Survey of fish abundance, habitat structure and the overall health of patch reefs in South Eleuthera, Bahamas

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Introduction

Patch reefs are small, isolated patches of coral that are transitional habitats, providing shelter and food for juvenile fish before they move on to larger coral reefs (Figure 1). They support Bahamian tourism and fishing, greatly benefiting the economy. The close proximity of patch reefs to shore makes them vulnerable to human impacts such as overfishing and coastal development.

Figure 1: A patch reef

Figure 2: Proposed marine reserve in South Eleuthera

In the past three decades there has been an 80% loss of coral cover in the Wider Caribbean (Gardner et al. 2003) and a corresponding increase in dominance of macroalgae on reefs (Hughes, 1994). Loss of coral threatens fish populations as they require the structurally complex shelter the coral provides. In 2000, the Bahamian government proposed a network of marine reserves throughout The Bahamas, including one in Cape Eleuthera (Figure 2). A marine reserve is an area where there are regulations on fishing with the goal of increasing the abundance and size of fish populations, causing them to eventually spill out into fished areas, benefiting fisherman (Gell and Roberts, 2003). An increase in herbivorous fish can reduce macroalgal abundance which could benefit coral populations (Mumby et al. 2006).

Since 2003, The Island School has collected data on patch reefs within the proposed marine reserve off of Cape Eleuthera. Through this research, the aim is to collect data showing trends in fish abundance and coral cover that will be provided to government officials who can use it to determine whether this is the best location for the proposed marine reserve.

Methods

At each patch reef, the length, perpendicular width, height, and depth were measured to calculate area (m^2).

Structural complexity was determined by placing a 1m chain in a straight line (Figure 3), a maximum of 12 times, along the surface of the reef and measuring the distance between the start and end point of the chain.

A 4-square, PVC quadrat grid measuring 50 cm by 50 cm was used to calculate the percentage of coral, macroalgae and sponge cover. The grid was placed randomly on each reef, a minimum of 4 times, and filmed using a *Go-Pro* camera. The videos were analyzed using *Vidana* video software (Figure 4).

Figure 3: Measuring the rugosity of a patch reef

Figure 4: Vidana program

Visual surveys were conducted to find abundance and size of every fish species as well as the presence of any Caribbean spiny lobster (*Panulirus argus*) and long spined urchins (*Diadema antillarum*).

Results

Identified fish were classified into 59 fish species with 1661 individuals recorded on 15 patch reefs in Spring 2012 (Figure 5).
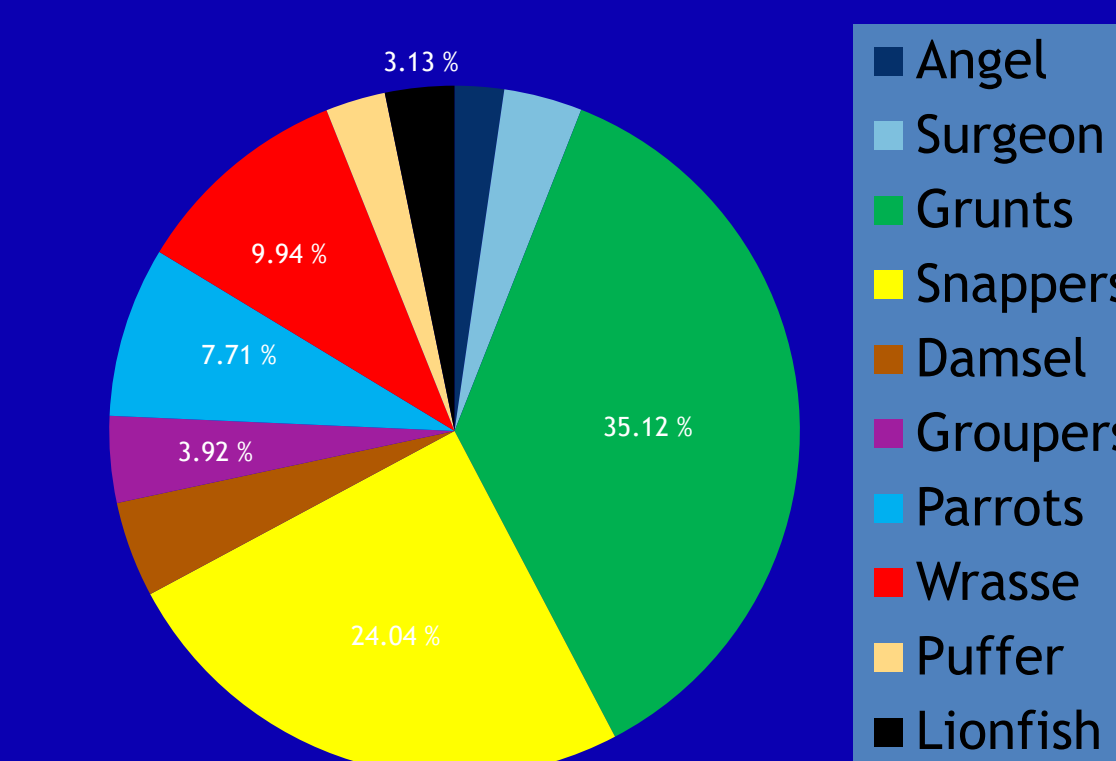
A total of 52 lionfish (*Pterois volitans*) were observed with a size range of 10cm-27cm. There was a statistically significant increase in abundance between Spring 2011 and Fall 2011 (p=0.003) but the population did not change significantly (p=0.99) in Spring 2012 (Figure 6).
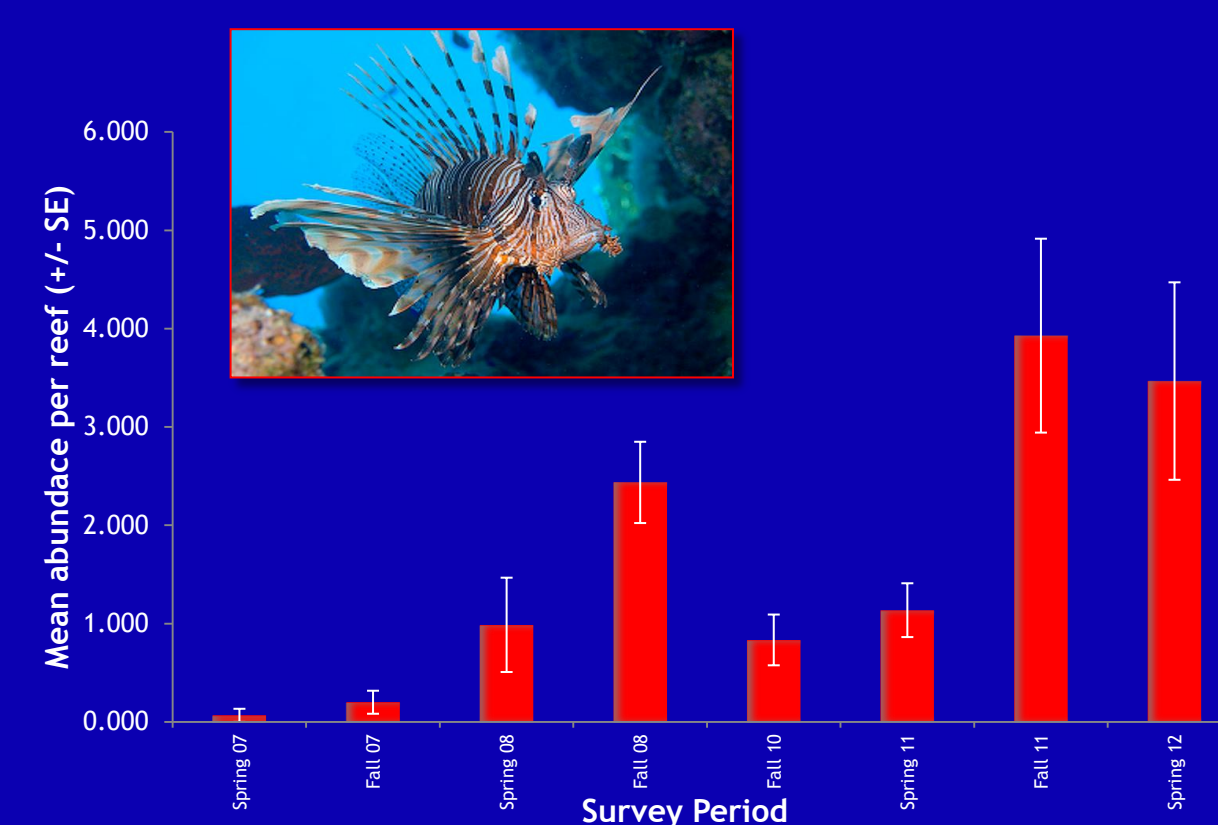
A total of 6 spiny lobster were recorded, averaging 0.27 per patch reef. There have been no statistically significant changes in abundance (p=0.261) (Figure 7).

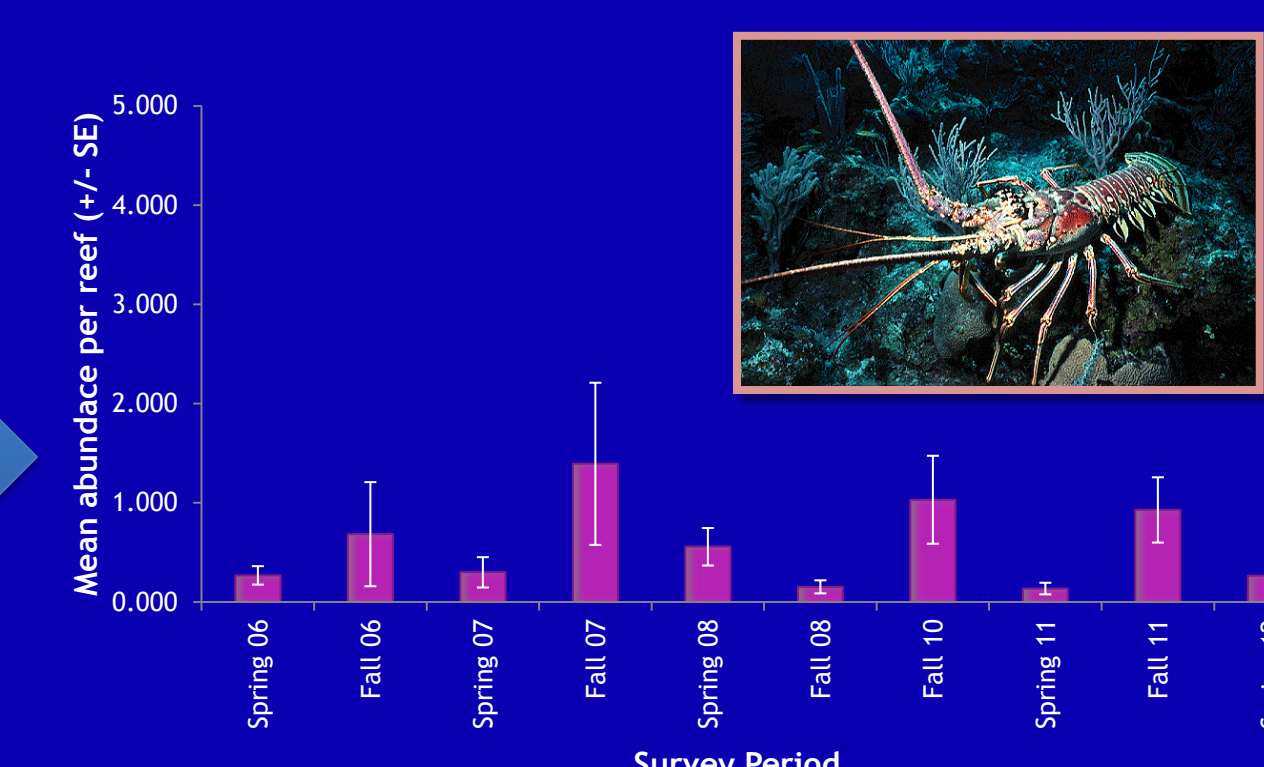A total of 65 grouper were counted in Spring 2012. Nassau grouper (*Epinephelus striatus*) accounted for 50.8% with a size range of 24-60cm (Figure 8). Black grouper (*Mycteroperca bonaci*) accounted for 9.2% with a size range of 33-70cm.
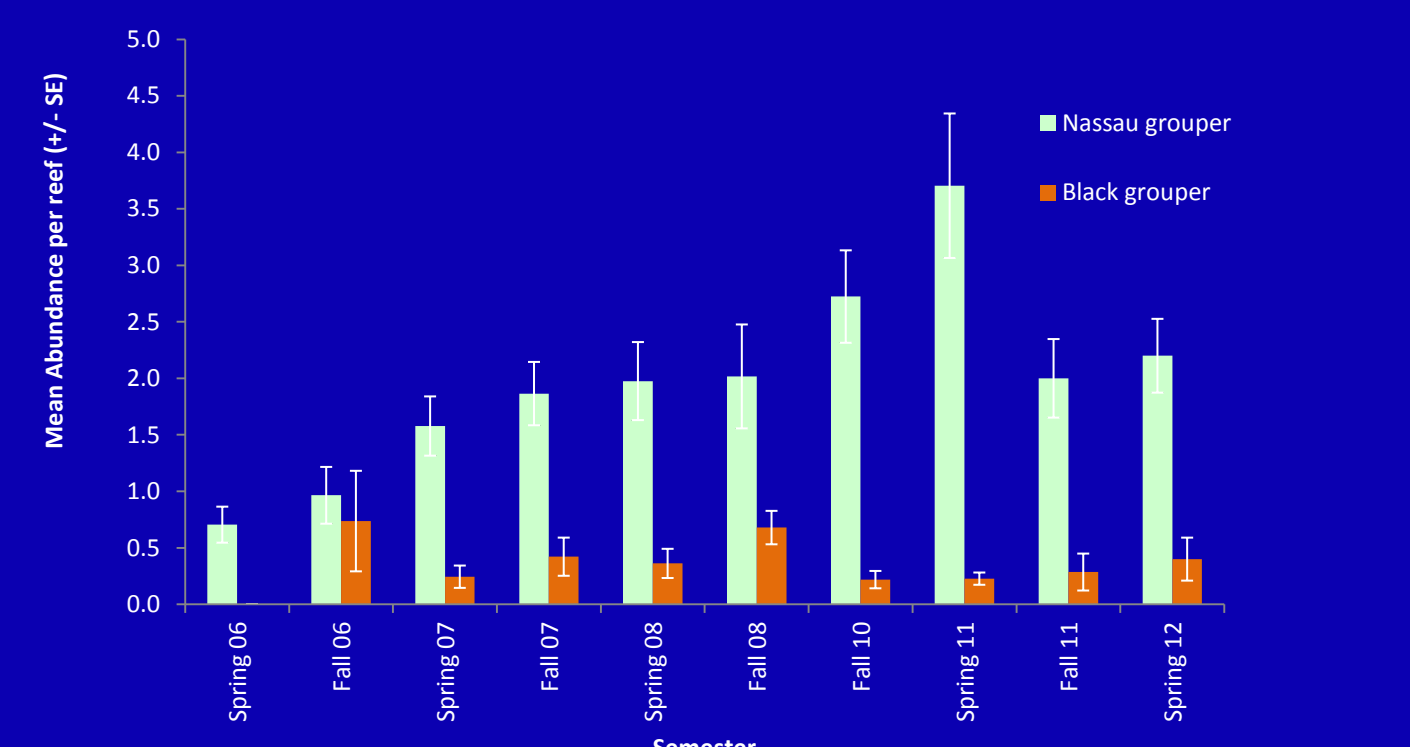
Mustard hill coral (*Porites* astreoides) was the dominant coral (57%) of the seven species recorded. Stinker sponge (*Ircinia felix*) was the most common sponge (58%). There was no significant difference between coral and algae cover (Figure 9).
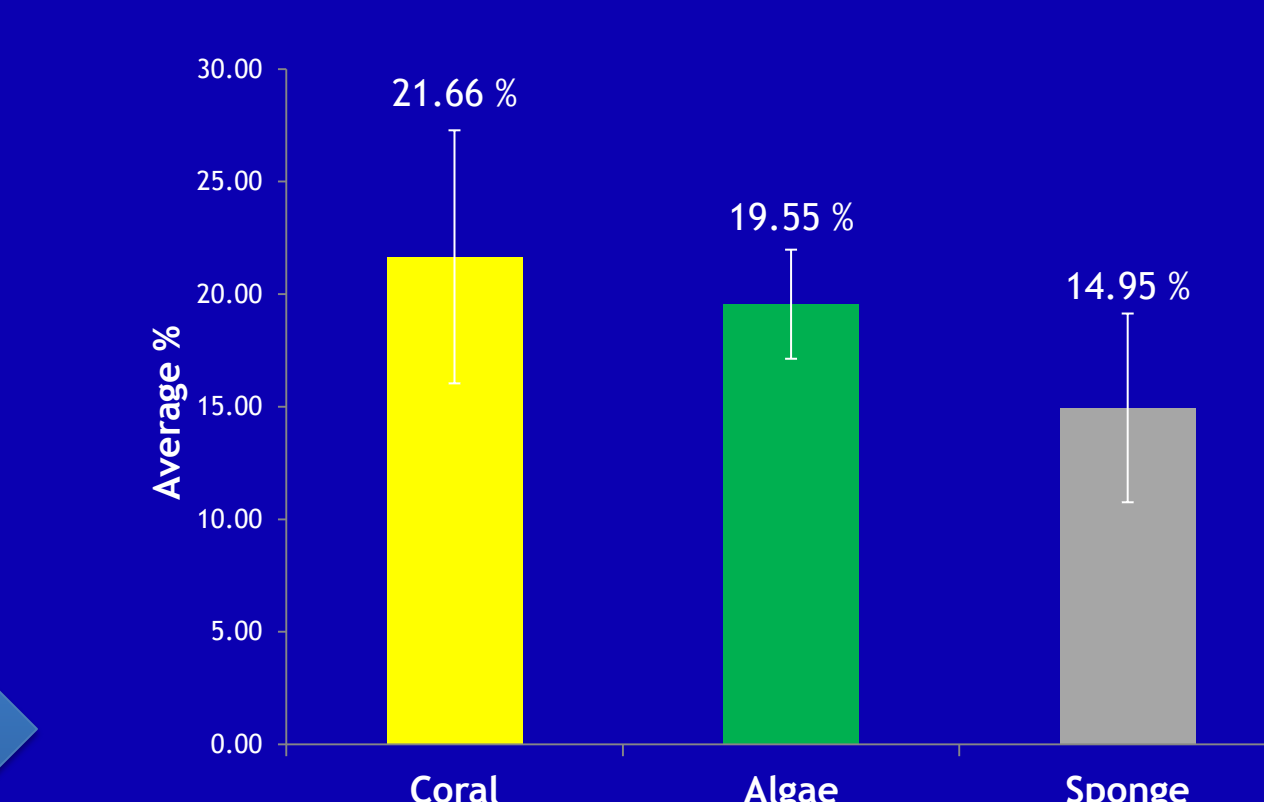
Figure 6: Mean abundance of Red Lionfish recorded on patch reefs from Spring 2006 to Spring 2012

Figure 8: Mean abundance of Nassau Grouper and black grouper recorded on patch reef sites from Spring 2006 to Spring 2012

Figure 5: Composition of fish families on patch reefs during Spring 2012

Legend: Angel, Surgeon, Grunts, Snappers, Damsel, Groupers, Parrots, Wrasse, Puffer, Lionfish

Figure 7: Mean abundance of spiny lobster recorded on patch reefs from Spring 2006 to Spring 2012

Figure 9: Reef cover of coral, algae, and sponge on patch reefs during Fall 2011 and Spring 2012

Coral 21.66% | Algae 19.55% | Sponge 14.95%

Discussion

Species Abundance

Since the first sightings of invasive lionfish in The Bahamas in 2004, populations have continued to increase. The success is due to high reproductive rates and limited predation (Albins and Hixon, 2011). Dramatic long term affects to native populations could result from the large appetite of lionfish (Albins and Hixon, 2011). Their predation on herbivous fish reduces grazing and promotes a phase shift from coral to algae. Increased removal efforts are necessary to reduce the impact.

Improved fishery regulations or enforcement may be required to increase the abundance of the economically important black grouper and Caribbean spiny lobster. The initial increase in Nassau grouper abundance observed was probably a result of the regulation created in 2004 that restricts fishing during the winter when grouper are spawning. This semester the population has remained very similar to last semester.

Coral Cover

The range (0-56.83%) of coral cover in the study area was higher than in Andros, San Salvador and Exuma Cays (2.5-22.5%)(Roff et al., 2012). Structural complexity of the reefs is important to support the inhabitants.

Mustard hill coral is the most dominant coral species on many shallow Caribbean reefs (Green et al. 2008) (Figure 10). It has a weedy growth style which may have allowed it to survive disturbances better than other coral species (Knowlton, 2001).

Turbulent waters created from Hurricane Irene in Fall 2011 probably caused the removal of macroalgae, resulting in coral cover being slightly higher. The quick growth rate of macroalgae compared to coral may cause a phase shift from coral to algae in subsequent semesters.

Figure 10: Mustard Hill Coral

Future Research

More patches and reefs should be surveyed at different depths to look for spatial and temporal trends in coral abundance and species richness. This could help determine where a marine reserve would be best suited.

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