Lionfish (*Pterois volitans*) Affecting Biodiversity of Patch Reef Species

CAPE ELEUTHERA INSTITUTE

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Introduction

Successful invasions of marine species are rare and limited research has examined their impact on invaded ecosystems (Hare and Whitfield 2003; Albins and Hixon 2008). Venomous lionfish (*Pterois volitans)*, native to the Indo-Pacific region, were recently introduced to the Western Atlantic waters. *P. volitans* have the potential to negatively impact the marine ecosystem through predation and competition with native reef species (Morris et al 2009). Since the introduction of *P. volitans* to the Atlantic, they have spread as far south as Jamaica and as far north as Rhode Island (Albins and Hixon 2008).

The rapid dispersion of lionfish throughout the Bahamas raises concerns about the health of the marine ecosystem. The density of lionfish in the Bahamas is eight times higher than in their native range (Morris et al 2009). Studies show that *P. volitans* in The Bahamas prey on both fish and crustaceans (Morris et al 2009). Small native species are relatively defenseless against *P. volitans*, allowing them to influence the biodiversity through predation and competition. The presence of one adult lionfish has been shown to reduce net fish recruitment to patch reefs by 79% (Albins and Hixon 2008). This signifies that *P. volitans* are likely outcompeting native piscivores for food and space, further reducing species abundance and diversity.

The objective of this study is to examine how *P. volitans* affect the biodiversity of patch reefs in Southern Eleuthera. Invasive lionfish will likely have a negative effect on the biodiversity and health of these reefs. The Bahamian government may use the data collected to support the creation of a Marine Protected Area (MPA) to reduce the effects of overfishing and invasive lionfish.

Figure 1. Two photographs of the patch reef team taking biodiversity surveys.

Methods

Sample Site and Reef Surveys

Visual surveys of 16 randomly selected patch reefs were conducted to assess the abundance of six key species. At each patch reef, environmental parameters, including water depth, water temperature, cloud coverage, and tide state, were taken. Physical reef characteristics, including the presence of sand halos, dimensions, and complexity, were also recorded. Four replicates are taken at each reef to reduce pseudo replication.

Manipulative Experiment

Two patch reefs where no lionfish were present were selected. One reef was manipulated by adding seven lionfish while the other reef was left as the control to compare the biodiversity between the two. Four replicates of complete reef surveys were taken on Period 1 (26/9/2009), 2 (9/10/2009), and 3 (16/11/2009) at both reefs (Fig 1).

Statistical Analysis

The Shannon Wiener Index was used to calculate the biodiversity because it takes into account species richness and evenness. The Kruskal –Wallis and Mann Whitney test, both non parametric tests, were used to compare the difference in biodiversity between the two reefs. P values were produced from these tests and significance was set at ≤ 0.05 for all statistical analysis.

Results

Reef Surveys

Lionfish, queen triggerfish, spiny lobster, and Nassau grouper have showed significant changes in abundance since 2004 (Fig 3). Mean lionfish abundance have increased exponentially since their first sighting by Island School students in Spring 2007 ($p = 0.001$). Queen triggerfish abundance has declined greatly since Spring 2007 ($p = 0.002$), which directly correlates with the time that lionfish populations began to increase greatly. Nassau grouper population changes were seasonal ($p = 0.003$). There was a significant increase in lobster populations in Fall 2009 ($p = 0.001$). Although lionfish compete with lobster, both populations were highest this semester. However, 13 spiny lobsters were spotted on one patch reef, raising the overall average. Lionfish have seen the greatest and most rapid increase of the six key species in the past 5 years.

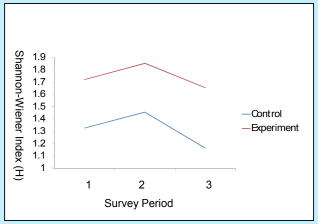

Figure 2. Changes in biodiversity between the control and manipulated reef during the semester using the non-parametric Shannon-Wiener Index.

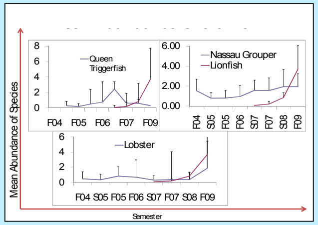

Figure 3. Comparisons of the mean abundance of 3 key species (queen triggerfish, Nassau grouper and spiny lobster) and lionfish abundance over the past five years.

Manipulation Experiment

There was no significant change in biodiversity on the manipulated reefs ($p = 0.57$, Fig. 2). The biodiversity increased during the second survey period and decreased during the third survey period on both the control and manipulated reefs. The largest change in species richness on the control reef was a 22% decrease between the first and second survey period. There was an increase in species richness from period 1 to 2 followed by a decrease in species richness on the manipulated reef between periods 2 and 3 (Fig. 4). Grunts, snappers, damselfish, and parrotfish exhibited a noticeable decrease in abundance between period 2 and 3 (Fig 5). The seven lionfish added distributed across the complex manipulated reef and only 5 were observed at the end of the experiment.

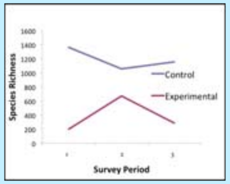

Figure 4. Change in species richness, S between the control and manipulated reef during the semester.

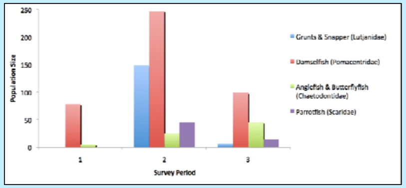

Figure 5. Changes in mean abundance of three families of reef fish over the semester on the experimental reef.

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Figure 6. *Pterois volitans*, commonly known as lionfish.

Discussion

This study did not show that lionfish (*Pterois volitans*) negatively affected patch reef biodiversity in South Eleuthera this semester. There was no significant change in biodiversity on the control and manipulated reef, contradicting the findings of Albins and Hixon (2008) (Fig. 2).

Albins and Hixon (2008) demonstrated that lionfish may have a role in altering community structure. In this study, fluctuations in the mean abundance of damselfish, grunts, snappers, and parrotfish were noted (Fig. 5). Increased competition and predation of lionfish on these species could account for the decrease in species richness observed in period 3 (Fig. 5). As gape limited predators (Morris et al 2009), lionfish are unable to prey on adult size angelfish that were present during the third survey period.

There has been a change in marine ecosystems of the eastern Atlantic as invasive lionfish continue to increase in distribution and abundance (Morris et al 2009). Effects of this invasion may be alleviated if the ecosystem was healthier. MPAs can be created to allow species targeted by fisheries to replenish and thereby restock the competitors and predators of lionfish (Mumby et al 2006; Hare and Whitfield 2003).

Future studies should examine multiple experimental reefs of similar characteristics. In this experiment, the control and experimental reefs differed in both size and complexity, and studies show that biodiversity is higher on more complex reefs (Maragos et al 1996). An increased number of reef surveys need to be conducted over a longer duration to observe seasonal trends.

Figure 7. Two lionfish at the manipulative reef

Figure 8. Patch reef student observing the reef to check for any fish

Acknowledgements

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