# Effects of invasive lionfish on benthic fauna in shallow, near-shore environments on Andros Island, The Bahamas

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**Abstract**

Lionfish is an invasive species to the Caribbean Sea causing a disturbance to native fauna. As a large predator in the Caribbean, this species has effects on local trophic levels. By studying population sizes of smaller prey animals in areas where lionfish population have flourished in comparison to population sizes of small prey animals where lionfish are not present, we can better understand their impacts on native animals. With data collected in 12 different areas on the island, the experiment will show that the population of benthic fauna will increase as the danger of lionfish are removed. The increase of this invasive species has negative implications towards the population of small prey and creates competition for nutrients and food in an already stressed and sensitive ecosystem. The results support research of other group in the Caribbean, in regards to the effects of lionfish; while also adding information to how lionfish affect the near-shore ecosystem of the Bahamas specifically.

## Introduction

The International Union of Conservation of Nature reports that there are approximately 500 alien marine species within the coastal waters of the United States (DePoorter, IUCN website). While not all alien invaders have a detrimental impact on their new home away from home, there are many examples of the potentially disastrous impacts of these introductions. In 1985 the zebra mussel (*Dreissena polymorpha*), a European native, was accidently introduced to North American waters via ship ballast (Mack et al, 2000). This bivalve not only out-competed the

native mussels, smothering entire populations, but has cost millions to clean from intake pipes, water treatment plants & varied other water pathway infrastructures. The tilapia, an example of intentional introduction of an exotic species for control of aquatic plants and insects as well as a food fish, had a number of unintended consequences upon the environments to which it was dispatched. Impacts included displacing native species and changing food webs, thereby radically altering the ecosystems to which it was introduced (Marine Invasive Species, National Park Service publication). Therefore it is of paramount importance to understand the potential impacts of a non-indigenous species to an ecosystem, whether its placement is intentional or not.

There are numerous sources in research and scientific literature that propose just that – an organized analytical approach to understanding and possibly predicting outcomes of invasive species. A group of researchers (Mack et al, 2000), propose a 'guilty until proven innocent' approach as a "productive first step" in anticipating potential invaders and taking effective steps to prevent their distribution and establishment. These delineations and predictions of impacts can be further complicated by the invasive species interactions with natives, humans, and local environmental conditions (Poulos et al, 2012). Furthermore, most researchers and documenting scientists agree that once an invasive species gains numbers and range, they are nearly impossible to eradicate.

The subject of our study, *Pterois volitans* and *P. miles*, two morphologically similar species of lionfish native to the Indian and Pacific Oceans, have spread throughout the eastern coast of the United States extending south to the Caribbean Sea and the Gulf Mexico. Though the first documented capture of a lionfish in this non-native range was in 1985 off Dania Beach, Florida (Morris & Akins, 2009), the causal event of the introduction of lionfish that resulted in the current invasion was thought to have occurred during Hurricane Andrew in 1992 from private

aquariums around Biscayne Bay, Florida (Côté & Maljković, 2010). With the first lionfish sightings in 2004 and a proposed mechanism of spreading lionfish larva via ocean currents, the Bahama archipelago (Morris & Akins, 2009) has become the focus of numerous studies on the invasive impact of the lionfish.

It is the opinion of a number of researchers that lionfish pose a major threat to coral reef ecosystems in the Bahamas. They have been shown to out-compete and prey upon a wide range of native reef animals (Côté & Maljković, 2010). As with some other highly successful invasive species, lionfish have an advantage whereby their prey never saw them coming. Lionfish are known for their voracious appetites. They use their exaggerated spiny fins to round up and corner prey, fan the sea bottom to flush out crabs, shrimp or juvenile fish, or to deliver venom that is potentially fatal to an adversary (Albins & Hixon, 2011). In short, they out-compete native species. With few documented natural predators in their native habitat (Albins & Hixon, 2011), the potential for compounding ecological effects in their non-native waters seems unavoidable. Grouper are considered a significant potential predator of lionfish. Unfortunately, the grouper's status as a prized food fish has led to overfishing and is not present in enough numbers to control lionfish population growth (Albins & Hixon, 2011).

While the literature reviewed in preparation for our study has been about the effects of lionfish on reef ecosystems, our focus will be on the near-shore environment and benthic fauna. Trays containing benthic fauna will be placed in shallow water. Each tray will receive a single lionfish with a matching set of control trays with no lionfish. The experiment will include a survey or inventory of the starting and ending populations, observations of feeding habits of the lionfish and its interactions with native animals. The goals will be to 1) inventory food types of the lionfish 2) document feeding approaches 3) observe interactions with other species.

To date there has been no research studies done on the effects of the lionfish in the near shore habitat. Our experiment has potential to show any undiscovered traits or adaptations that the lionfish may employ in this particular habitat or maybe vulnerabilities that can be exploited to control their spread and impact on the area.

**Methods**

**Study site.** This study will be carried out in July of 2013 off of Andros Island, Bahamas. Twelve pairs of benthic trays will be distributed along the research site. Each pair of trays will be placed approximately 20 meters apart, while adjacent pairs of trays will be placed approximately 50 m apart. The trays will be placed on a mostly North-South linear transect (see Fig.1.1). An initial survey of each site will be taken to ensure that no lionfish are present during the installation of the benthic trays. One tray per pair will be designated as a control tray, and will have no lionfish introduced. The other tray in each pair will be a treatment tray and will receive a lionfish introduction. Single lionfish will be brought into each of the research sites from nearby populations using gloves, hand nets, and vinyl collection bags, and released into the treatment site (Morris 2012).

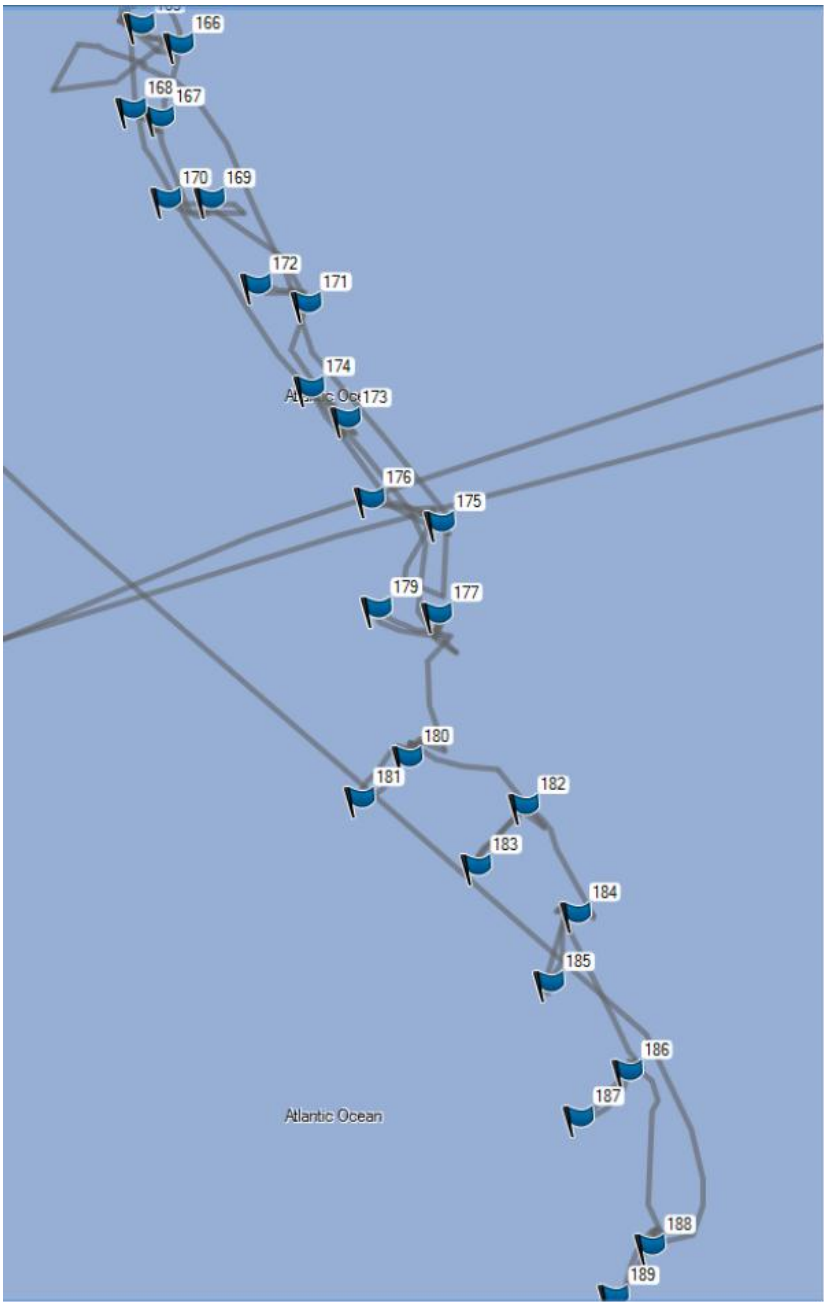


**Figure 1.1:** Distribution of 12 pairs of benthic trays within the research site in Andros Island, Bahamas

**Field Observations**

Observations of the lionfish will be made twice daily; once in the morning and once later in the afternoon to best capture potential lionfish hunting activity as well as benthic organism activity. Underwater surveys, pictures, and videos will be utilized in order to track the lionfish movements and predatory habits, as well as the response of the benthic organisms to the introduced invasive predator. At the conclusion of the experiment, each tray will be lifted out of the water, and all of the organisms will be removed, identified, and counted. This sampling of various benthic organisms will allow the impacts of the lionfish to be observed in terms of how lionfish affect benthic organism abundance, as well as how the presence of a predator affects the community structure of the benthic tray. This information will then be compared to the control benthic tray consisting of an environment without lionfish.

**Potential Results**

We hypothesize that our potential results will conclude that lionfish are posing threats to the community structure of benthic animals. According to a previous study conducted in Bahamian coral reefs lionfish introduced to non-native habitats have the potential to severely damage the already declining populations of prey (Cote & Maljkovic, 2010). This leads researchers to believe that lionfish are better competitors against natives when it comes to finding food. Another study concluded that trophic impacts of lionfish could alter the entire structure of the native fish communities (Morris & Whitfield, 2009). One example of this is that lionfish are responsible for the decrease in herbivorous reef fish populations. These macroalgal grazers are important for microalgal growth, recruitment and recovery after disturbances (Barbour et al., 2010). This indicates that these exotic fish are causing more destruction than just reducing prey numbers and are possibly reducing shallow near-shore fauna. This could

negatively impact the smaller native species of fish if habitats are unavailable and cause malnutrition which may stunt growth and cause a reduction in spawning numbers.

Other results to consider are economic impacts that these fish are having in the Bahamas. Fish are important resources to the community and if evidence suggests that fish populations or fauna is declining this could severely disrupt the economy. A study was conducted to assess the damage in Jamaica and although a true economic impact can't be derived since there are numerous invasions it's safe to say this is an extremely costly problem. Money will have to be allocated to mitigate and manage the invasion (Moonsammy et al., 2012). Ultimately, we hope to find how much destruction is occurring in these shallow waters to have the ability to implement new rules and regulations. Along with these new regulations more education programs will become available to help protect the waterways and regenerate new native species of fish.

**Implications of Findings**

The results of our research could lead to many possible implications. If our research yields findings that show lionfish pose a severe threat to benthic fauna found in shallow, near-shore ecosystems, we would validate the notion that lionfish are harming the coral reefs around the Bahamas. We could also conclude that solving or more likely mitigating the presence of lionfish is a top priority. Our research efforts and results may or may not show that lionfish negatively affect the local reef ecology in the Bahamas and thus could then be applied more broadly to other Caribbean islands or similar areas where lionfish are also found as an invasive species. The findings could bring more attention to this pressing issue, which not only affects marine ecology but also the economy. Island nations like the Bahamas rely heavily on natural resources; many of which are marine resources such as fish, conch, lobster, and many more to

stimulate the economy and provide income or food for its population. It is possible that the presence of lionfish could place added pressures on other marine animals that also inhabit the same reefs, which are sold commercially or eaten. This ecological pressure in the form of predation or resource competition could lead to local extinctions of aesthetic and monetarily valuable species. Confirmation of this fact could lead to local or possibly national programs or initiatives to combat the lionfish epidemic and in general all invasive species. Some examples could be increasing awareness to the public, creating tournaments to catch and kill lionfish for sport, creating a market for lionfish meat for human consumption, and could lead to other studies conducted in the area, among the numerous possibilities.

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