Traps with Gaps: Testing Fish Traps with Escape Gaps as an Option to Improve the Sustainability of the Reef Fishery in Montserrat

Trampas con Escape: Probando Trampas de Peces con Vías de Escape como Opción de Mejora de la Sostenibilidad de la Pesca en Arrecife en Montserrat

Pièges a Trous: Tester des Pièges a Poissons avec des Brèches pour Améliorer la Durabilité de la Pêche Récifale a Montserrat

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EXTENDED ABSTRACT

Fish traps are a commonly used fishing gear in the Caribbean (CRFM 2014, Mahon and Hunte 2001). They are minimally selective, catching a high diversity of fish, including juveniles and unwanted species (Jiménez and Sadovy 1996, Mahon and Hunte 2001). Traps are generally simple and cheap to build, requiring only basic materials such as wire mesh and wood that can be found easily in most locations. They can be fished on rough substrates where other gears, such as nets, might be damaged (Miller and Hunte 1987), and they don't need to be actively fished; most traps are left at sea for one or more days (Hawkins et al. 2007). All these factors contribute to their popularity as a fishing gear in the Caribbean. However, as with most fishing gears, there are several disadvantages of traps that can lead to unsustainable fishing pressure and so several management measures have been proposed. These management measures include escape doors to mitigate the impact of ghost fishing from lost traps (Selliah et al. 2001), increasing the mesh size to limit the number of juvenile fish that are caught (Sary et al. 1997), and spatial management to avoid traps being placed on sensitive substrates such as coral reefs (Mumby 2014). The management measure investigated here is the use of escape gaps: narrow gaps in the trap through which thin-bodied and small-sized fish can escape. Previous investigations of the effects of escape gaps on catch have found that they achieve an increase in the average length of the catch by allowing juvenile fish to escape, and can also reduce bycatch of less desirable thin-bodied fish such as butterflyfish (Condy et al. 2015, Johnson 2010).

We tested traps with (experimental traps) and without (control traps) 1-inch escape gaps in Montserrat in the Lesser Antilles. Montserrat has a relatively small number of active fishers but fish traps are used extensively, with a 2015 survey recording 157 traps around the island. We deployed a total of 40 traps through March – November 2018 in experimental-control trap pairs placed in close proximity. The positions of traps were kept approximately constant throughout the experiment and were recorded using a handheld GPS. Trap depths were recorded using a depth sounder. Following the practice of local fishers, traps were left to soak for two weeks between hauls, but if a trap could not be located or weather/ocean conditions made hauling dangerous, traps could be left till the next trip (i.e. 4 weeks between hauls). When hauled, all fish from were removed from each trap and put in bags that were tagged with an identification code that matched the traps. Species, weight and length of each fish was then recorded at the landing site.

The fishers, who set and hauled the traps, a data collector, and a local outreach officer were hired through a Youth Apprentice scheme, run in conjunction with the Montserrat Ministry of Education, Youth Affairs & Sports. This was done with the aim of building local capacity, offering employment to local youths, and so that the apprentices could act as ambassadors for the project.

Data analysis presented here is preliminary. Number of fish caught and biomass are summarized at the trap level, and length data are summarized at the individual fish level. Differences between the length, biomass, and number of fish caught in control and experimental traps were tested for using t-tests. All data were normalized using natural log transformation. Unpaired t-tests were used because trap pairs could not always be hauled together due to problems locating or reaching traps, therefore using only paired data would have required discarding data from unpaired trap hauls. Length data was further examined using a length-density histogram, used in place of a length-frequency histogram because total fish counts were different for control and experimental traps. To examine differences in the family composition of fish caught in experimental and control traps, 2-proportions Z-tests were used on the count data for each family group. To aid understanding of the results, families were grouped into two broad categories, thin-bodied and thick-bodied, based on the shape and size of the species within those families. Data analysis and visualization was done using R version 3.5.2 (R Core Team, 2018)

A total of 23 days at sea were spent hauling traps, and fish from 21 families and 58 species were recorded. Doctorfish (*Acanthurus chirurgus*) and Blue tang (*A. coeruleus*) were the most common species in the catch, representing 34.8% of all species recorded by number. Whitespotted filefish (*Cantherhines macrocerus*; 11.9%), Honeycomb cowfish

(*Acanthostracion polygonius*; 8.4%), Red hind (*Epinephelus guttatus*; 5.0%), and Squirrelfish (*Holocentrus adscensionis*, 3.6%) were the next most common species, with the remaining 52 species each representing less than 3% of the total number of fish, and combined totaling 35.9% of the catch by number.

The length of fish in control traps (23.6 ± 6.3 cm [mean ± sd], n = 1501) and experimental traps (24.1 ± 5.8 cm [mean ± sd], n = 1707) differed significantly (t(3054) = -2.78, p = 0.005), though the absolute difference is small. No significant differences were found for biomass (control = 3.70 ± 3.53 kg, n = 142; experimental = 3.69 ± 3.35 kg, n = 162) and number of fish ((control = 10.3 ± 9.2, n = 142; experimental = 10.5 ± 10.0, n = 162) in control and experimental traps (p > 0.9 in in both cases). Examining the length-density data for control and experimental traps suggests that the slightly lower mean length of fish caught in the control traps could be explained by the larger proportion of fish caught in the smaller size classes, specifically fish less than 16.5 cm in length (Figure 1).

The proportion of thin-bodied fish found in control traps was higher for all of the 5 families classified as thin-bodied (Figure 2), and significantly higher for Balistidae (Triggerfish; $\chi^2(1)$ = 33.9, p < 0.001), Chaetodontidae (Butterflyfish; $\chi^2(1)$ = 9.5, p = 0.002), and Monacanthidae (Filefish; $\chi^2(1)$ = 10.8, p = 0.001). Ten out of the 11 fish families classified as thick-bodied had higher proportions in the experimental traps, of which 5 were significantly different: Holocentridae (Squirrelfish; $\chi^2(1)$ = 6.8, p=0.009), Labridae (Wrasses; $\chi^2(1)$ = 9.9, p = 0.002), Lutjanidae (Snappers; $\chi^2(1)$ = 14.8, p < 0.001), Ostraciidae (Boxfishes; $\chi^2(1)$ = 5.1, p=0.02), and Scaridae (Parrotfish; $\chi^2(1)$ = 3.9, p = 0.048).

These initial results suggest that escape gaps reduced the proportion of the smallest fish being caught in the traps, while maintaining the same average biomass and number of fish as caught by the control traps. Fitting traps with escape gaps could therefore improve the sustainability of catches, by allowing juvenile fish to escape, while having limited effect on fishers livelihoods as landed biomass of catch is unchanged.

As would be expected, the traps with escape gaps caught proportionally fewer fish classified as thin-bodied compared to the control traps, presumably because these fish were able to escape through the gaps. The resulting reduction in butterflyfish, triggerfish and filefish, which are generally viewed as less desirable fish for market, could be beneficial for fishers, especially as there was a significantly higher proportion of snappers in the experimental traps (10.3% versus 6.5% in the control). However, the experimental trap also caught a slightly higher proportion of parrotfish compared to the control trap (1.8% versus 0.9%), though the absolute numbers caught were relatively small (31 versus 14). This is of potential concern as parrotfish are the principal algal grazers on most Caribbean reefs, therefore reducing their numbers can have negative impacts on reef health (Mumby et al. 2006).

KEYWORDS: Fish traps, pots, escape gaps, gear-based management, coral reef fisheries

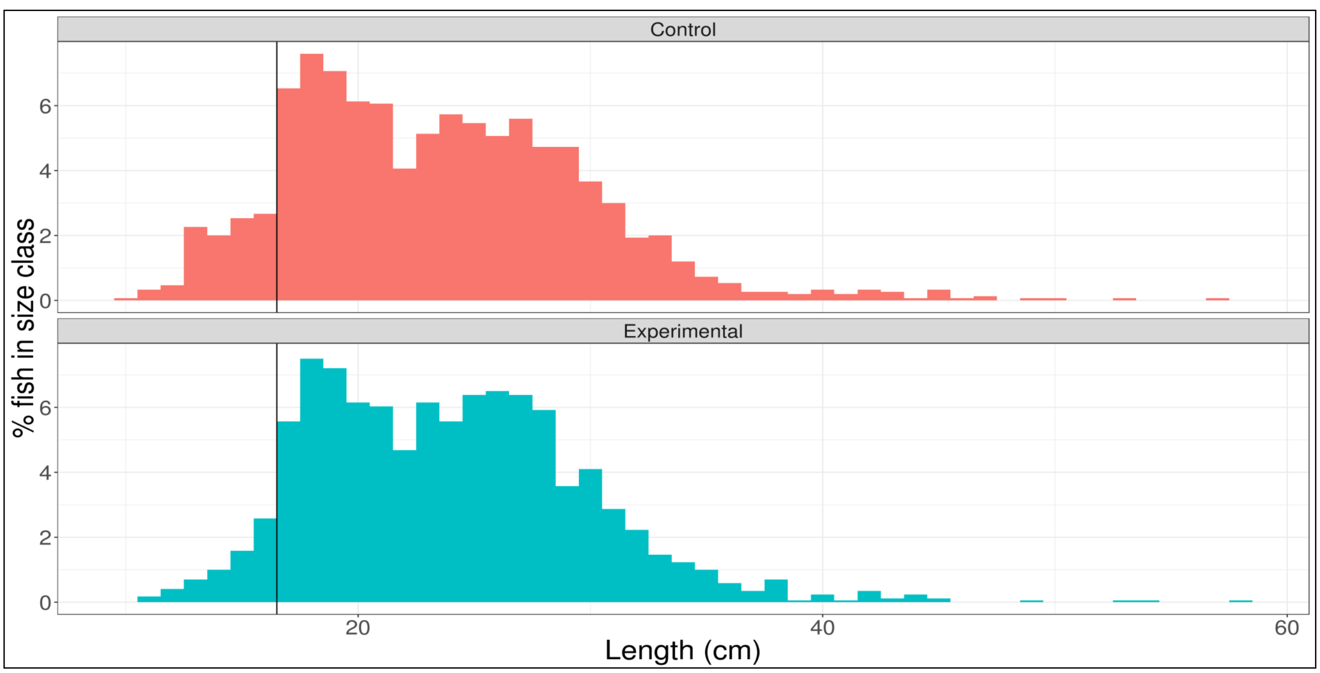

Figure 1. Length-density of fish in Control (top panel) and Experimental (bottom panel) traps. Height of bars correspond to the proportion of fish in each size class. Black vertical line is at 16.5 cm.

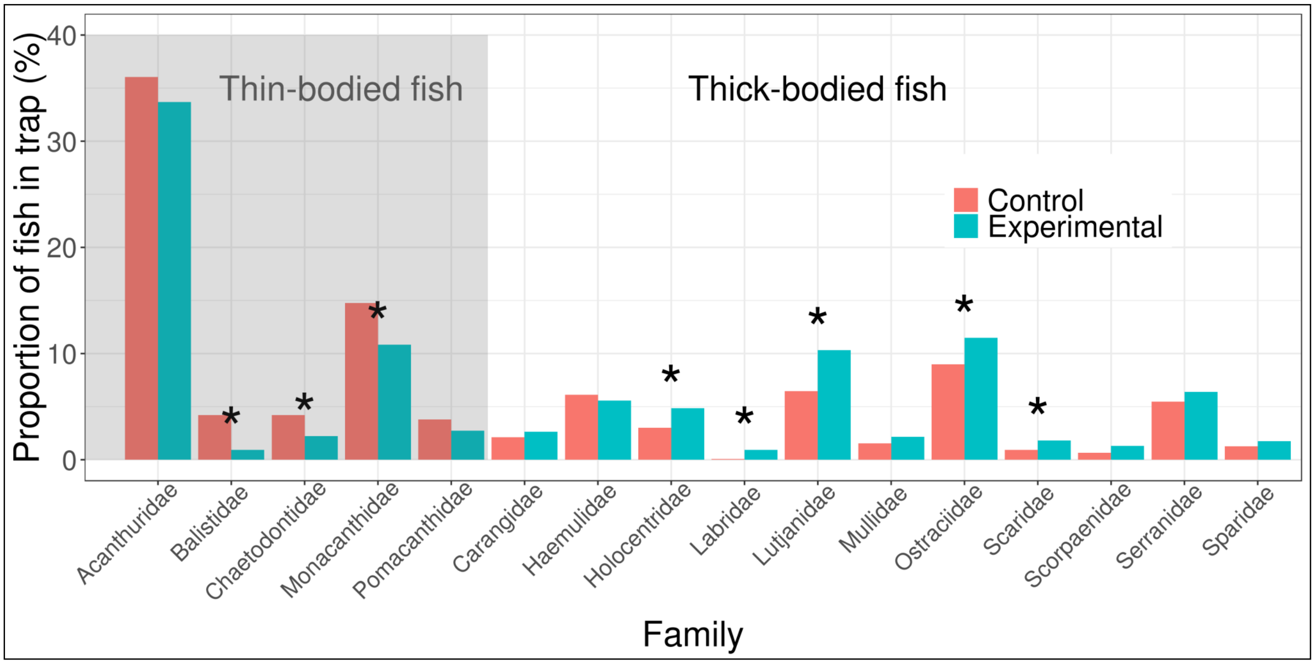

Figure 2. Proportion of each fish family in control and experimental traps. Shaded grey area indicates those fish classified as thin-bodied, remaining white area are fish classified as thick-bodied. Asterisk above bars indicates there was a significant difference between control and experimental traps ($p < 0.05$, 2-proportions Z-test)

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