Diadema Restoration Projects

Diadema Restoration Project

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Project Goals/Narrative

Reef-building corals with their diverse growth forms are responsible for the structural relief that supports a high diversity of commercially, recreationally, and ecologically important organisms on coral reefs including groupers and snappers, lobsters, and sea turtles. Corals co-exist in a dynamic balance with reef algae, which are at the base of the coral reef food web. High levels of herbivory (grazing) are critical to maintaining competitive dominance of corals and to algal production fueling the coral reef food web. On Western Atlantic and Caribbean coral reefs, there have been recent shifts away from dominance by corals, and reefs have become dominated by thick turf and fleshy algae since the 1983 epizootic die-off of the major coral reef grazer, the sea urchin *Diadema antillarum*. The resulting alterations of coral reef substrate characteristics and trophic structure have impacted coral recruitment and survival of corals that do recruit. Effective ecological restoration of coral reefs may require the replenishment of critical/keystone members of the coral reef ecosystem, such as the herbivorous urchin *Diadema antillarum*. This urchin is still in low abundance on most coral reefs in the Caribbean, two decades after the mass die-off. Repopulation of *Diadema* may help create reef substrates more suitable for coral recruitment, prevent further smothering of corals, and improve the survivorship of recruited coral colonies in the Florida Keys. A desirable outcome of this project is to create a network of reefs within the Florida Reef Tract with locally high densities of adult *Diadema*. When *Diadema* spawns, these aggregations may serve as centers of dispersal by providing greater numbers of larvae for colonization of other reef and hard-bottom areas.

Methods

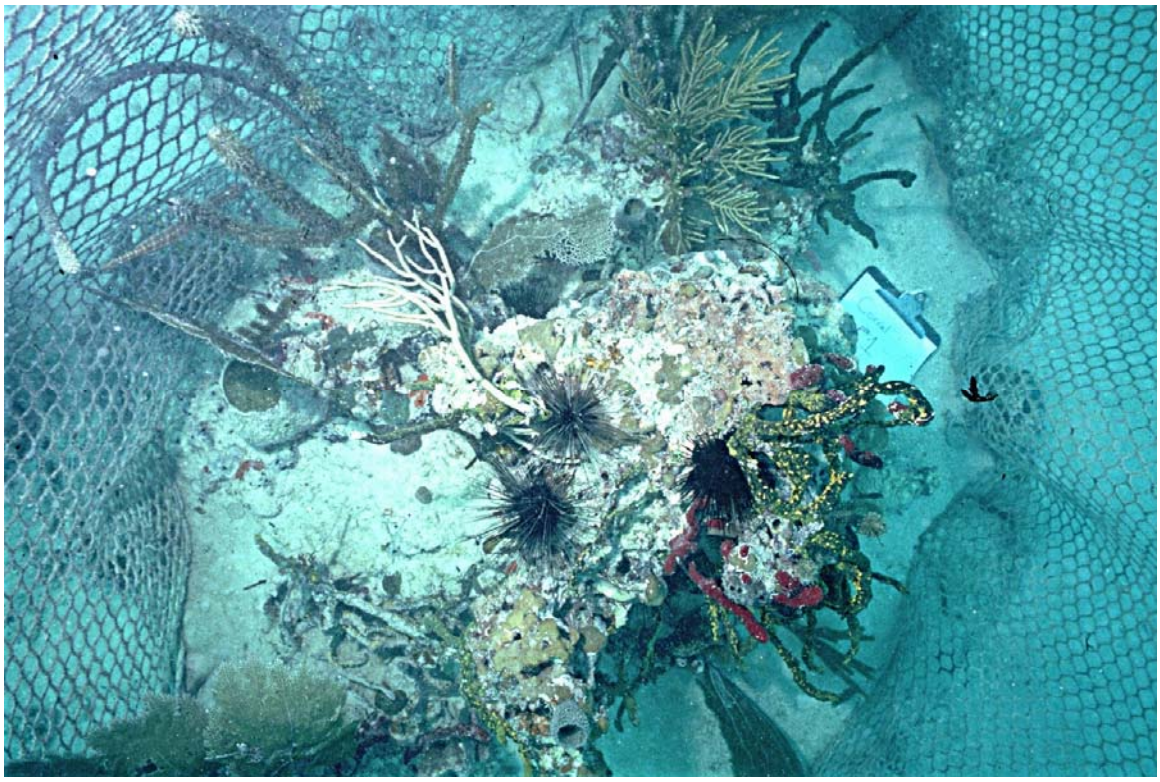
"Corrals" made of nylon mesh were deployed around four coral heads at a site with low coral cover located off of Big Pine Key in the Lower Keys. These corrals were stocked with densities of adult urchins approximating pre-die-off densities (approx. 4 individuals per m^2) (Photo 1). Four other coral heads were selected to act as controls for this project; they were not encircled with the corral material or stocked with *Diadema*. The benthic community within the corrals and controls was surveyed utilizing point-intercept transects conducted at monthly intervals to document substrate characteristics. It was hypothesized that algal communities would decrease in density within the corralled coral heads compared to untreated coral heads because of *Diadema* herbivory. Surveys were also conducted every week or two to assess the abundance of *Diadema* within corrals. As densities of *Diadema* fell below $4/m^2$, more urchins were collected and placed within corrals. Three months following the introduction of urchins into corrals, coral spawn was collected and coral larvae were introduced to the four corralled coral heads. The settlement and survivorship of juvenile corals was monitored sporadically. Lab-raised juvenile urchins were released into two separate corrals adjacent to the other four corrals utilized for the wild urchins. Survivorship of these lab-raised urchins was monitored on a regular basis.

Results

Results were measured in three ways: 1) changes to benthic communities within corrals and control areas, 2) survivorship of wild and lab-raised Diadema*, and 3) settlement and survivorship of the "seeded" corals.*

Photo 1: View of Corral #1 (Interior)

Legend: This is a photograph of corral #1. *Diadema* can be seen on top of the corralled coral head. The nylon mesh material used for the corral can be seen surrounding the coral head.



Changes to the Benthic Community

Point intercept transects were conducted every month within corrals and controls to determine changes in benthic communities over time. Corrals stocked with wild urchins displayed a drastic reduction of turf algae over a short period of time (Graph 1). In the initial survey of the four corralled areas, average cover of turf algae was 43%. The last survey was conducted 152 days later; cover of turf algae was reduced to 3%. The slope of the curve suggests that algal cover was reduced rapidly (within 60 days) following the inclusion of *Diadema*. The percentage of corals, sponges, gorgonians, and bare substrate within corrals remained relatively level throughout the duration of the project.

The results of benthic surveys of controls showed high variability of algal turf percentages (Graph 1). The percentage of corals, sponges, and gorgonians, and bare substrate remained relatively level throughout the entire project. The variability (standard deviation) of observations was quite high for most benthic surveys, for both corrals and controls; one factor for this may be inter-observer variability.

Survivorship of Diadema

Wild *Diadema* were collected from various sites throughout the Lower Keys and were placed within each of the four corrals. Initially, 32 urchins were collected and eight were placed into each corral (Graph 2). Twenty-nine days later, 21 more *Diadema* were added to the corrals to raise the densities to approximately $4/m^2$. As densities dropped over time due to predation, escapes, or natural mortality, 12 more urchins were collected and added to the corrals 104 days following the beginning of the project. The total number of *Diadema* collected was 65 and we could account for 34 individuals 174 days later, which corresponded to a loss rate of 48%. During an 18-day period (days 118 through 136), we lost 16 urchins, or 25%. It is unclear why losses increased so drastically during this short period of time. Prior to this sudden decrease, losses had been approximately 20% for the first 118 days of the project. Occasionally, *Diadema* were located outside of corrals and were presumed to have escaped. These animals were relocated into corrals.

Two additional corrals were constructed and used to contain a total of 27 lab-raised urchins. These *Diadema* exhibited a very high rate of loss (Graph 2). Over the course of several weeks, not one lab-raised urchin could be accounted for.

Coral Settlement and Survivorship

Coral spawn was collected from numerous individuals of *Montastrea* spp. The coral larvae were then released onto the corralled coral heads. The substrate on the coral heads was appropriate for coral settlement because of the high rate of herbivory by *Diadema*. Prior to seeding with coral larvae, areas were surveyed for existing juvenile corals to serve as a baseline. Following the coral spawn collection, it was estimated that over one million coral larvae were released onto the site. “Settlement tents” were used to confine larvae above coral heads until larvae naturally settled to the substrate. Two weeks after the larvae settled, pieces of coral rubble that were placed within the “seeded” area were removed and transported to a lab for inspection under dissecting microscopes. Settlers were observed (Photo 2). Three months later, the corralled areas were surveyed and many more juvenile corals (0.5-1.5 cm) were observed compared to the initial survey.

Graph 2: Total Number of *Diadema* Counted During Surveys

Legend: The blue curve illustrates the total number of wild *Diadema* observed within the four corrals over time. Note that 32 wild *Diadema* were placed within the four corrals initially. Twenty-one more were added to the corrals on day 29 and an additional twelve were added on day 104. The red curve illustrates the total number of lab-reared *Diadema* observed within two separate corrals over time. Twenty-seven lab-reared urchins were placed within these two corrals initially.

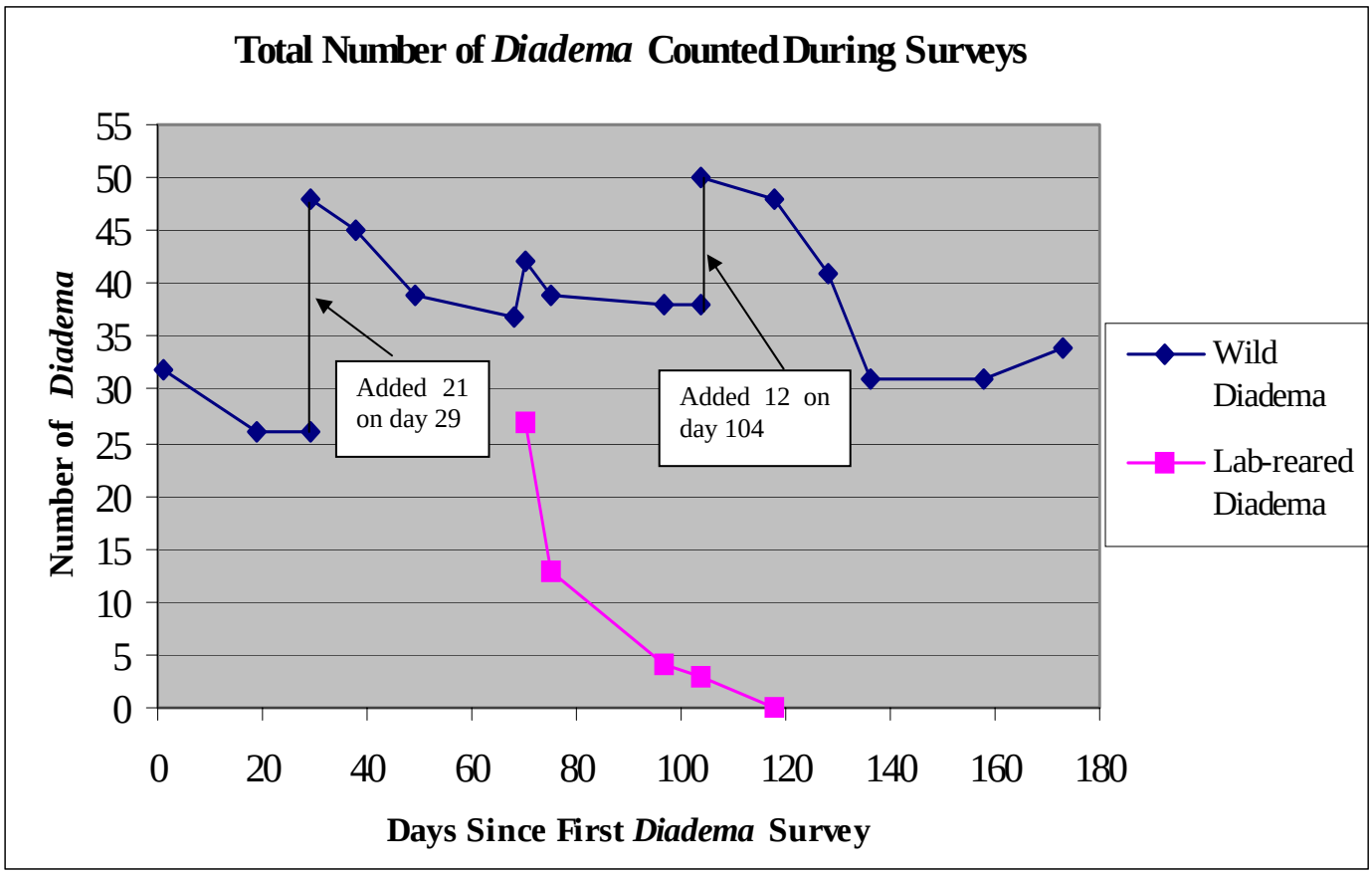


Photo 2: Two-Week Old Coral Polyp (New Recruit)

Legend: This is a micrograph of a two-week old juvenile coral that recently settled out onto substrate within the corralled area.