Biotic Factors that Influence Re-colonization of Lionfish (*Pterois volitans*) on Patch Reefs in South Eleuthera

By: Lucy Cram, Natalie Grune, Kyle Forness, Gabriel Taliaferrow, Ann-Marie Carroll, and Eric Witte
Skylar Miller, Jason Selwyn

Introduction

Lionfish (*Pterois volitans*) are native to the Indo-Pacific Ocean and were introduced into the Atlantic ocean off the coast of Florida as a result of aquarium trade (Morris and Akins 2008). Broadcast spawning and frequent reproduction coupled with major ocean currents have aided in the rapid geographic spread of lionfish (Fig. 1). Lionfish were first reported in the Bahamas in 2004 (Morris and Akins 2008).

Figure 1. The red dots along the eastern coast of America and the Caribbean represent reported sightings and the spread of lionfish as of 2011.


Figure 2. A red lionfish, *Pterois volitans*, hovers on a reef.

Specialized feeding techniques, such as herding and directed water jets (Morris and Akins 2009, Albins and Lyons 2012) have enabled lionfish to become efficient predators in their invaded range, thereby adding new stressors to economically and ecologically important native species (Fig. 4). Lionfish do not have any known native predators in areas they have invaded, due to their venomous spines (Morris *et al.* 2009). The effects of these factors have been seen in 79% decreases in recruitment rates of reef fishes (Fig. 3) and have strongly disrupted the natural food web (Albins and Hixon 2008).


Figure 3. The juvenile stoplight parrot fish is a prey species for lionfish.


Figure 4. Yellowtail snapper are competitor species for lionfish.

A previous study at the Cape Eleuthera Institute (CEI), running since 2009, has focused on the removal of lionfish on patch reefs in South Eleuthera. A new focus is to observe the re-colonization of lionfish to these previously managed reefs. Modeling shows that frequent removal efforts are more effective than less frequent, larger-scale removal efforts. (Arias-González et al. 2011) It is valuable to know how frequently removals need to occur to eradicate lionfish from a reef. Understanding recolonization patterns of lionfish in South Eleuthera will aid in the development of an effective regional management plan.

Purpose and Hypotheses

The purpose of this project was to study the biotic factors, including prey, competitors, and conspecifics, that influence the re-colonization of lionfish on 12 patch reefs in South Eleuthera.
It was predicted that prey, competitors, and con-specifics would all positively influence lionfish re-colonization on patch reefs.

Methods

Since November 2011, data has been collected from 12 patch reefs in Rock Sound, Eleuthera (Fig. 5), which have been part of a CEI study since 2009. Using SCUBA (Fig. 6), populations of competitors and prey (Table 1) were surveyed along 8x2m transects, while the total number of lionfish were counted at each site (Fig. 7).

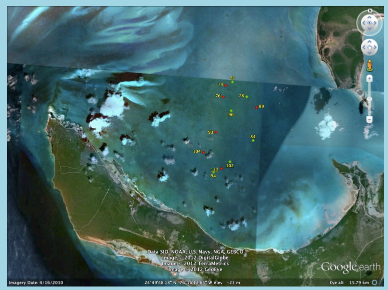

Figure 5. Rock Sound, South Eleuthera hosts the 6 no removal (green dots) and 6 full removal (red dots) sites surveyed.

Prey Species	• French Grunt • White Grunt • Tomtate • Slippery Dick • Blueheaded Wrasse • Yellowheaded Wrasse • Puddingwife • Redband Parrotfish • Stoplight Parrotfish • Striped Parrotfish
Competitor Species	• Mutton Snapper • Mahogany Snapper • Yellowtail Snapper • Grey Snapper • Nassau Grouper • Black Grouper • Graysby • Red Hind

Table 1. Lionfish prey include a variety of grunts, wrasses, and parrotfish, while their competitors are species of grouper and snapper.


Figure 6. A diver surveys along a transect, looking for prey.

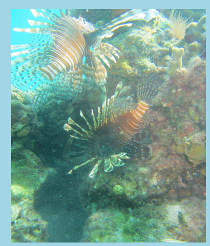
Figure 7. Two lionfish lurking on the reef are added to the lionfish count during the survey.

Results

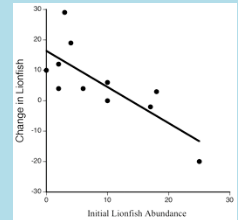

Figure 8. There is a significant negative trend of initial lionfish abundance to the change in lionfish over the course of the experiment (p=0.005).

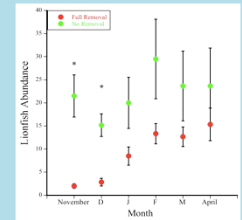

Figure 9. The average change in abundance of lionfish as a function of time (months) on full removal (red) and no-removal (green) sites, asterisks indicate significance.

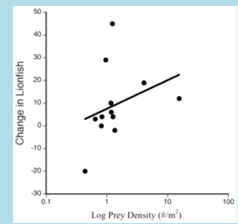

Figure 10. There is no significant effect of prey density (prey/m^2) on the change in lionfish over the course of the experiment (p=0.32).

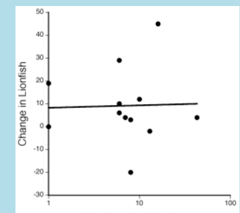

Figure 11. Competitor abundance shows no significant effect on lionfish re-colonization (p=0.93).

Lionfish re-colonization was significantly negatively affected by the initial abundance of conspecifics on a reef (Fig. 8, p=0.005, r^2= 0.60). Lionfish re-colonization was not influenced by prey (Fig. 10, p=0.32, r^2=0.10) or competitor (Fig. 11, p=0.93, r^2=0.001) densities. Full removal sites show a steady increase in lionfish re-colonization from November to April (Fig. 9, p= 0.004). No removal sites show no significant change in lionfish re-colonization (Fig. 9, p=0.82).

Literature Cited

- Albins, M. A. and Hixon, M. A., 2008. Invasive Indo-Pacific lionfish *Pterois volitans* reduce recruitment of Atlantic coral-reef fishes. Marine Ecology Progress Series 367: 233-238.
- Albins, M. A. and P. J. Lyons. 2012. Invasive red lionfish *Pterois volitans* blow directed jets of water at prey fish. Marine Ecology Progress Series 448: 1-5.
- Morris, J. A. and Akins, J. L., 2009. Feeding ecology of invasive lionfish *(Pterois volitans)* in the Bahamian archipelago. Environmental Biology of Fishes 86: 389-398.
- Morris, J.A., Akins, J.L., Barse, A., Cerino, D., Freshwater, D.W., Green, S.J., Muñoz, R.C., Paris, C. and Whitfield, P.E. 2009. Biology and Ecology of the Invasive Lionfishes, *Pterois miles* and *Pterois volitans*. Gulf and Carribbean Fisheries Institute 61:1-6.
- Arias-González, J. E., González-Gándara, C., Cabrera, J. L. and Christensen, V. 2011. Predicted impact of the invasive lionfish *Pterois volitans on the food web of a Caribbean coral reef. Environ Res: 1-9.*

Discussion

Removal
Lionfish recolonization indicated a negative density-dependent relationship, which indicates a possible carrying capacity. This could be a reason that lionfish did not re-colonize to the no removal sites (Fig. 5). This shows that a carrying capacity may influence how quickly lionfish colonize other reefs, where there may be limited resources like prey and territory. Also a carrying capacity means there is a limit to the impact lionfish can have on a reef. This study found that only two months after ending removal efforts the abundance of lionfish on the full removal sites was the same as the no removal sites (Fig. 9). Thus, to effectively maintain a minimal level of lionfish, removal is necessary every two months. These data indicate that Lionfish Derbies may not be a particularly effective management strategy as they occur only infrequently. The development of a lionfish fishery could serve as an effective removal strategy as this could lead to a fairly high removal frequency.

Prey effects
This study also shows that the prey species surveyed had no significant effect on the re-colonization of lionfish


Figure 12. Lionfish prey on crustacean species like the emerald crab.

(Fig. 3). Juvenile lionfish prey primarily on crustaceans, (Green unpub. Fig. 12) rather than juvenile reef fish. Further research is needed to determine if juvenile life stages are more important to re-colonization than adult stages. This could lead to crustaceans acting as a more influential factor in re-colonization than small reef fishes.

Competitor effects
The study does not indicate that competitors affect the re-colonization of lionfish (Fig. 4). Lionfish have been shown to be particularly effective competitors (Morris et al. 2009) with out results supporting the idea that lionfish are able to outcompete any competitors leading to competitor abundance not influencing re-colonization.

Future work
Future research could include surveying other biotic factors, such as crustaceans. Abiotic factors including coral cover, rugosity, and current patterns could also be factors that influence the re-colonization of lionfish. With the combination of these factors, new trends could be found which could help in developing new, more effective removal methods of lionfish.