Vertical Movement and Site Fidelity of Lionfish (*Pterois volitans*) Along a Deep Reef Wall Using *in situ* Acoustic Telemetry

Movimiento Vertical y Fidelidad del Sitio de Pez León (*Pterois volitans*) a lo Largo de una Pared de Arrecife Profunda Usando Telemetría Acústica *in situ*

Le Mouvement Vertical et la Fidélité du Ste du Lionfish (*Pterois volitans*) le Long d'un mur de Récif Profond Utilisant la Télémétrie Acoustique *in situ*

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EXTENDED ABSTRACT

The persistence of lionfish, *Pterois volitans*, as an invasive species in the Caribbean has led to major concerns about the loss of biodiversity and the ecological and economic impacts to small island communities (Morris and Whitfield 2009, Lesser and Slattery 2011, Green et al. 2012, Albins 2015). Removal efforts, primarily using spears and recreational SCUBA divers, have been established successfully across the region including in the Cayman Islands to help manage lionfish populations (Frazer et al. 2012, Green et al. 2014, Usseglio et al. 2016, Peiffer et al. 2017). In Little Cayman, weekly community organized group culls, local volunteers, and the Cayman Islands Department of Environment (DoE) have combined to remove over 18,000 lionfish from the reef since 2011. Lionfish have been reported at depths far below recreational SCUBA diving limits (> 40 meters) in multiple locations in their invaded range, including Little Cayman. The issue of lionfish potentially utilizing deep habitats as a refuge where they are inaccessible to current capture and management methods has been raised across the invaded region (Andradi-Brown et al. 2017). Lionfish density surveys along permanent transects in six sites in Little Cayman reveal vertical movements from deep to shallow reefs during crepuscular periods. An external tagging study in 2015 of lionfish at an unculled site in Little Cayman found minimal horizontal movement of lionfish to adjacent culled sites, results that are in line with similar studies in other areas (Jud and Layman 2012, Atkins et al. 2014). However, subsequent density surveys recorded a low percentage of resightings of tagged lionfish which suggests a potential vertical movement of tagged fish away from the tagging/survey site. Continuing from these preliminary assessments, the current study employed acoustic telemetry to further examine horizontal and vertical movement patterns (daily, monthly, seasonal) of lionfish for the first time along a deep, contiguous reef wall system.

The existence of three control (unculled since the lionfish invasion) sites on Little Cayman presented a regionally unique opportunity for the tagging of the lionfish in this study; there is a long-term dataset (2012 - 2017) of lionfish populations at these sites, individual lionfish were available for tagging and the tagged lionfish would not be targeted by culling efforts. Using the results from initial range tests of the acoustic transmitters, a 2000 m gate of 13 receivers was deployed along the northeast reef wall of Little Cayman to achieve consistent detection of tagged fish for six months. Receivers were placed at a depth of 10 meters, pointing down, attached to a floating line anchored off a reef spur that protruded from the wall to maximize the line of site at depth as well as to detect fish moving along the top of the reef wall and into shallow habitats. Thirty adult lionfish (13 female and 17 male) were internally tagged at dusk, between May 22, 2017 and July 31, 2017, with Vemco V9P 1H transmitters along the array at depths of 21 to 33 meters. The coded sensor transmitters reported depth with each detection of the individual. *In situ* tagging was elected to avoid barotrauma stress, however it did include logistical challenges; low light, current, recreational diving limits, and the presence of reef predators.

Initial receiver downloads and surveys in August through October 2017 indicated that the tagging method was successful. Tagged lionfish were observed acoustically and visually and exhibited typical behavior post-tagging (feeding, swimming, resting with other conspecifics). Anomalous movement patterns of certain transmitters indicated that some lionfish were preyed upon the night of tagging or even months post-tagging. The transmitter was tracked in the predator's stomach until excretion. Native reef predators in the area that could be responsible include groupers, snappers, eels and sharks. An individually identifiable nurse shark, *Ginglymostoma cirratum*, was present and aggressive towards the lionfish in the receiver array during many of the tagging dives as well as post tagging surveys and is therefore suspected by the authors to be a predator of the tagged fish.

Preliminary data analysis reveals high site fidelity, with individuals remaining within a 300-meter horizontal range. Daily vertical movement is greater than 30 meters in some fish, although it is variable between individuals. Fish have been detected as deep as 50 - 60 meter regularly, and three individuals recorded detections below 100 meters. A number of fish were observed diving deep every two days for short periods of time (~20 minutes) in the middle of the night which is suggestive of spawning behavior and is supported by previous findings that a lionfish can spawn every 2 - 4 days (Gardner et al. 2015, Candelmo et al. 2015). While a majority of tagged fish did dive below recreational limits, all fish were also detected along the top of the reef wall regularly and therefore would be accessible to culling efforts. Final results from this study will provide a more comprehensive understanding of lionfish movement patterns and may allow for targeted removals

to be scheduled more effectively. Future work should focus on the question of deep spawning grounds and the importance of sustainable native predator populations to help control the population densities

KEYWORDS: Lionfish, acoustic tagging, reef wall, telemetry, Little Cayman

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