Efficacy of Lionfish Traps in the Northern Gulf of Mexico

Eficacia de Trampas para el Pez León en el Norte del Golfo de México

Efficacité des Pièges pour le Poisson-Lion dans le Nord du Golfe du Mexique

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EXTENDED ABSTRACT

Introduction

Invasive Indo-Pacific lionfish (*Pterois volitans/miles* complex, hereafter lionfish) are now well established in the western Atlantic Ocean, Caribbean Sea, and Gulf of Mexico. Lionfish reduce recruitment of native reef fishes, outcompete native predators, destabilize marine food webs, and are correlated with large-scale declines of native fishes (Côté et al. 2013). Mitigating the negative impacts of invasive lionfish is a top priority for the ocean management community, with human removal considered the most viable method of biocontrol (Morris 2012). Lionfish removals are widely promoted and conducted, but the capacity to control lionfish is primarily from spearfishing by divers (Morris 2012).

Over 665,000 km^2 of benthic habitat lies in 30 – 300 m depths within the invaded range (NOAA 2018). There is evidence of an ontogenetic movement of lionfish to deeper, mesophotic (>40 m) reefs (Andradi-Brown et al. 2017), which suggests the largest egg producers likely inhabit refugia depths beyond spearfishing capabilities. Surveys with remote operated vehicles, divers, or trawls sampling mesophotic reefs show deepwater lionfish densities are higher than densities in shallow-water reefs (e.g. Andradi-Brown et al. 2017). Establishment of lionfish on mesophotic reefs has been followed by large-scale reductions in reef fish diversity and abundance of reef herbivores (Lesser and Slattery 2011), and lionfish were believed to be the primary driver of a shift from predominantly coral-dominated to algal-dominated mesophotic reef habitats (Lesser and Slattery 2011).

Lionfish trapping has been proposed as a means to remove lionfish biomass from mesophotic reefs (NOAA 2018). Since 2016, a collaborative effort by scientists and stakeholders has developed a non-containment, curtain (NCC) trap to target lionfish (Figure 1). These traps were designed to exploit the rapid colonization behavior of lionfish compared native species, which in turn are deterred by the presence of lionfish. NCC traps remain open while deployed and close during

Figure 1. Photo of a non-containment, curtain lionfish (NCC) trap deployed near an artificial reef in the northern Gulf of Mexico. NCC traps are un-baited and use a piece of plastic lattice to act as a fish attracting device. Traps remain open during deployment and fish are captured when the trap closes during retrieval. Photo taken July 6, 2018 by Alex Fogg.

retrieval. The design attempts to prevent ghost-fishing and reduce bycatch of species other than lionfish.

Our objectives were to test NCC traps in the northern Gulf of Mexico (nGOM) with respect to 1) recruitment (i.e., fish observed within the trap footprint during retrieval) of lionfish versus native species to traps deployed near versus far from artificial reefs, and 2) test the capture efficiency of traps for both lionfish and native reef fishes. We evaluated gear deployment effectiveness and accuracy, deployment success, retrieval success, and movement of traps post-deployment. Deployment and retrieval strategies included trap distance from source reefs, trap density, soak time, and source reef lionfish density.

Methods

Twelve NCC traps were constructed. NCC traps were composed of two frames made of 4.5 m sections of #6 rebar (19 mm diameter) bent into two half-hoops with a curved extension on one end to act as a deflector for opening the trap. Trap frames open and close around a center axle (#6 round bar, 19 mm diameter) that feeds the frame through holes on the end of each hoop. A piece of 2.5 cm plastic lattice (71 cm h x 75 cm) is used as the fish attraction device. Trap netting is 3 m^2 of polyethylene mesh (#420 green knotless, 7/8" mesh nylon netting, 22 mm diameter). A two-line harness is attached to the apex of each jaw using 7/64" twisted polyester rope (Amsteel Blue, 2.78 mm diameter), and an inline syntactic foam float was secured at the apex of the harness to prevent line from fouling within the trap. GoPro Hero 4 cameras were equipped with CamDo Blink time-lapse controllers and affixed to inline floats above a subset of traps (n = 6).

NCC traps were deployed on sand bottom near eight nGOM artificial reef sites (i.e., source reefs) Sites were approximately 30 km south of the mouth of Choctawhatchee Bay, Florida in depths of 32 – 37 m in an area in which artificial reefs have historically high (>30 fish per 100 m^2) lionfish densities. Artificial reef structures consisted of steel-frame chicken transport units (n = 4), a steel pyramid (n = 1), a cement mixer (n = 1), and military vehicles (n = 2). Descent rates for five trap deployments were recorded with GoPro cameras. Lionfish densities were surveyed at each source reef by SCUBA divers during trap deployment and retrieval. Surveys consisted of point-counts conducted within a 15-m wide cylinder with the reef at the center. Counts made on opposite sides of the reef, followed by a count of lionfish inside of the reef. Source reef lionfish densities ranged from 12 to 63 lionfish.

Deployments consisted of single or paired (~ 3 m apart) traps, at three general distances from source reef [adjacent (< 5 m), near (~15 m), and far (> 50 m)], and with three levels of soak time [short (4 - 5 d), intermediate (8 d), and long (14 d)]. Generalized linear mixed models (GLMMs) were computed to test factors affecting recruitment of lionfish and native species to the NCC traps. GLMMs were fit using Laplace approximation to estimate maximum likelihood. Source reef was included as a random effect. Fixed effects included soak time (short, intermediate, and long), trap number (single and paired), proximity to source reefs (adjacent, near, and far), and source reef lionfish density. Error distribution was determined to be negative binomial via visual analysis of quantile-quantile plots. Models were built in R and used the LME4, MASS, and MuMIN packages.

Results and Discussion

Gear testing — Field deployments were conducted during June – November 2018. Traps were deployed in two rounds of three deployments, totaling 60 trap deployments and retrievals. Traps were able to be deployed within ~3 m of target distances from reefs. Total descent time for traps deployed in 34 – 37 m ranged from 23 – 31 s. Mean descent rate was 1.49 m/s (± 0.06 SE), which can be used to calculate time of decent for future deeper water trap deployments.

Traps successfully landed upright and opened during 68% of deployments. Identifying NCC trap design modifications to increase deployment success is critical before testing at deeper depths. We plan to increase the offset of the deflectors, add bottom weights, and test if a sea anchor will maintain an upright position during descent. Time-lapse recordings were prematurely terminated in over 95% of deployments despite extensive testing of camera housings in the lab and discussions with the manufacturer. Additional field testing with modified camera housings is underway to correct this issue.

On Sep 4-5, the center of Tropical Storm Gordon passed within 150 km of traps (n = 12) deployed on the nGOM shelf with maximum sustained winds of 112 km/h. NOAA weather buoy station 42012, located ~50 km east of the storm center and ~100 km west of the traps, recorded maximum sustained wind speed of 21.0 m/s and significant wave height of 4.9 m. Traps were retrieved two days later. All traps were found in the upright position and with no change in location. Traps were heavily fouled with algae and sand. These observations suggest high-energy storm events may bury NCC traps thus restrict benthic movement. However, it is unclear if traps would be more likely to move if attached to surface buoys.

Recruitment of lionfish and native reef fishes to traps — Recruitment of lionfish to NCC traps was over nine-fold greater than native species (Figure 2A). During 60 trap retrievals, 232 lionfish and 22 native reef fishes recruited to traps. Native species were predominantly sand perch *Diplectrum formosum* (n = 11), tomtate *Heemulon aurolineatum* (n = 3), and porgy *Calamus* spp. (n = 2). Native fishes recruiting to NCC traps also included two fishery species: one Gulf Flounder *Paralicthys albiguttata*, and one Scamp *Mycteroperca phenax*.

Proximity to reef was a significant factor in predicting lionfish recruitment to traps (Figure 2B). Traps placed far (55 – 75 m) from reefs attracted 98% fewer lionfish than traps placed adjacent to or near reefs ($p < 0.001$). There was no significant difference between traps placed adjacent to versus near ($p = 0.20$). Mean lionfish recruitment to traps was generally higher during shorter soak times and under single versus paired deployments, and generally higher during shorter deployments, but neither trap number nor soak time were significant in the GLMM ($p > 0.13$). After one trap was lost briefly during retrieval, it was found nearby with 24 lionfish that recruited to it in less than 1 hour. Future tests will be conducted to test if soak times < 4

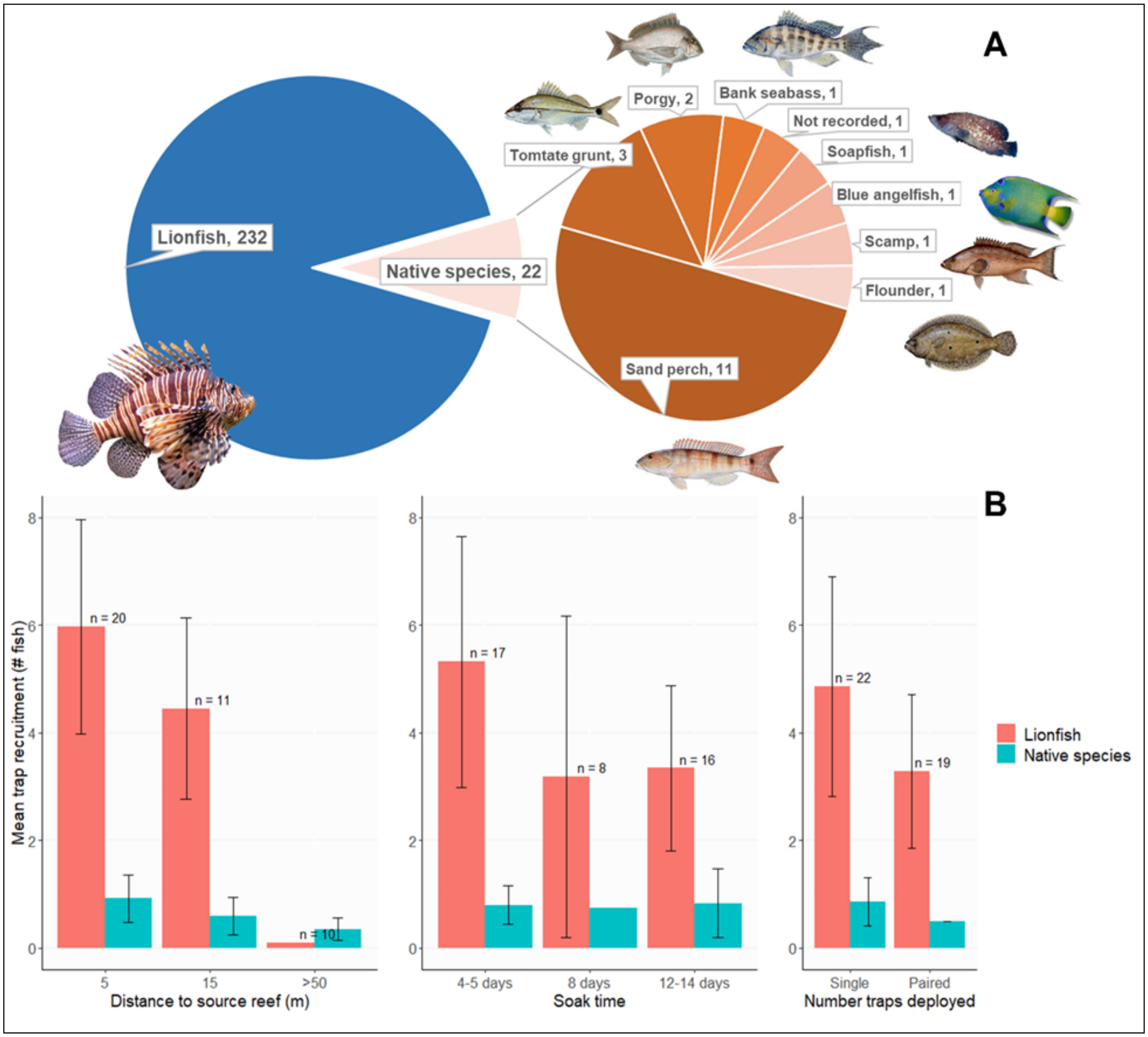

Figure 1. A) Total number of lionfish and native reef fishes that recruited to non-containment curtain traps (i.e. were within trap footprint at time of retrieval). B) Mean recruitment of lionfish and native species based on treatments of distance to source reef (5 m, 15 m, and >50 m), soak time (4-5 d, 8 d, 12-14 d), and number of traps deployed (single and paired). Error bars represent 95% CI.

d may have higher recruitment of lionfish. Lionfish density at source reefs increased lionfish trap recruitment at a rate of ~2% per lionfish originally present on source reefs ($p = 0.027$). Recruitment of native reef fishes to traps was much lower than lionfish recruitment (Figure 2B). The GLMM for native species showed no factors tested were significant predicators of mean recruitment of native species.

Continuing research. Design modifications to the NCC traps are being developed and tested. For example, an octagonal, straight-sided NCC trap has been designed and built by two research partners. The design reduces rebar bending to several bends per trap frame and makes construction less labor intensive and less expensive. Upcoming research will compare efficacy of NCC traps, Florida Keys wooden lobster traps, and US Atlantic black sea bass pots for capturing lionfish on nGOM mesophotic reefs. Ten trap deployment events are planned for 2018 - 2019. During each event, we will deploy 10 NCC traps, 10 lobster traps, and 10 sea bass pots over the course of two days. Catch per unit effort will be estimated for each trap type and tested among traps.

Conclusions

Trap recruitment of lionfish was 9X higher than recruitment of native species. Traps placed > 50 m from source reefs attracted significantly fewer lionfish. No factors tested had a significant effect on the recruitment of native species. Gear testing NCC traps showed that traps were placed accurately and did not move post-deployment. Observations during severe weather events suggest habitat damage due to trap movement may be unlikely; however, future tests will need to be conducted with surface buoys. Continued work is needed to guarantee upright deployment and operational time-lapse cameras. Design developments of NCC traps is underway and upcoming research will test shorter soak times and compare catch rates of NCC traps versus other trapping gears. We anticipate results from this research may ultimately support the development of a deepwater trap fishery for lionfish, thus mitigating lionfish impacts to mesophotic reef ecosystems.

KEYWORDS: Lionfish traps, invasive species, mesophotic reefs, innovative fishing gear, Gulf of Mexico

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