as the corallivorous gastropod *C. abbreviata* would not pose an imminent threat to a species. However, because acroporid populations are in such low abundance, *C. abbreviata* are concentrated on the few colonies in the area. Indeed, during this baseline assessment, *C. abbreviata* were found at three out of four sites.

The 95% decline of acroporid corals in the Caribbean in last several decades can be attributed largely to white band disease. However, during this baseline assessment, no disease was recorded on any colony at any of the sampling locations, providing some hope that south Eleuthera's live *A. palmata* populations may be resilient.

Because acroporids can reproduce through fragmentation, restoration and gardening, especially *A. cervicornis* has become common practice among scientific and recreational dive institutes around the Caribbean. Though CEI's coral nursery is still in its infancy (Figure 6), successful growth of *A. cervicornis* fragments has been observed. Future coral research should focus on an expansion of this independent initiative in order to aid the wider scale restoration effort of this important reef-building species.

**Figure 6**. *A. cervicornis* fragments attached to a nursery tree branch

## Conclusion

This study focused on establishing a baseline assessment of *Acropora palmata* in south Eleuthera, the first recording of species health around the island. Although healthy, possibly recovering colonies were observed, much larger dead structures were also evident, indicating much higher population density in the past. Continued monitoring in southern Eleuthera is recommended to track the recovery or decline of these corals in future years. Restoration efforts currently underway at CEI should be continued and assessed for further progression and expansion.

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