The Spatial and Temporal Abundance of Fish Species on Patch Reefs in South Eleuthera

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Introduction

A patch reef (Figure 1) is a small, isolated reef, located in shallow water that acts as a transitional nursery habitat for many economically and ecologically important fish species.

Figure 1: A patch reef

Figure 2: Invasive lionfish

Figure 3: Algal-dominated reef

These important reefs are subject to many threats that could potentially restrict their ability to serve as a vital habitat and economic resource. These include overfishing (Danylchuk, 2003), the invasion of lionfish (Albins and Hixon, 2011) (Figure 2), and a major phase shift from coral to algal dominated reefs (Mumby and Steneck, 2008) (Figure 3).

One way to increase the overall health of essential marine habitats, is the establishment of a marine protected area (MPA). If located and enforced correctly, an MPA could replenish fish stocks, increase fish size, and induce spillover of fish into nearby unprotected areas (Gell and Roberts, 2003).

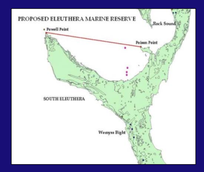


Figure 4: Proposed MPA in South Eleuthera

In 2000, the Bahamian government proposed an MPA, encompassing patch reefs in South Eleuthera (Figure 4). Since 2003, the Island School has monitored the size and abundance of fish and lobster on these reefs.

Purpose

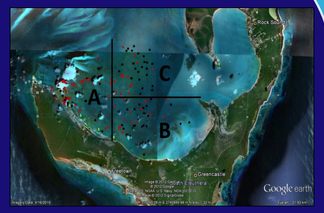
To determine the long term abundance and spatial distribution of economically and ecologically important fish species on patch reefs in South Eleuthera. The information collected can be used to inform local fishermen about fish stocks and provide policy-makers with information regarding whether or not there should be an MPA on Cape Eleuthera.

Hypotheses

- Patch reefs closest to mangrove nurseries will have a higher abundance of fish due to the easier transition between growth habitats.
- There will not be a significant change in abundance of the fish species monitored since 2003.
- There will be an increase in the abundance of lionfish on the patch reefs since spring 2012.

Methods

- Figure 5: The reefs were divided into three zones for comparative analysis. Red dots represent patch reefs surveyed, black dots are patch reefs that have yet to be visited. Green trees indicate mangrove creeks.



- Figure 6: Fish surveys were conducted by cataloging the size and abundance of all species.

- Figure 7: Rugosity, a measure of reef structural complexity, was determined by laying a one-meter long chain across a random surface of the reef and measuring the secondary length.

- Figure 8: Reef dimensions were recorded by measuring the depth, height, length, and width of each patch reef.

- Figure 9: The relative abundance of algae and coral were calculated by video taping a 50cm by 50cm quadrat placed on the reef, a minimum of 4 times. The videos were analyzed using *Vidana* computer software.

Results

Temporal Findings

Over the Fall 2012 semester 11 patch reefs were surveyed. Native species monitored since 2003 (Nassau grouper, black grouper, yellowtail snapper, queen triggerfish and Caribbean spiny lobster) did not show any significant changes in mean abundance per patch reef. Currently , the mean abundance of Nassau grouper (the most economically important finfish in The Bahamas) per patch reef is 2.4 (Figure 10). Lionfish, as predicted, did increase in abundance, however the increase from last semester was not statistically significant. Currently, the average abundance of lionfish per patch reef is 4.8 (Figure 11).

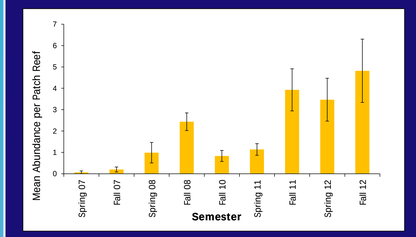


Figure 11: Mean abundance of lionfish per patch reef from Spring 2007 until Fall 2012.

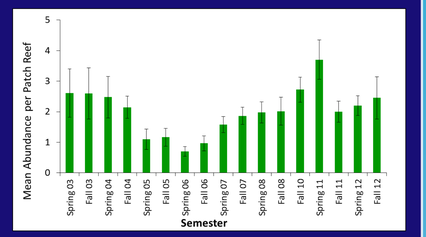


Figure 10: Mean abundance of Nassau grouper per patch reef from Spring 2003 until Fall 2012.

Spatial Distribution

- Small parrotfish (<15 cm) were significantly more abundant in zones B and C (p=0.0001) with approximately 70 per reef in zone B.
- Lionfish were significantly more abundant in zone C (p=0.001) with 22 fish per reef.
- Snappers did not have a statistically significant difference in abundance between zones, however the abundance was higher in zones B and C.
- More grouper were found in zones A and C (Figure 12), however this difference was not statistically significant.
- Red-hind grouper were only found in zone A.
- Grunts were significantly more abundant in zones B and C (p=0.001) (Figure 13) with about 300 fish per patch reef in zone B.

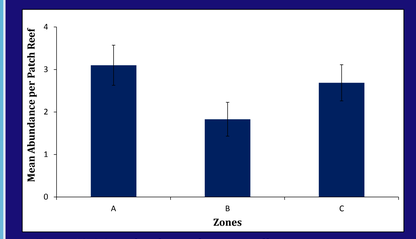


Figure 12: Mean abundance of economically important grouper in each spatial zone.

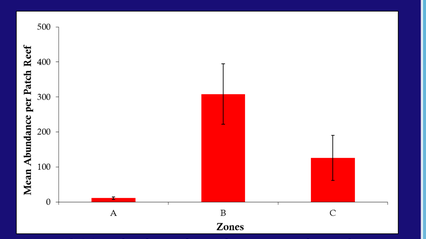


Figure 13: Mean abundance of juvenile grunts in each spatial zone.

Table 1: The number of reefs surveyed, mean area of each reef, mean abundance of fish and the mean species richness in zones A, B and C. More reefs have been surveyed in zone A than in zones B and C. There are larger reefs in zones B and C that have a higher mean fish abundance (p=0.001) and species richness (p= 0.0007).

Zone	No. of reefs surveyed	Mean area (m^2)	Mean fish abundance	Mean spp. richness
A	40	54	54	16
B	18	116	116	23
C	18	127	128	23

Discussion:

Temporal

Fish abundances of the key native species monitored did not change significantly. This follows the trend that previous semesters have witnessed. However, invasive lionfish abundance over time did, as predicted, increase; this may be due to characteristics such as high reproductive rates (Ruiz-Carus et al. 2006), no natural predators (Csányi and Dóka, 1993), and little effort to reduce their population in South Eleuthera.

Spatial

There was no direct correlation between fish abundances on patch reefs and their proximity to mangroves. This may be due to a number of factors that could impact the populations of fish species such as: reef size, coral abundance, currents, reef complexity, and surrounding habitats. Reef size and complexity in particular were generally larger in zones B and C (Table 1, Figure 5) which could provide more living, spawning, and feeding space for fish. Also, the high abundance of grouper in zone A and high abundance of grunts in zones B and C may be partially attributed to the habitats surrounding the reefs. Low relief coral with surrounding hard bottom areas prevalent in zone A are ideal habitat for red-hind grouper (Figure 13) (Lopez-Rivera, 2009) and there may be a higher density of sea grass habitat in zones B and C which are feeding grounds for grunts (Figure 14) (Grober-Dunsmore, 2007).

Conclusion

An MPA that extended from Powell Point to Poison Point in South Eleuthera (Figure 4) (zones A and B), Bahamas could effectively protect key juvenile grouper species that were most abundant in zone A, as well as a large range of species that live in zone B. However our study in zone C indicates that there is a high biodiversity and abundance of fish elsewhere, so those grounds may benefit from protection as well.

Future Research

More extensive research in zones B and C (Figure 5) would be recommended to provide more information on the fish abundance and distribution in that area. Future long term research should also consider spatial fish distributions when determining which patch reefs to survey. Studies in just one specific zone alone could potentially skew temporal abundance data.

Figure 13: Red hind grouper

Figure 14: Grunts in seagrass

Figure 15: Reef with Lionfish

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