Investigation of Lionfish (*P. volitans/miles*) Use of Estuarine Mangroves in the Indian River Lagoon, Florida, USA

Estudio del Uso de los Manglares Estuarinos de la Laguna Indian River de la Florida (EE.UU.) por el Pez León (*P. volitans* y *P. miles*)

Etude de L'utilisation par le Poisson-lion (*P. volitans/miles*) des Mangroves Estuariennes dans la Lagune de L'indian River, Floride, Etats-Unis

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ABSTRACT

Since 2008 the invasive lionfish (*Pterois volitans/miles*) has been reported along man-made structures and mangroves in Florida's Indian River Lagoon (IRL), one of the most biodiverse estuaries in the U.S. With limited research on estuarine lionfish, our objective was to examine their presence in the IRL, specifically in the mangroves. We conducted this study within 5 km of five major inlets of the IRL from April 2013 to September 2013, surveying a variety of habitats, examining size, diet, gonad stage and site fidelity. Including pilot data from 2012, we found a total of 132 lionfish in IRL, with 73 in the mangroves. Our size and reproductive status data suggest an estuarine resident population. Our tagging effort found lionfish exhibiting fidelity for up to three months. Diet analysis revealed a prevalence of demersal teleosts and decapods, including commercially important species such as *Farfantepenaeus duorarum* and *Callinectes spp*.

KEY WORDS: Lionfish, mangroves, estuarine, biodiversity, invasive

INTRODUCTION

Estuarine and coastal ecosystems are some of the most anthropogenically exploited and threatened ecosystems on the globe (Barbier et al. 2011). Many factors pose a threat to coastal zones including rapidly growing human populations, deterioration of environmental quality, loss of habitat, overfishing, reduced biodiversity, and increasing vulnerability to natural hazards (Westmacott 2002). Such threats have not spared one of the nation's most biodiverse and critical fisheries estuaries, the Indian River Lagoon (IRL) (Tremain and Adams 1995) in east-central Florida, USA. Covering the temperate-tropical ecotone, much of this unique estuary is considered 'Essential Fish Habitat'for many managed species, including the snapper/grouper complex, as designated by the South Atlantic Fisheries Management Council. The health and function of the habitats in the IRL and the communities they support are currently facing an additional threat, the invasive Indo-Pacific lionfish (*Pterois volitans/miles*).

Reports of this highly invasive predator's presence in the IRL started in 2008 (USGS). Currently there is only one study examining the lionfish estuarine intrusion by Jud et al. (2011). They found lionfish as far as 4.1 miles up the Loxahatchee River (Jupiter, Florida) in salinities less than 10‰. This study firmly suggests that continued research on lionfish presence in estuaries is needed, emphasizing the potential impacts that they might have on these already vulnerable ecosystems. Additionally, attention has been drawn to the need to research lionfish presence in mangroves, an essential fisheries habitat in many subtropical/tropical estuaries. After researching mangrove use by lionfish in the Bahamas, Barbour et al. (2010) strongly suggested the expansion of current management actions to include targeting lionfish in the mangroves. They also discussed the importance of monitoring less-trafficked areas, as the potential for lionfish colonization is high. Colonization of mangrove nursery habitat coupled with existing populations offshore, potentially increases juvenile-stage mortality of native ecologically and economically important fish, raising great concern for coastal ecosystem functionality (Barbour et al. 2011). Therefore, this study aimed to examine the presence of lionfish in the IRL, while focusing on lionfish use of the mangrove habitat. This was done by examining size structure, diet and reproductive condition of lionfish found in a variety of estuarine habitats, including mangroves. Additionally, we examined mangrove microhabitat characteristics and employed a tagging effort to examine fidelity in the mangroves.

METHODS

We conducted underwater visual surveys while snorkeling in a variety of habitats (mangroves, natural ledges, docks, riprap, seawalls) within 5km of all five inlets of the IRL April 2013 to September 2013. Pilot surveys were also conducted in summer of 2012. Sampling frequency and spatial extent differed between the inlets. Primary sampling locations were the Fort Pierce and St. Lucie Inlets. Large continuous belts were run parallel with the shoreline starting in the inlets and then moving either up or down river. Surveying was done opportunistically, between sunrise and sunset, surrounding high tide to maximize visibility (more than 1m). Lionfish were captured with hand nets and pole spears and immediately put on ice.

Additionally, five lionfish used in this study were donated from an inlet marine debris cleanup event and on one occasion SCUBA was used to survey natural ledge along the north ICWW in Fort Pierce.

Mangrove surveys consisted of continuous belts along the mangrove fringe of main shores, islands and channels. Primarily mangroves that were greater than .5 m deep at MLW were surveyed. Water visibility was the main limiting factor influencing the extent and location of mangroves surveyed. Mangrove surveys were thorough, making sure to examine under peat banks, amongst roots and in little cuts and channels. Surveys in the mangroves were more extensive in the Fort Pierce Inlet area due to an on-going mark-recapture study.

Offshore lionfish were obtained while using SCUBA. Specimens were collected from six different locations (water depth range 22 - 26 m) within 25 km of the Fort Pierce Inlet. Surveys were conducted along natural ledge, a locally predominant deep water habitat, making sure to thoroughly examine the bottom and top sides of ledge to account for all sizes of lionfish. Lionfish encountered were either captured with bags (smaller lionfish) or killed with a spear pole and put on ice upon reaching the surface.

The tagging effort followed methods employed by Jud and Laymen (2012) in which both a unique number (floy-fingerling tag) and a unique sequence of colored beads was sutured into dorsal muscle to allow for underwater identification of individuals. Tagged lionfish were caught using hand nets, anesthetized using tricaine methanesulfonate (MS222) mixed with aerated seawater (100 mg/l) and measured for standard and total lengths. Following tagging, fish were placed into aerated seawater until fully recovered and released back to exact capture site. Mangrove micro-habitat characteristics were measured at each unique location of lionfish capture/sighting. Depth was measured with a calibrated tape and adjusted to MHW based on growth on roots. We estimated size for sighted/un-captured fish (2 out of 127).

Dissection, diet analysis, and identification of gonad stage followed methods by Green et al. (2012). When dissecting for gut contents, we measured the volume of each prey item and identified them to the lowest possible taxon.

RESULTS

Mean TL (± SD) of all captured/sighted estuarine lionfish (n = 127) was 179.7mm ± 61.3mm, (range 55 - 320mm). Amongst that population, the mean TL for lionfish found in the mangroves (n = 68) was 154.6mm ± 52.1mm, (range 55 - 243mm) and the mean TL for lionfish captured in all other estuarine habitats (n = 59) was 208.7mm ± 58.5mm (range 80 - 320mm). Mean TL of lionfish sampled offshore (n = 151) was 211.5 ± 53.2mm (range 116 - 376mm).

Mean TL was significantly smaller in sampled inshore lionfish than offshore lionfish ($p < .005$) (Figure 1) and mean TL of mangrove lionfish was significantly smaller than all other estuarine habitats ($p < .001$) (Figure 2). Of the lionfish dissected from the mangroves (n = 24) (Figure 3), we were not able to identify sex of 18 due to small sizes, yet we were able to identify six as females with early developing gonads.

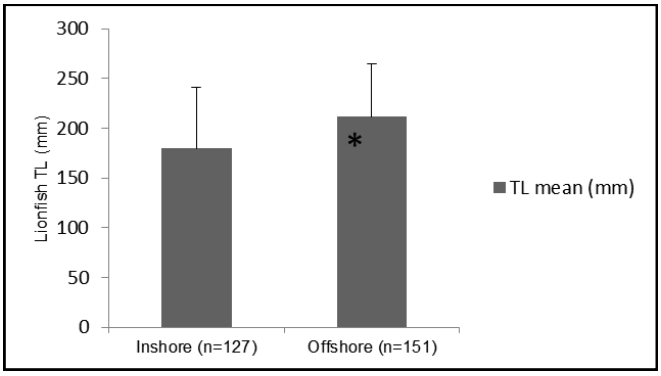

Figure 1. Comparison of lionfish mean TL (mm) between inshore and offshore populations.

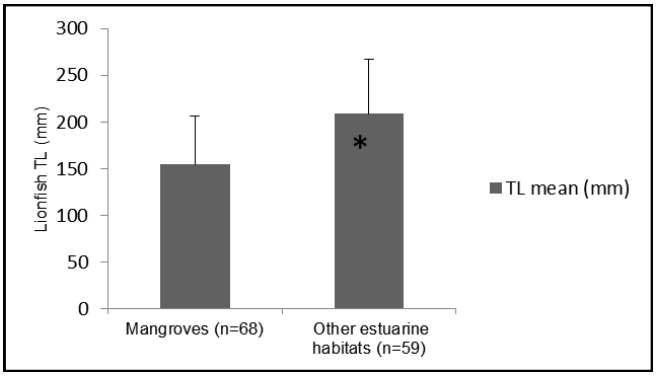

Figure 2. Comparison of lionfish mean TL (mm) between mangroves and estuarine habitats.

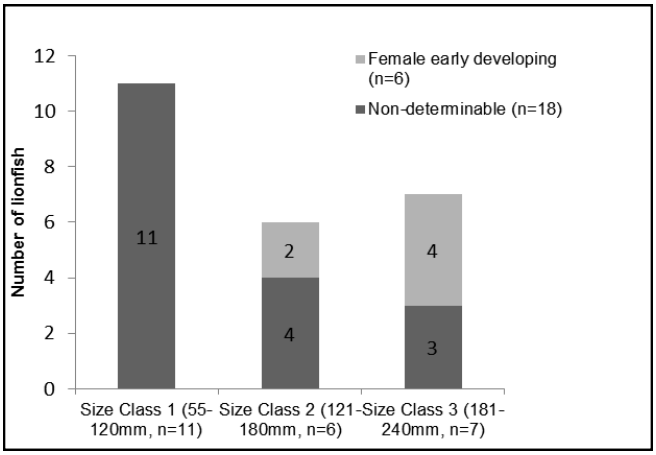

Figure 3. Gonad stages for mangrove lionfish (n = 24).

Two of these were in the size class of 121 - 180 mm (TL) and four in size class 181 - 240 mm. In all other estuarine habitats (n = 57) (Figure 4) we were not able to determine sex or gonad stage of any fish from 55 - 120 mm (n = 7). We were able to identify three early developing gonads in three females in size class 121 - 180 mm (n = 4) and 13 in size class 181 - 240 mm (n = 29). In addition, we identified 2 spawning capable males and 1 immature male in the latter size class. In the next size class (241 - 300 mm) (n = 15), we were able to identify four early developing females and four spawning capable males. In the largest category (> 300 mm) (n = 2), we identified one as an early developing female and one as a spawning capable male.

Diet of all estuarine species (n = 89) (Figures 5 and 6), by volume, consisted of 18% decapod crustaceans, 72% teleosts and 10% was unidentifiable material. By number, decapod crustaceans made up 53% and teleosts made up 47%. Eighty-two out of the 89 (92%) stomachs contained prey items. Teleost families represented were Blenniidae, Labrisomidae, Haemulidae, Pomacentridae and decapod crustaceans were Xanthidae, Porcellanidae, Portunidae, Panaeidae and Palaemonidae. Strictly in the mangroves, 34 out of the 38 (89%) stomachs contained prey items. Teleost families represented were Gerreidae, Labrisomidae, Blenniidae and decapods were Palaemonidae, Panaeidae, and Sesarmidae.

In the mangrove habitat, lionfish (n = 73) were first sighted not only directly in the mangroves, but in and around associated structure. We found 36% directly in the roots, 33% more than 1 m off the roots (within 5 m), 18% under peat banks and 14% within 1m off the roots (Figure 7). Most (90%) of these fish were associated with erosional mangrove shorelines and 10% with depositional. Average depth of sightings was 1.6 m, (range .5 - 3.35m).

Out of 27 tagged lionfish in the mangroves, 17 were recaptured (sighted) at least once (63% recapture rate). Seven fish were spotted in the exact initial sighting spot for at least 50 days and one for 92 days. We were able to physically recapture five individuals during the tagging study (range 38 - 58 days in between captures) and found their average growth rates to be .39 mm/day.

CONCLUSION

There are more lionfish present in the Indian River Lagoon than previously reported. As we concentrated our efforts within 5 km of inlets, we acknowledge that the population will be hard to gauge and monitor throughout the rest of the lagoon due to unfavorable snorkeling conditions. The presence of larger and reproductively mature individuals in the IRL suggests reaching sexual maturity or adulthood did not trigger offshore migration, suggesting a resident population. In addition to likely competing with native snapper species, we found lionfish directly consuming commercially important species; *Farfantepenaeus duorarum* and *Callinectes spp*. The wide range of sizes of lionfish found in the mangroves and their

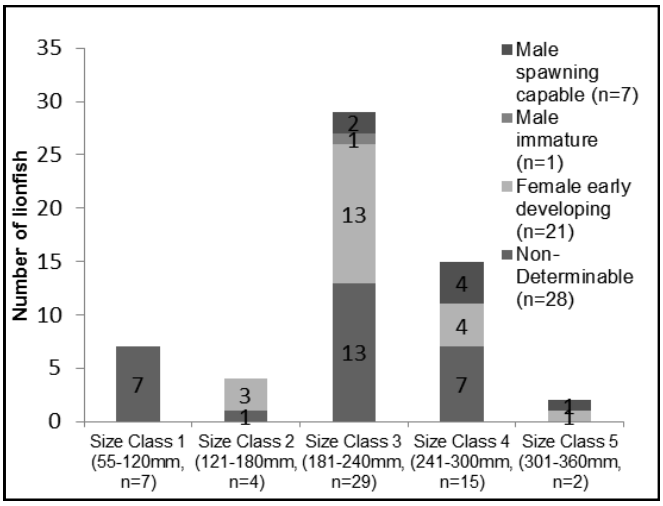

Figure 4. Gonad stages for estuarine lionfish (n = 57).

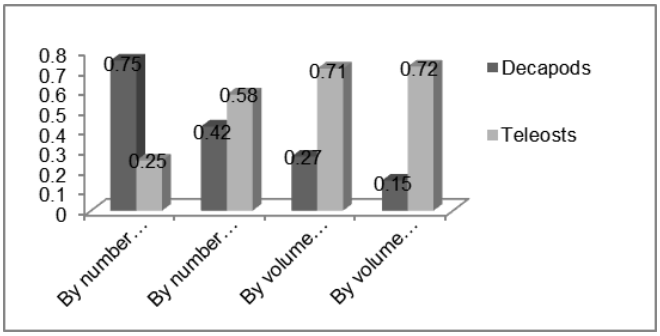

Figure 5. Diet of estuarine lionfish (n = 89).

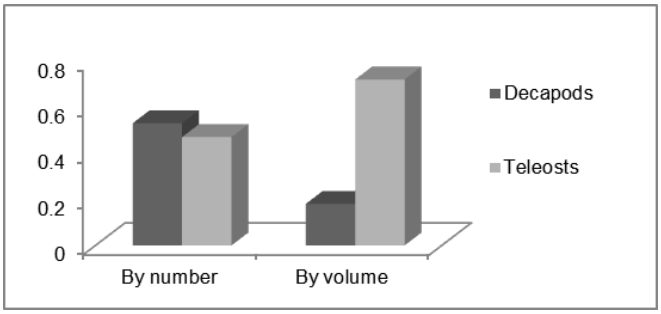

Figure 6. Diet of all estuarine lionfish (n = 89).

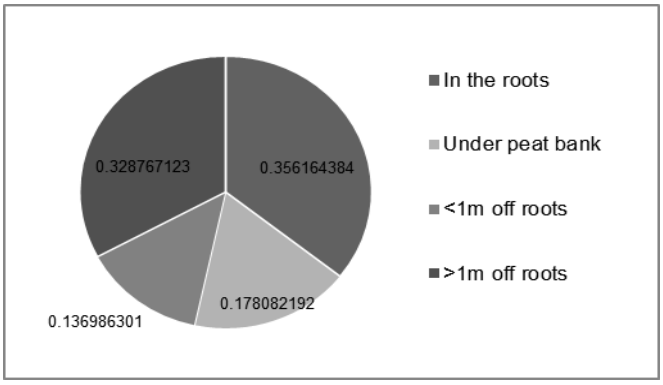

Figure 7. Where did we find the lionfish in the mangroves? (n=73).

observed fidelity suggests that mangroves in the IRL may serve as both juvenile and adult habitat. We recommend control efforts start by focusing on inlet areas, making sure to include mangroves. Research on effective trapping methods is also recommended for estuarine systems.

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