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Lionfish (*Pterois volitans* [Linnaeus, 1758] and *P. miles* [Bennett, 1828]) records within mesophotic depth ranges on natural banks in the Northwestern Gulf of Mexico

Marissa F. Nuttall*, Michelle A. Johnston, Ryan J. Eckert, John A. Embesi, Emma L. Hickerson and George P. Schmahl

NOAA Flower Garden Banks National Marine Sanctuary, Galveston, TX, USA

E-mail: Marissa.Nuttall@noaa.gov *(MFN)*, Michelle.A.Johnston@noaa.gov *(MAJ)*, Ryan.Eckert@noaa.gov *(RJE)*, John.Embesi@noaa.gov *(JAE)*, Emma.Hickerson@noaa.gov *(ELH)*, George.Schmahl@noaa.gov *(GPS)*

**Corresponding author*

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Abstract

The Indo-Pacific red lionfish *Pterois volitans* (Linnaeus, 1758) and devil firefish *Pterois miles* (Bennett, 1828) invasions through the western Atlantic, Caribbean, and Gulf of Mexico are reasonably well documented. While lionfish have been reported on multiple natural and artificial reefs in the Gulf of Mexico, this study notes their presence at previously undocumented mesophotic habitats and depths surrounding natural banks in the northwestern Gulf of Mexico.

Key words: lionfish, invasive, exotic, Gulf of Mexico, mesophotic reefs

Introduction

The invasion of the Indo-Pacific lionfishes *Pterois volitans* (Linnaeus, 1758) and *P. miles* (Bennett, 1828) (Family: Scorpaenidae) (Figure 1) outside of their native range has been reasonably well documented throughout the past decade. Lionfish were first reported in North Carolina in 2000. Since then, extensive efforts have been made to track the spread and progress of these invasive species (Morris and Whitfield 2009). By 2009, lionfish were considered established throughout the Caribbean (Morris and Akins 2009) and in 2010 the first lionfish sightings were reported for the northern Gulf of Mexico by SCUBA divers and remotely operated vehicles (ROVs). To date, lionfish have been documented on natural and artificial reef structures throughout the Gulf of Mexico and are now considered established in the region (Aguilar-Perera and Tuz-Sulub 2010; Schofield 2010).

The continental shelf edge of the northwestern Gulf of Mexico is scattered with both interconnected and isolated reef and bank features, occupying depths from approximately 20 to 200 meters. In addition, there are over 3,000 petroleum platforms and numerous artificial reefs sites in the northwestern Gulf of Mexico (BSEE 2012). All of these features support diverse benthic and fish communities, and represent potential habitat for lionfish, given the species thermal, depth, and salinity tolerances. Anecdotal reports suggest that lionfish populations have increased rapidly in the deep waters of the northern Gulf of Mexico, following their initial colonization in the southern and eastern Gulf.

Methods

Features surrounding fourteen banks in the northwestern Gulf of Mexico were surveyed using video from an ROV during seven expeditions between October 2011 and June 2013 (Table 1). The surveys were part of an ongoing study to characterize "potentially sensitive biological features" (PSBFs) that occur outside of the Bureau of Ocean Energy Management (BOEM) designated no-activity zones (NAZs).

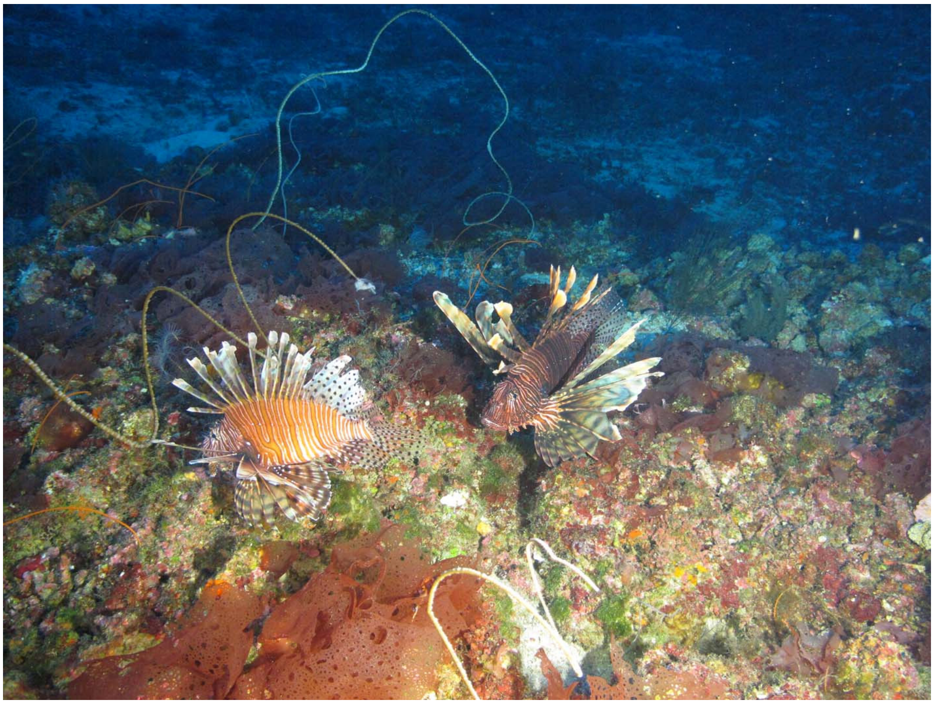

Figure 1. Two lionfish recorded during ROV survey over coralline algae reefs on banks in the Northwestern Gulf of Mexico. Photograph by FGBNMS/UNCW-UVP.

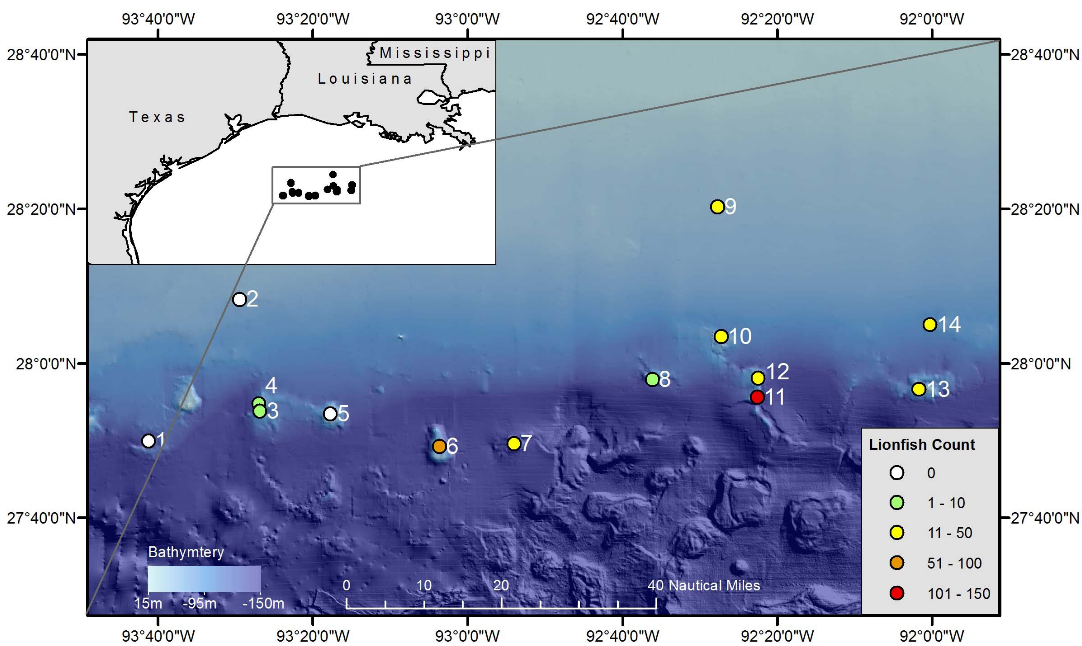

Figure 2. Map of study site locations. 1. Horseshoe Bank, 2. 29 Fathom Bank, 3. 28 Fathom Bank, 4. Rankin Bank, 5. Bright Bank, 6. Geyer Bank, 7. Elvers Bank, 8. McGrail Bank, 9. Sonnier Bank, 10. Bouma Bank, 11. Sidner Bank, 12. Rezak Bank, 13. Parker Bank, and 14. Alderdice Bank. The color of the circle indicates the quantity of lionfish observed at each location. Darker blue coloration represents deeper water.

Table 1. Lionfish observations by location, with average depth of sightings and average depth of survey for each location.

Bank name	Bank coordinates		Year	Month	Count	Average Depth Lionfish Observation (m)	Average ROV Survey Depth (m)
	Latitude	Longitude					
Horseshoe	27°49'N	93°41'W	2011	October	0	-	122.5
29 Fathom	28°08'N	93°29'W	2011	October	0	-	75.4
28 Fathom	27°53'N	93°26'W	2012	September	2	93.6	110.7
Alderdice	28°05'N	92°00'W	2013	April	50	82.5	82.4
Bouma	28°03'N	92°27'W	2013	April	27	91.1	95.8
Bright	27°53'N	93°17'W	2012	September	0	-	105.0
Elvers	27°49'N	92°54'W	2013	June	40	90.4	122.1
Geyer	27°49'N	93°03'W	2012	September	55	87.7	101.8
McGrail	27°57'N	92°36'W	2013	June	9	101.8	104.2
Parker	27°56'N	92°01'W	2013	June	48	95.5	93.8
Rankin	27°54'N	93°26'W	2012	September	2	92.2	95.0
Rezak	27°58'N	92°22'W	2013	April	23	93.7	100.0
Sidner	27°55'N	92°22'W	2013	June	111	95.8	103.6
Sonnier	28°20'N	92°27'W	2013	May	31	57.6	57.6

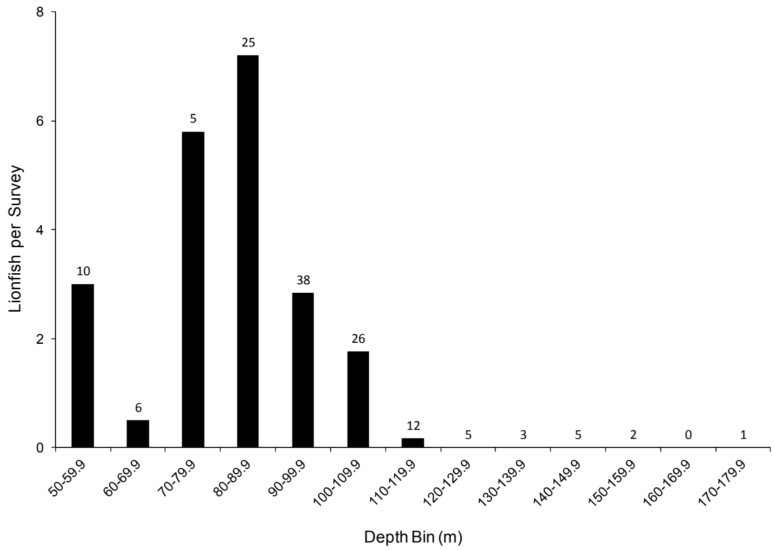

Figure 3. The depth distribution of lionfish observed per survey. Numbers indicate the number of surveys conducted in each depth range. Depth is binned in 10 m increments.

Oil and gas operations are prohibited within the NAZs, and surveys were therefore conducted to assess features outside of these zones at each bank. Ten locations on each of the features were selected randomly on potential hard bottom habitat, identified by bathymetric data for each location. At each drop site, five 10-minute surveys were conducted over hard bottom habitat. Video was recorded and notes were made in five minute intervals, recording benthic invertebrate and fish observations, depth and location. These notes were used to calculate the average depth of each drop site and document the quantity, approximate location, and approximate depth of all encountered lionfish. Lionfish observations and drop site depths were binned into 10 m depth increments to describe the peak depth distribution.

Results

We detected 398 lionfish in total on features surrounding the 14 banks surveyed (Table 1), with the highest number of animals observed at Sidner Bank (111 observations). In contrast, no lionfish were observed on the features surrounding 29 Fathom Bank, Bright Bank, and Horseshoe Bank (Table 1; Figure 2). Surveys were conducted at depths between 50.0 m and 176.7 m, with the majority of surveys conducted between 90 m and 99.9 m (28% of all surveys). Lionfish were observed from a minimum water depth of 53.9 m to a maximum depth of 112.4 m, with the greatest abundance of lionfish occurring between 80 m and 89.9 m (Figure 3). The majority of lionfish sightings occurred upon natural, coralline algae, reef habitats where the dominant benthic biota consists of sponges, leafy algae, octocorals, and black corals (Schmahl et al. 2008). The dominant fish species in these habitats are small (5–10 cm) sea basses, including roughtongue bass *Pronotogrammus martinicensis* (Guichenot, 1868) and threadnose bass *Anthias tenuis* (Nichols, 1920) (Nuttall et al. 2013).

Discussion

The invasion of exotic lionfish (*P. volitans* and *P. miles*) throughout the Caribbean, Atlantic, and Gulf of Mexico has been extensively documented. However, the data were collected primarily by SCUBA divers and, therefore, is limited in its application to relatively shallow depths. Thus, previous studies show lionfish to have shallow average depth ranges (Johnston and Purkis 2011), but this mostly reflects sampling effort. There are very few observations available for depths beyond recreational SCUBA diving limits. This study extends the depth range reported for lionfish in the Gulf of Mexico to over 112 m and demonstrates that additional sampling beyond traditional diver surveys is needed to gain a more complete understanding of the lionfish invasion process and the threats it poses to different habitat and ecosystem types.

Previous studies have documented that lionfish invasions can begin in shallow habitats, progressing to deeper habitats with time (Claydon et al. 2012). On the continental shelf edge of the northwestern Gulf of Mexico, there is a limited amount of shallow (<50 m) habitat available, and lionfish appear to be successfully and extensively using the available, deeper, mesophotic habitat (reefs characterized by a limited availability of light and dominated by corals). In the Bahamas, lionfish inhabiting mesophotic reefs occur at densities ten times greater than on nearby shallow reefs (Lesser and Slattery 2011; Claydon et al. 2012). In this study, lionfish were also documented in large numbers in mesophotic depth ranges, highlighting the need to continue monitoring and observation efforts at deeper depth ranges. These observations are also needed to help us better understand the extent to which mesophotic ecosystems serve as sources of recruits that either initiate the invasion of shallow habitats or recolonize them following lionfish culling (Green et al. in press).

In shallow reef habitats, lionfish are generalist carnivores, consuming fish species from multiple families in quantities proportional to their abundance (Morris and Akins 2009; Muñoz et al. 2011). While no gut content analysis was performed in this study, previous studies indicate that lionfish will consume the dominant fish species found in the habitat. For these mesophotic coralline algae reefs, this includes two Anthiinae species: the roughtongue bass and the threadnose bass (Nuttall et al. 2013). Little is known regarding the trophic ecology of these deep water basses, making predictions on the impact of changes in their populations on ecosystem structure and functioning difficult. However, both species are thought to have medium to high resilience, with population doubling times of 15 months and 1.4–4.4 years (respectively), and K-selection characteristics (Froese et al. 2002). Whether this will buffer the populations from this new source of predation and competition is currently unknown.

In this study, lionfish were absent from all surveys conducted below 120 m. While limited surveys were conducted below this depth (<12% of all surveys), the absence of lionfish is likely due to changing available habitat. At this depth, habitat changes from shallow, clear water reefs, dominated by coralline algae, to deeper, silted patch reefs, dominated by octocorals and black corals.

Based on patterns seen in the Atlantic and Caribbean (Lesser and Slattery 2011; Morris and Whitfield 2009), we anticipate that lionfish populations will continue to increase within mesophotic depths in the northern Gulf of Mexico. Additionally, our data show an increase in lionfish occurrence from 2011 to 2013, with greater lionfish observations on more westerly located banks. This suggests that the data presented here may be documenting the early stages of the lionfish invasion into the northwestern Gulf of Mexico. It is unknown what impact lionfish will have to mesophotic reef communities and additional information is needed to document the spread and potential impacts to these habitats and associated fish communities. As these habitats are well below recreational SCUBA diving limits, creative management strategies will be needed to deal with lionfish at these depths.

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