Caribbean Spiny Lobster (*Panulirus argus*) Post-larval Collector Design: Problems and Perspectives

Diseño de Colector Post-larvales de la Langosta Espinosa de la Caribe (*Panulirus argus*): Problemas y Perspectivas

Conception du Collecteur Post-larves de la Langouste Épineux de Caraïbes (*Panulirus argus*): Problèmes et Perspectives

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EXTENDED ABSTRACT

Artificial collectors, in various forms, have been used over the years to monitor abundance of post-larval spiny lobsters in many different regions and for multiple species (Butler et al. 2010, Eggleston et al. 1998, Gutiérrez-Carbonell et al. 1992, Phillips 1972, Serfling and Ford 1975, Witham et al. 1968). The Witham collector was created in the 1960s using a ridged frame and 9 folded sheets of nylon webbing to capture Caribbean spiny lobster (*Panulirus argus*) post-larvae in Florida. It was designed to mimic nearshore macroalgae, the preferred habitat of spiny lobster post-larvae (Witham et al. 1968). In Florida, several modifications have been made to the Witham collector since its inception (see review by Phillips & Booth 1994). The modified-Witham collector made with a PVC pipe frame and 6 folded sheets of coconut fiber air conditioning filter material was used to monitor post-larval recruitment (i.e. arrival to the Florida Keys) starting in 1987 (Figure 1a). The coconut fiber air conditioning material used to make the modified-Witham collectors became difficult to acquire; as a result, in 2013, a new collector constructed using frayed ½ inch blue bi-polymer olefin fiber rope was developed as a replacement (Figure 1b). Herein, we compared the modified-Witham and frayed-rope collectors to evaluate durability of each collector type and post-larvae catch between collector types.

Spiny lobster post-larval monitoring occurred at two sites in the Florida Keys. Collectors were located in shallow water, less than two meters in depth, in the nearshore Atlantic Ocean waters near the islands of Big Munson and Long Key. From August 2013 until August 2017, modified-Witham and frayed-rope collectors were used simultaneously at both locations. Both collectors were supported by buoys, floated at the surface, and were anchored to the ocean floor. The collectors were checked 7 ± 2 days after the new moon each lunar month. All lobster post-larvae were counted and classified as clear, semi-pigmented, or pigmented pueruli, or as juvenile. All early juvenile stages were lumped into one juvenile category.

We first compared catch on each collector type based on the number of weeks collectors had been in the water (collector age) to determine whether the age of the collector affects catch. We analyzed data from each site separately, as the Long Key site experienced greater catch per collector on average than the Big Munson site. For the modified-Witham collectors, we ran a generalized linear mixed effects model with a negative binomial distribution using collector age, lunar month, and their interaction as categorical fixed --factors for the 23 years of modified-Witham data (1994 - 2017). We included lunar month as a factor due to the seasonality of the influx of post-larval lobster. We also included year as a random effect to account for annual variability in pueruli recruitment. We found that the mean catch-per-modified-Witham collector declined in week 12 and was significantly different from weeks 4 and 8 for both Big Munson and Long Key. Consequently, we dropped week 12 collectors from any further analyses, as they under-caught when compared to younger collectors. In contrast, we had insufficient data from the frayed-rope collectors to incorporate seasonality (lunar month) into the model. Consequently, we compared differences in catch for all dates that contained data from both a collector of the age being examined and collectors of other ages. From those results, both 4- and 24-week-old collectors under-caught compared to 8-, 12-, 16- and 20-week old collectors at both Big Munson and Long Key. Subsequently, we dropped 4- and 24-week old collectors from further analyses.

After adjusting the dataset for collector age, we compared differences between the collector types. Frayed-rope collectors caught more post-larvae in 10 out of 12 months at both Big Munson and Long Key (Figure 2). To eliminate month and year effects, we calculated the direct catch

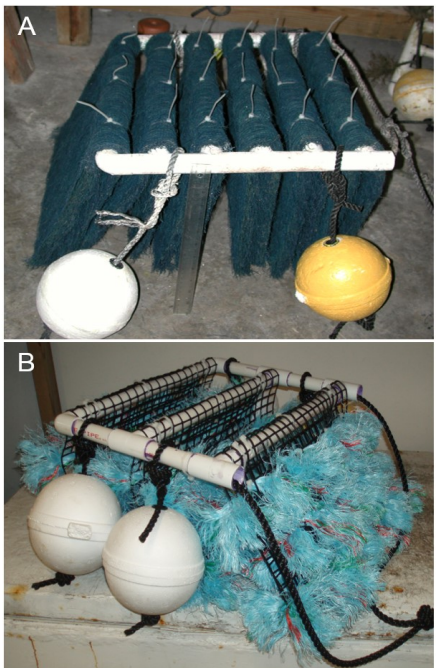

Figure 1. Modified-Witham (A) and frayed-rope (B) collector designs.

differences between modified-Witham and frayed-rope collectors by taking the mean catch of all modified-Witham collectors on a given date and subtracting that mean catch from every frayed-rope collector catch on that same date. The results indicated that frayed-rope collectors consistently caught slightly more than the modified-Witham collectors, but the annual cycle of post-larval recruitment was the same. There was no indication that catch on modified-Witham collectors ever reached a maximum, alleviating concerns that collector catch was saturated and peak lobster recruitment times were missed. Comparisons of collector lifespan indicate that the frayed-rope collectors were more durable. Previous research had demonstrated that 12 weeks was the effective deployment period for modified-Witham collectors before catch declined. After 12 weeks, the collectors were removed from the water, the pages discarded, and fresh material added before being redeployed. Results from this study indicate that modified-Witham collector catch declined after only 8 weeks. Collector age also affected catch for frayed-rope collectors: catch declined after 20 weeks and 4 -week old collectors caught significantly fewer lobsters and could not be used for monitoring post-larval lobster abundance. However, catch was consistent for 16 weeks, double the effective sampling duration of modified-Witham collectors. Frayed-rope collectors were also reusable, after being dried and cleaned, unlike modified-Witham collectors. Overall, frayed-rope collectors were more durable, reusable, and could be used to monitor post-larval lobster abundance for a longer time.

Catch comparison between the two types of collectors suggest that both collector types have similar seasonal catch patterns; however, the frayed-rope collectors had consistently higher catch. Consequently, the post-larval recruitment index value, calculated using monthly post-larval catch on collectors, can be compensated mathematically, allowing data from the frayed-rope collectors to be used in combination with the 23 years of modified-Witham data. Future research will focus on using this updated dataset to explore the potential relationship between post-larval recruitment and fishery landings.

KEYWORDS: Witham collector, *Panulirus argus*, recruitment, postlarvae, Florida Keys

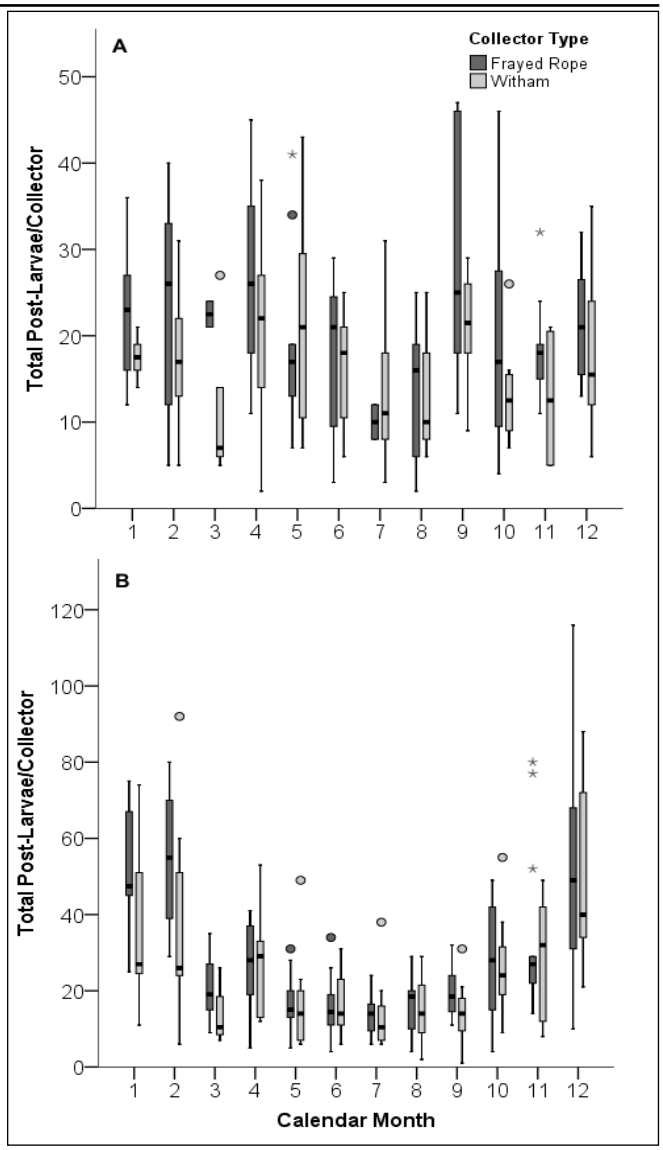

Figure 2. Box and whisker plot indicating total post-larval lobster per collector by month for frayed-rope and modified-Witham collectors at (A) Big Munson and (B) Long Key (2013–2017). The boxes indicate the interquartile range, the black bars within the boxes indicate the median value, the whiskers indicate the minimum and maximum values (excluding outliers), the circles represent outliers, and the asterisks represent extreme outliers.

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