Diadema antillarum: Observing Populations in the Cape Eleuthera Area

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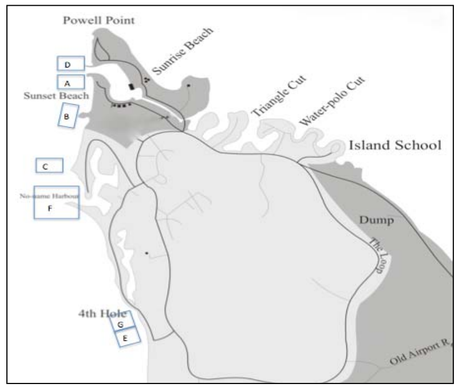
Introduction

The coral reefs of the Western Atlantic Ocean have undergone several dramatic changes in the past two decades due to both natural and anthropogenic factors. In 1983, there was a mass mortality of *Diadema antillarum* (Fig. 1), the long-spined black sea urchin, of over 93% of the populations in the Western Atlantic (Lessios 1988). Diadema are keystone algal grazers on reefs, so this led almost immediately to the out-competition of coral by macroalgae (Fig. 2) (Engman 2002) making it a major factor in a phase shift from coral to macroalgal dominance (Edmunds and Carpenter 2001). This left many organisms without food and shelter, and human economies dependant on the reefs for fishing and tourism may have been negatively affected.

In the last two decades, recovery has been documented in areas such as Barbados (Hunte and Younglao 1988), Panama (Lessios 2005), and the Florida Keys (Chiappone et. al. 2002). This recovery has been linked to an increase in scleractinian corals, particularly Elkhorn and Staghorn coral, and a decrease in macroalgae (Edmunds and Carpenter 2001).

In January 2006, *Diadema* were sighted at Fourth Hole, Cape Eleuthera, and in 2007 the *Diadema* research group was started at The Island School. **The purpose of this study was to gather new abundance, size, and benthic assessment data from previously studied sites on Cape Eleuthera. The objective was to compare this data with baseline data from Spring 2008 to obtain information on the recovery of *Diadema* and its effects on reefs in the Cape Eleuthera area.**



KEY:
A – Mouth of the Marina South
B – Sunset-Chub Rock
C – Chub Rock
D – Mouth of the Marina North
E – Fourth Hole South
F – Mouth of No Name
G – Fourth Hole North

Figure 3: Study sites on Cape Eleuthera.

Methods

The study was conducted at seven different sites on Cape Eleuthera (Fig. 3). Sites were located close together for similar conditions, including relative distance from shore and depth.

ABUNDANCE, USABLE HABITAT, AND SIZE

At each site, six 10m x 2m belt transects (Fig. 4) were conducted and abundance of *Diadema* was noted, checking under rocks and in crevices. Any usable habitat, such as hard substrates with cracks and crevices, that crossed into the transect belt was measured. To determine size, maximum test diameter of *Diadema* was measured using bow calipers (Fig. 5).

BENTHIC COMPOSITION

0.25 m² quadrats were centered at the 0, 5, and 10 meter marks on the transect. Composition was divided into 10 subdivisions; macroalgae (M), sand (S), man-made rubble (MR), limestone rubble (LR), coral rubble (CR), hard coral (HC), soft coral (SC), rock (R), sponge (SP) and sea grass (SG). Subdivisions represented in each quadrat were then grouped into five percentage categories (Fig. 6) based on cover of the quadrat. Specifically, both abiotic and biotic cover were measured into these percentage categories.

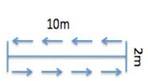


Figure 4.

CAT 0 = 0-10%
CAT 1 = 11-25%
CAT 2 = 26-50%
CAT 3 = 51-75%
CAT 4 = 76-100%

Figure 6.

Figure 1: *Diadema antillarum*; the black long-spined sea urchin.

Figure 2: Finger coral covered in macroalgae.

Discussion

RECRUITMENT

Although there was no statistically significant change in either density or size, there appeared to be fewer juvenile *Diadema* present at three of our sites. This was contradictory to expectations of this study because *Diadema* spawn in early summer and late fall with a four to six week delay between peak spawning and peak recruitment (Hunte and Younglao, 1988). As most of the data was collected during mid to late fall, the presence of more juveniles in this area was expected. *Diadema* recruitment could have been affected by many factors, which in turn would have affected the number of small *Diadema* present on the reefs. Wind could potentially have been a major factor in larval recruitment. Up until recently, all of the sites – which were grouped on the southern side of the Cape – were given some wind cover by the trees and land. However, recent clear cutting could have allowed the wind to have a much greater effect on the surface currents in this area. These new currents would have then carried larval *Diadema* away from these sites.

DENSITY

Another factor that could have affected recruitment is density. Preceding the mass mortality, densities across the Caribbean ranged from 1.1 to 14.4 *Diadema* per m² (Lessios 1988). This would have affected recruitment because juvenile *Diadema* thrive on reefs with large adult populations (Hunte and Younglao, 1988). The densities of this study ranged from 0.1 to 1.9 *Diadema* per m², which falls at the extreme low end of the pre-mortality densities. Juvenile *Diadema* could be settling at reefs down current with larger adult populations.

OVERALL POPULATION CHANGES

There are several possibilities as to why an overall increase in population was not observed. Possibilities outside of this study include changing conditions in habitat due to runoff, changing seasonal temperatures, delay between spawning and recruitment, increase in predation, or the presence of different species at the sites.

Overall, signs of a phase shift reversal in the Cape Eleuthera area were not observed and macroalgae remains the most common benthic cover.

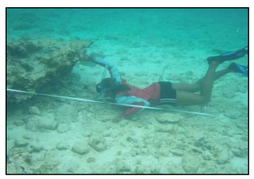


Figure 9: Researcher checking under usable habitat for *Diadema*.

Figure 7: Recording benthic composition using 0.25 m2 quadrats.

Figure 5: Using bow calipers to measure the maximum test diameter.

Figure 8: Researchers recording sizes of *Diadema*.

Acknowledgements

The Island School and Cape Eleuthera Institute for support and encouragement of our research project. Hannah Berardi and Ben Dougherty for directing and advising us. Annabelle Oronti for providing us with her guidance in the scientific process.

Results

In the seven sites surveyed, there was a mean density of 0.8 *Diadema* per m² of useable habitat. Densities ranged from 0 to 2.1 *Diadema* per m² of usable habitat (Fig 10.). Sizes ranged from 15 to 112 mm. The most consistent factor observed in benthic composition was macroalgae, which was present in over 90% of the quadrat samples. In all of the sites there was a healthy amount of both juvenile and mature specimens. The abundance of the *Diadema* was also affected by the amount of macroalgal cover; where there was more macroalgae, there was a larger amount of *Diadema*. There were some places however, where there was still a large amount of macroalgae, but a low abundance of *Diadema*. At Site F (Mouth of No Name), there was large algal cover but there was an average of 1.6 *Diadema* per transect. In comparison, Site D (Mouth of the Marina North) had an average of 29 *Diadema* per transect but had a very similar amount of algal cover and usable habitat.

Even though we can observe some differences between this semester and last semester's data results, there was no statistically significant difference ($p > 0.05$) between them. While there were a few decreases in mean size, abundance and useable habitat there was a large increase in useable habitat at Site A (South of the Marina). Site A was the only site that had a statistically significant change in useable habitat.

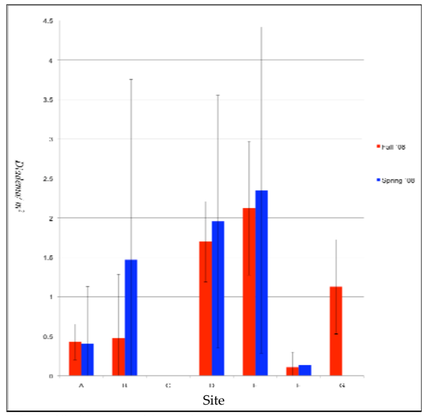


Figure 10: Mean densities at sites

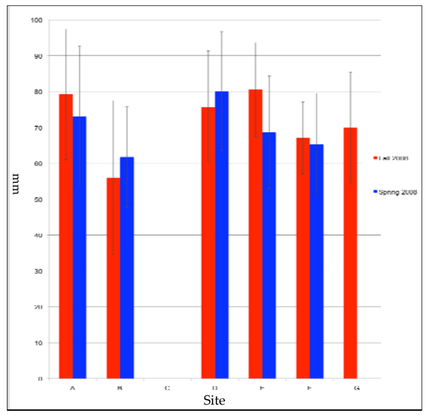


Figure 11: Mean sizes at sites

FALL 08		
Sites	**Dominant Benthic Cover**	**Size Range (mm)**
A	M and S	40-104
B	S and LR	15-85
D	M and MR	25-112
E	M and R	26-98
F	M and LR	50-80
G	M and CR	30-111
SPRING 08		
Sites	**Dominant Benthic Cover**	**Size Range (mm)**
A	MR and S	20-95
B	LR and M	20-89
D	MR and S	37-123
E	CR and S	33-94
F	LR and M	40-87

Figure 12: Comparison of benthic cover and *Diadema* sizes between study periods.

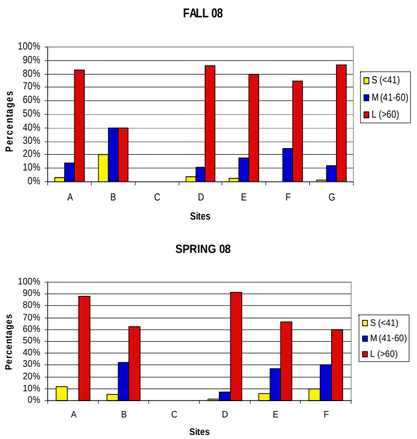


Figure 13: Size-frequency distribution amongst sites.

Literature Cited

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