Modification of a lobster trap to catch the invasive lionfish (*Pterois spp.*)

Modificación de una trampa langosta para capturar al pez león invasor

La modification d'un piège à homard pour capturer le poisson-lion envahissant

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ABSTRACT

In the tropical Western Atlantic, lionfish (*Pterois volitans* and *P. miles*) are highly invasive and can have negative impacts on ecosystems. In the Florida Keys (USA), divers have had some success in reducing lionfish abundance in waters within SCUBA diving depths; however, the depth range of lionfish greatly exceeds common diving limits. Commercial spiny lobster (Panulirus argus) fishers occasionally catch lionfish in their traps, particularly when using traps constructed primarily of wire at depths between 30 and 100 meters. The goal of this project was to modify wire-style lobster traps to increase lionfish catch in these deep waters while ensuring that the catch of other fish remained low. Modifications of the trap throat, throat location, escape gap size, and bait type were evaluated to determine the best trap designs with respect to bycatch reduction and lionfish catch. Simple modifications to these lobster traps increased lionfish catch and reduced bycatch. Two critical elements of creating a species-specific lionfish trap were: 1) a narrow top-entrance throat to preclude entry of legal-size lobsters and other large fish and 2) an escape gap to reduce the retention of small lobsters and small fish. These two trap design elements effectively reduced the catch of both lobsters and other fish, which was the key attribute to increasing the catch of lionfish. Bait type did not have a strong influence on lionfish catch. Fishers evaluated if the traps were an effective addition to their commercial fishing operations and generally concluded the experimental traps caught more lionfish than their standard spiny lobster traps and could be used to target lionfish at known lionfish aggregation sites. The use of lionfish-specific traps to enhance commercial fisher income remains to be assessed by individual fishers. However, the strategic use of this trap in no-fishing or marine protected areas could remove invasive lionfish while posing a smaller risk to non-targeted, native species compared to traditional lobster and fish traps.

KEYWORDS: Lionfish trap, spiny lobster, invasive species, Florida, bycatch

INTRODUCTION

Lionfish (*Pterois volitans* and *P. miles*) first invaded Atlantic waters off the coast of Florida in the mid-1980s, arrived in the Florida Keys in 2009, and are now fully established in the Gulf of Mexico and Caribbean Sea (Whitfield et al. 2002, Schofield 2009, Bryan et al. 2018). While widely distributed throughout the Caribbean, they have also invaded a broad range of habitats and depths making their invasion particularly pernicious (Côté et al. 2013, Cure et al. 2014). They are voracious predators of small fish including juvenile commercial and recreational fishery species, such as snappers and groupers, and pose a risk to both ecosystem function and fisheries (Albins 2015, Johnston et al. 2017).

Complete eradication of this invasive species is no longer considered feasible (Morris and Whitfield 2009, Schofield 2010, Barbour et al. 2011, Albins and Hixon 2013, de León et al. 2013), but controlling the population by continuous, directed fishing remains a management alternative (Barbour et al. 2011, Ulman et al. 2022). Population models predict that culling can reduce lionfish abundance substantially, but removal rates must be high (Jud et al. 2011, Côté et al. 2013, Cure et al. 2014). In addition, modelling different management scenarios show that if all adult lionfish are exploited, it is possible to fish the lionfish to very low abundance, but the fishing pressure will have to be maintained or lionfish populations will recover (Arias-González et al. 2011). Removals by divers using spears in water shallower than 30 m appears locally effective, but divers have relatively small spatial coverage and limited dive time (Andradi-Brown et al. 2017, Davis et al. 2021). Greater spatial coverage and more continuous fishing pressure may be possible using traps (Gittings et al. 2017, Harris et al. 2020). Lionfish are a common bycatch in commercial spiny lobster traps (particularly in traps made of wire) in the Florida Keys (Lazarre et al. 2013) and other fish traps in the Caribbean (Brokke and Veldman 2020), but these devices are often illegal in marine protected areas (MPAs) and other management areas where the need for lionfish removals are presumably important.

Development of new fishing gear not only requires maximizing catch efficiency of the target species but must also minimize bycatch and protected species interactions; existing fishing gear regulations and, in well-established fishing communities, acceptance by fishers must also be considered. Long-term removal of lionfish from deep water (>30 m) through modifications to a wire spiny lobster trap will address both the ecological imperative to reduce the number and impact of lionfish on the native fish population and may provide an economic opportunity for the commercial sale of lionfish. As an existing and regulated fishing gear in Florida, a modified lobster trap meets existing regulations and likely requires limited adaptation for use by commercial fishers. In Hutchinson et al. 2019, modifications to a wire spiny lobster

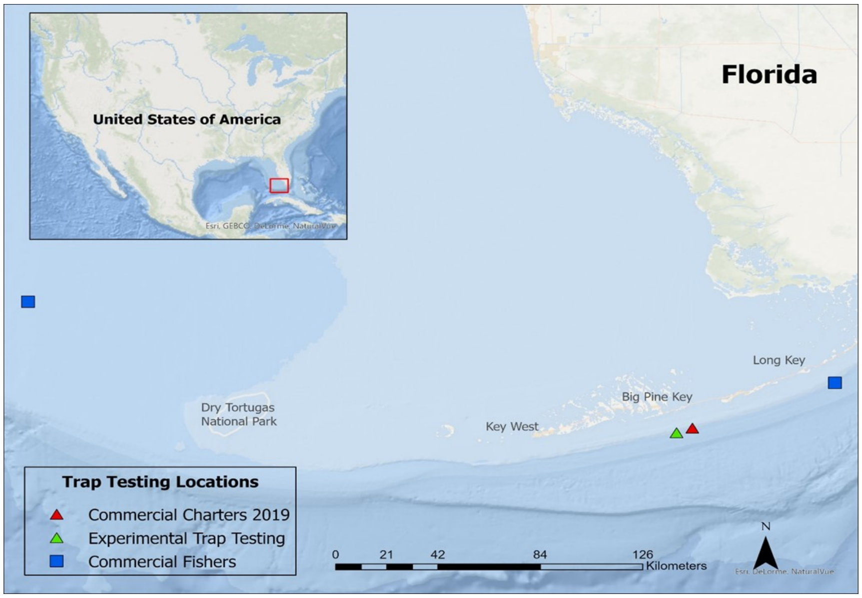

Figura 1. . Trap testing locations with commercial fishers. The red box indicates the study location within the United States of America. The red triangle indicates the location of the experimental trap design testing (Hutchinson et al. 2019) off Marathon, Florida, the green triangle indicates the location of the experimental trap testing with a commercial fisher off Big Pine Key, Florida, and the blue squares indicate the approximate locations of real-world testing with commercial fishers west of the Dry Tortugas National Park and off Long Key, Florida.

trap currently used in the spiny lobster fishery in Florida were used to develop a trap to catch lionfish; various trap designs and baiting techniques were evaluated for differences in catch of lionfish, lobsters, and bycatch. In this study, the best modified trap designs were tested in waters deeper than 30 meters with a commercial lobster fisher to compare and evaluate the catch of standard spiny lobster traps to modified traps and assess their use in real-world fishing scenarios with commercial fishers.

METHODS

Experimental Trap Design

Experimental lionfish traps were constructed through modifications to the standard wire lobster traps currently used in the spiny lobster fishery in Florida. The standard trap measures 81.3 cm x 61.0 cm x 45.7 cm, is weighted with cement, and constructed with a wood-lath lid, a top-loading plastic throat with a 15.2 cm opening, and 3.8 cm wire mesh on the sides and bottom. All metric length units were converted from the United States customary imperial measurement system (1, 1/2, or 1/8 inch) and rounded to the nearest millimeter. Detailed methods for previous testing of trap designs included unique pairings of throat type, throat placement, escape gap configuration, and bait type (Hutchinson et al. 2019). Testing occurred over 30 research trips between December 2018 and October 2019 in Atlantic waters off Marathon, Florida (Figure 1). Results of that initial lionfish trap testing indicated that critical elements of a species-specific lionfish trap include narrowing the top entrance plastic throat (Figure 2A, 2B, and 2D) to preclude entry of legal-size lobsters and large fish and adding escape gaps (Figure 2C) to prevent the retention of small lobsters and fish. These critical elements were incorporated into trap designs tested by commercial fishers for this research.

Experimental Trap Testing with a Commercial Fisher

The most effective (i.e., high lionfish catch and low bycatch) experimental lionfish trap designs determined by Hutchinson et al. (2019) were tested in this study with a commercial spiny lobster fisher off Big Pine Key, Florida (Figure 1) to investigate the use of these modified traps in real fishing scenarios. Experimental lionfish traps were fished alongside standard spiny lobster traps currently used in the Florida fishery to compare lionfish catch and bycatch during 16 research trips between October 2019 and November 2020. Twenty-five standard wire spiny lobster traps and twenty-five experimental lionfish traps were randomly placed along two lines in depths ranging from 30.5 m to 36.6 m. We tested four experimental lionfish trap configurations and used a standard lobster trap as a control (Table 1). All lionfish traps included a narrow 5.4 cm top-loading plastic throat, and one of two escape gap configurations (two vertical 3.8 cm x 19.1 cm gaps or one vertical 7.6 cm x 19.1 cm gap). Each lionfish trap was baited with a live lionfish or left empty (Table 1). Availability of lionfish as bait depended on catch from previous deployments. Lionfish caught in traps were redistributed as bait among traps and retained in the trap using plastic mesh measuring 62.2 cm x 48.6 cm formed into a holding pen within the trap. Standard spiny lobster traps were baited as is customary in the fishery, with one to three live sublegal-size spiny lobsters. Upon retrieval, all catch in individual traps was identified to the lowest taxonomic level possible and measured to the nearest cm for fish (total length) and to the nearest mm for crustaceans

Table 1: Experimental trap treatments tested with a commercial fisher comparing standard lobster traps to experimental lionfish traps and total number of pulls for each trap. Lobster traps included a standard (15.2 cm) throat, no escape gap, and lobster bait. Lionfish traps included a narrow (5.4 cm) throat, either two vertical, narrow gaps (19.1 cm x 3.8 cm) or one vertical, wide gap (19.1 cm x 7.6 cm), and a live lionfish or no bait treatments.

Trap Treatment	Throat Type	Escape Gap	Bait Treatment	N
Lobster Trap	Standard	None	Lobster	214
Lionfish Trap 1	Narrow	Two vertical, narrow gaps	Live Lionfish	66
Lionfish Trap 2	Narrow	Two vertical, narrow gaps	No Bait	86
Lionfish Trap 3	Narrow	One vertical, wide gap	No Bait	43
Lionfish Trap 4	Narrow	One vertical, wide gap	Live Lionfish	41

(carapace length/width). Lionfish were retained and used as live bait, and all other bycatch from experimental traps were released.

Real-world Testing with Commercial Fishers

Upon the completion of experimental trap testing with a commercial fisher (Section 2.2), the single best design was given to two other commercial spiny lobster fishers to be fished amongst their standard spiny lobster traps and evaluated based on overall catch performance and feasibility in a real-world scenario. Five experimental traps were given to each of the fishers and were fished in waters west of the Dry Tortugas National Park and in Atlantic waters off Long Key, Florida (Figure 1). They placed one lionfish trap within five separate trawl lines consisting of 25 traps each. Each time a trawl line was pulled, the fishers were requested to record lionfish catch and bycatch in the experimental lionfish traps. One fisher submitted catch by taking photographs of each trap with lionfish, GPS locations of those traps, and reported them via text message.

Data Analyses

Trap catch from Section 2.2 (Experimental Trap Testing with a Commercial Fisher) was separated into lionfish, spiny lobster, Snapper Grouper Complex, and other bycatch to analyze trap performance. Species categorized as Snapper Grouper Complex are listed under the South Atlantic Fishery Management Council's Snapper Grouper Management Plan (SAFMC 2022). To test for significant differences in catch between trap designs, we used generalized linear mixed effects negative binomial regression models (GLMM) to model count data. The number of days between trap pulls (i.e., a trap's "soak time") was initially included as a predictor variable; however, soak time did not improve model fit and was subsequently removed from further analyses. All final models included trap type as a fixed effect and trap retrieval date as a random effect. Models for lionfish catch, lobster catch, and other bycatch also included trap type as a predictor variable in the dispersion component of the model, which allowed counts from each trap type to exhibit a different degree of variability with respect to the mean. Post-hoc pairwise comparisons of estimated marginal means were used to compare differences in catch between trap types. The p-values were Tukey-adjusted to control for multiple comparisons. All statistical analyses were carried out in R (R Core Team, 2019) using the glmmTMB (Brooks et al. 2017) and emmeans (Lenth 2020) packages. For the real-world testing with commercial fishers, data collection was not rigorous enough for statistical testing and reporting of results were qualitative.

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RESULTS

Trap Catch

A total of 450 single traps of varying trap types were pulled during the duration of this study (Table 1). Lionfish Traps 3 and 4, with a 7.6 cm wide escape gap, were deemed ineffective due to low lionfish catch and were discontinued from the study on March 24, 2020. Data collected from these traps were not included in any further analyses.

In the three remaining trap treatments, a total of 117 lionfish, 1,172 spiny lobster, 108 fish from the Snapper Grouper Complex, and 252 other bycatch animals were caught over 231 days of trap deployments. The negative binomial regression models showed that trap type significantly affected catch (Table 2). Lionfish catch was significantly higher in both experimental lionfish traps compared to the standard spiny lobster trap; however, lionfish catch between Lionfish Trap 1 and Lionfish Trap 2 did not differ significantly (Table 3, Figure 3). Lionfish catch in Lionfish Trap 1 was greater than Lionfish Trap 2 and comprised 33.1% and 26.7% of the total catch in each trap type respectively, compared to only 0.7% of the total catch in the standard spiny lobster trap (Table 4).

Standard wire spiny lobster traps had the highest total lobster catch of any trap treatment, representing 89.4% of the total catch in that trap treatment and averaging 5.38 ± 0.32 SE lobsters per trap (Table 4, Figure 3). Lionfish Trap 1 (0.15 ± 0.09 SE lobster per trap) and Lionfish Trap 2 (0.13 ± 0.096 SE lobster per trap) caught significantly fewer lobsters than the standard lobster trap (Table 3, Figure 3). In total, 831 sub-legal size lobsters, 338 legal-size lobsters, and three partially decayed, indeterminate-size lobster were caught during the duration of our study. Lionfish Traps 1 and 2 caught zero legal-size lobsters and 10 and 11 sub-legal size lobsters, respectively. Standard lobster traps were responsible for the remaining 98% of the

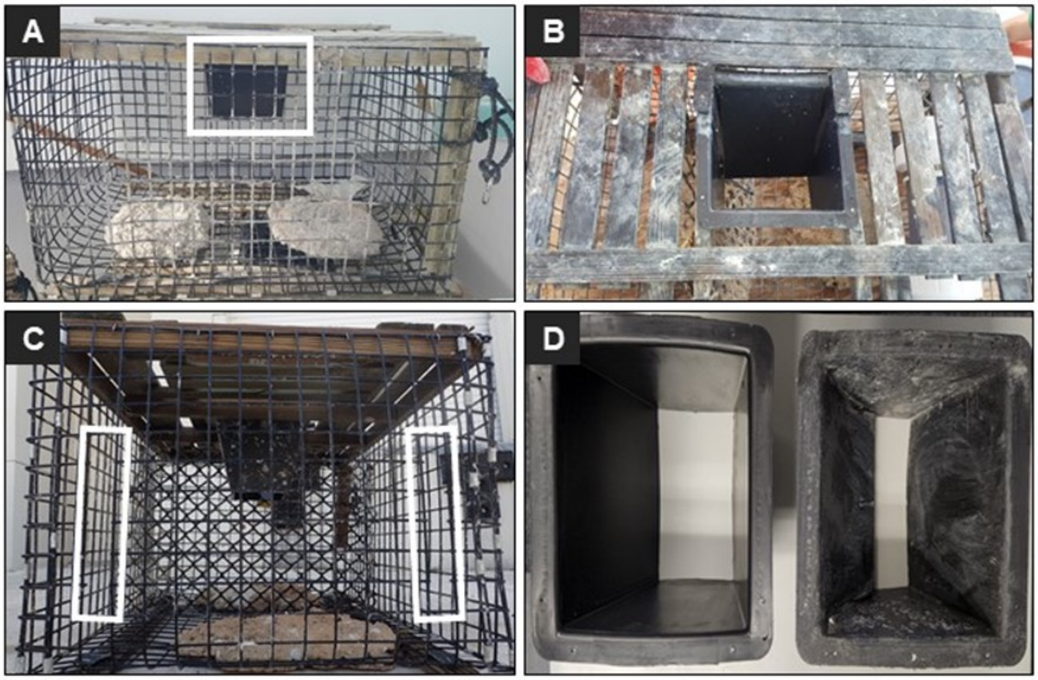

Figura 3. Images of A) a wire spiny lobster trap with a top-loading throat highlighted with a white rectangle, B) top view of a modified, narrow throat installed on a trap, C) vertical escape gaps highlighted with white rectangles, D) top view of a standard, plastic throat (left) and a modified, narrow throat with a 5.4 cm opening (right).

total lobster catch (Table 4).

Bycatch per trap of fish in the Snapper Grouper Complex was low for both Lionfish Trap 1 (0.59 ± 0.12 SE) and Lionfish Trap 2 (0.57 ± 0.11 SE) but was significantly higher than that for the standard spiny lobster trap (0.094 ± 0.022 SE) (Table 3, Figure 3). Of the 11 species in the Snapper Grouper Complex caught in this study, 81% of the total catch comprised of four species. Those species included hogfish (*Lachnolaimus maximus*, n = 31), gray triggerfish *(Balistes capriscus*, n = 21), mutton snapper (*Lutjanus analis*, n = 18), and lane snapper (*Lutjanus synagris*, n = 17). No other species comprised more than 7% of the total Snapper Grouper Complex bycatch, and the composition and abundance of bycatch species differed by trap type (Table 4).

There were 41 species including one decomposed, unidentifiable fish, caught in the “Other Bycatch” category. Three species comprised 63% of the total catch: scrawled cowfish (*Acanthostracion quadricornis*, n = 98), stone crab (*Menippe mercenaria*, n = 35), and slender filefish (*Monacanthus tuckeri*, n = 28). No other species comprised more than 7% of the total bycatch. Species composition and abundance again differed by trap type (Table 4). Catch per trap of “Other Bycatch” did not differ between Lionfish Trap 1 (0.97 ± 0.16 SE) and Lionfish Trap 2 (0.97 ± 0.14 SE) but was significantly higher in both experimental lionfish traps compared to the standard spiny lobster trap (0.51 ± 0.068 SE) (Table 3, Figure 3).

Testing with Commercial Fishers

The experimental lionfish trap design given to commercial spiny lobster fishers to test included a narrow 5.4 cm top-loading plastic throat, two vertical 3.8 cm x 19.1 cm escape gaps, and no bait. Self-reported data from commercial fishers varied by participants. Only qualitative observations and impressions were obtained for traps fished in waters west of the Dry Tortugas National Park. Traps fished near Long Key, FL were deployed in targeted locations near structure (i.e. wrecks and fish aggregating devices) and in depths from 36.5 m – 47.8 m. Although sample size was small (n = 8), experimental traps consistently caught lionfish, in one case, six lionfish when the fisher targeted locations near structure. Lionfish catch in standard lobster traps was typically less than one per 25 traps.

DISCUSSION

Introducing new fishing gear to a fishery requires meeting certain guidelines for gear type, maximizing catch efficiency of targeted species, and minimizing bycatch of other species. Key characteristics of a species-specific lionfish trap included a narrow plastic throat with a 5.4 cm opening and two vertical 3.8 cm x 19.1 cm escape gaps. The narrow plastic throat deterred legal-size lobsters and larger fish species from entering the trap, while the slightly narrower, vertical escape gaps allowed for smaller reef fishes and smaller spiny lobsters to escape. Previous research in Florida has shown fish bycatch reduction in standard lobster traps occurs more often when lobsters were present in traps (Matthews and Donahue 1997,

Table 2. Estimates, standard errors (SE), and 95% confidence intervals (CI) for the parameters included in the negative binomial regression models for lionfish catch, spiny lobster catch, Snapper Grouper Complex bycatch, and other bycatch. The model for Snapper Grouper Complex Bycatch does not include trap type as a predictor variable in the dispersion component of the model. Random effects associated with retrieval date are expressed as standard deviations. Estimates associated with fixed effects are on the log link scale. The default parameter for comparison is the lobster trap.

	Lionfish Catch			**Lobster Catch**			**Snapper Grouper Complex Bycatch**			**Other Bycatch**		
	Estimate	SE	95% CI	Estimate	SE	95% CI	Estimate	SE	95% CI	Estimate	SE	95% CI
Fixed Effects												
Count Model												
Intercept	-3.35	0.45	-4.22 – -2.47	1.53	0.16	1.22 – 1.84	-2.44	0.27	-2.97 – -1.91	-0.85	0.21	-1.27 – -0.43
Lionfish Trap 1	2.92	0.43	2.09 – 3.76	-3.73	0.63	-4.96 – -2.50	1.82	0.31	1.21 – 2.44	0.63	0.20	0.24 – 1.02
Lionfish Trap 2	2.64	0.47	1.73 – 3.55	-3.72	0.84	-5.37 – -2.07	1.78	0.30	1.19 – 2.37	0.69	0.20	0.31 – 1.08
Dispersion Model												
Intercept	-1.67	1.31	-4.24 – 0.89	1.03	0.18	0.68 – 1.37	N/A	N/A	N/A	-0.60	0.30	-1.19 – 0.00016
Lionfish Trap 1	1.97	1.48	-0.93 – 4.88	-3.91	0.79	-5.46 – -2.37	N/A	N/A	N/A	1.93	0.93	0.11 – 3.75
Lionfish Trap 2	0.46	1.40	-2.30 – 3.21	-4.97	0.80	-6.53 – -3.41	N/A	N/A	N/A	1.37	0.67	0.054 – 2.69
Random Effects												
Intercept (Retrieval Date)	0.71	N/A	N/A	0.51	N/A	N/A	0.43	N/A	N/A	0.55	N/A	N/A

Matthews et al. 2005). Our current research appears consistent, that reducing lobsters as bycatch is an essential aspect for increasing lionfish catch in these modified traps. Hutchinson et al. (2019) validated this hypothesis with correlations between the reduction of bycatch of other species, particularly spiny lobsters, and increased catch of lionfish in traps. The location of the trap throat was also relevant for increased catch of lionfish and was an unexpected result for commercial fishers testing these traps. Research by Hutchinson et al. (2019) had higher lionfish catch with top-entrance throats compared to other throat types. It was not clear if the top entrance facilitated lionfish entry into traps or reduced entry of other fish species. While throat design is a critical element in trap selectivity for many fish species (Li et al. 2006, Prajith and Madhu 2022), the observed increased catch of lionfish using top-entrance throats may reflect the reduction of catch of other fish species and the effect of

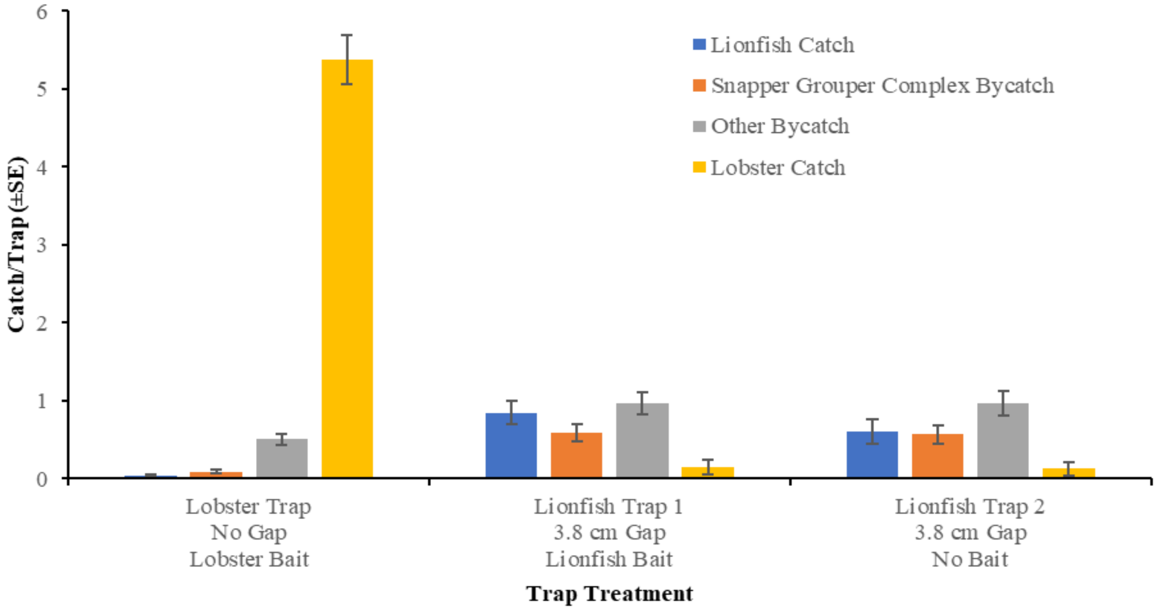

Figure 3. Average catch per trap (±SE) for each trap treatment. Trap treatments included standard lobster traps and experimental lionfish traps with narrow 5.4 cm top-loading throats and two 3.8 cm vertical escape gaps with or without a live lionfish as bait. “Other Bycatch” included all catch that was not lionfish, spiny lobster, or a species listed in the South Atlantic Fishery Management Council’s Snapper Grouper Complex.

bycatch reduction driving the increased catch of lionfish.

Previous experiments with commonly available baits (i.e. cat food, pigs’ feet, and dead mullet) did not increase lionfish catch but rather exacerbated the catch of commercially and recreationally important fish species (Hutchinson et al. 2019). Video observations of bait use provided some insight that schooling of small lionfish prey species in otherwise empty traps may act as bait and attract lionfish, but further testing of this hypothesis will need to be conducted. Lionfish catch per trap in modified traps using live lionfish as bait were not significantly different than those traps with no bait. However, due to low lionfish catch during the latter half of this study we were unable to bait half of all experimental traps deployed each research trip with a live lionfish. While there remains a possibility that live lionfish as bait may increase lionfish catch, observations aboard commercial vessels and discussions with commercial fishers indicate little desire to use lionfish as bait due to potential harm from venomous spines while handling live lionfish in traps and live wells. Additionally, using live lionfish as bait risks escapement of an invasive species back into the environment, and therefore may not produce benefits that outweigh the risks.

Fish traps are illegal in the State of Florida and adjacent federal management regions, apart from traps for black sea bass and some bait fishes. Creating a species-specific lionfish trap from a modified spiny lobster trap would allow fishers to use gear and traps they currently utilize with minimal associated modifications, cost, or change in familiar fishing methods. Florida spiny lobster fishers often use bottom long lines or lines of traps to facilitate rapid retrieval of hundreds of traps per day. Inserting a lionfish trap among a group of lobster traps resulted in an increased catch of lionfish in those modified traps and did not interfere with the rate of trap retrieval when pulled. Placing modified lionfish traps near structure resulted in higher lionfish catch per trap than randomly using traps throughout fishing lines. Lionfish prefer to aggregate on large, wide structures (Hunt et al. 2019), so having more knowledge of habitats or access to electronics to find suitable habitat would be beneficial when using modified traps. It remains unclear practically or economically if use of a modified lionfish trap could be a primary gear for fishers, or an addition to the suite of fishing gears used during a single fishing trip.

In other areas in the Caribbean, fishers who primarily catch lobster could utilize this modified trap to target lionfish for food and additional income. Fishers using traditional multispecies fish traps may be less interested in using a trap that limits catch of all other desirable fish to solely catch lionfish. However, modified lionfish traps could potentially be used within no-fishing MPAs to aid in lionfish population management and reduce the detrimental effects lionfish have on native species. Developing a species-specific trap in a high diversity, tropical reef ecosystem is problematic, but our results

Table 3. Summary of pairwise comparisons between trap types for lionfish catch, spiny lobster catch, Snapper Grouper Complex bycatch, and other bycatch. Results are presented on the response scale. Estimates represent the ratio of the estimated marginal means. Confidence interval (CI) ranges that contain the value of 1 indicate that there was not strong evidence of a difference.

Catch Type	Contrast	Estimate	SE	95% CI
Lionfish Catch	Lobster Trap – Lionfish Trap 1	0.054	0.023	0.020 - 0.15
	Lobster Trap – Lionfish Trap 2	0.071	0.033	0.024 - 0.21
	Lionfish Trap 1 – Lionfish Trap 2	1.33	0.42	0.63 - 2.81
Spiny Lobster Catch	Lobster Trap – Lionfish Trap 1	41.67	26.13	9.53 -182.3
	Lobster Trap – Lionfish Trap 2	41.35	34.85	5.69 - 300.5
	Lionfish Trap 1 – Lionfish Trap 2	0.99	1.04	0.084 - 11.7
Snapper Grouper Complex Bycatch	Lobster Trap – Lionfish Trap 1	0.16	0.05	0.077 - 0.34
	Lobster Trap – Lionfish Trap 2	0.17	0.05	0.083 - 0.34
	Lionfish Trap 1 – Lionfish Trap 2	1.04	0.29	0.54 - 2.01
Other Bycatch	Lobster Trap – Lionfish Trap 1	0.53	0.11	0.33 - 0.85
	Lobster Trap – Lionfish Trap 2	0.5	0.098	0.32 - 0.79
	Lionfish Trap 1 – Lionfish Trap 2	0.94	0.19	0.59 -1.50

indicate that both modified trap types tested caught approximately one lionfish out of every three to four fish caught (Table 4). While it is likely that air expansion injuries from pulling traps from depth could cause the death of fish caught in traps, it remains unclear whether those deaths are an acceptable loss relative to the long-term predation of lionfish on juvenile reef fish. Continued testing of our best trap design (a narrow 5.4 cm top-loading plastic throat, with two vertical 3.8 cm x 19.1 cm gaps) in real-world scenarios with commercial fishers near known lionfish aggregation sites or structure where lionfish are more likely to be located will be beneficial for understanding if this trap can be used to aid in the reduction of lionfish in waters invaded by these predators and help determine the economic opportunity for commercial fishers.

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Table 4. Total catch and percent of total catch for each trap type listed by species. Dark grey rows indicate bycatch species within the Snapper Grouper complex. Lobster bait, lionfish bait, and no bait indicate that lobsters, lionfish, or nothing was used as bait in each trap. N is the number of each trap type pulled per treatment .

	Lobster Trap - Standard		Lionfish Trap - Two Vertical, Narrow Gaps			
	Lobster Bait		Lionfish Bait		No Bait	
	(n = 214)		(n = 66)		(n = 86)	
Species	**#**	**%**	**#**	**%**	**#**	**%**
Acanthostracion quandricornis	51	4.00	26	15.39	21	10.77
Argopecten sp	0	0.00	0	0.00	2	1.03
Astropyga magnifica	0	0.00	2	1.18	2	1.03
Balistes capriscus	9	0.70	4	2.36	8	4.10
Calamus proridens	4	0.31	4	2.36	2	1.03
Chaetodon ocellatus	0	0.00	1	0.60	2	1.03
Dromiidae spp	1	0.08	2	1.18	2	1.03
Haemulon aurolineatum	0	0.00	3	1.78	3	1.54
Haemulon parra	0	0.00	0	0.00	2	1.03
Haemulon plumierii	0	0.00	2	1.18	5	2.56
Lachnolaimus maximus	2	0.16	9	5.33	20	10.26
Lutjanus analis	2	0.16	11	6.51	5	2.56
Lutjanus synagris	1	0.08	10	5.92	6	3.08
Menippe mercenaria	19	1.48	4	2.36	12	6.15
Monacanthus tuckeri	5	0.40	9	5.33	14	7.18
Panulirus argus	1151	89.4	10	5.92	11	5.64
Pomacanthus arcuatus	2	0.16	2	1.18	6	3.08
Priacanthus arenatus	0	0.00	5	2.96	9	4.62
Pterois spp	9	0.70	56	33.14	52	26.67

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