Availability of post-larvae for grow-out aquaculture of the Caribbean spiny lobster *Panulirus argus*, in Florida, United States

Disponibilidad de postlarvas para acuicultura de la langosta espinosa del Caribe *Panulirus argus*, en Florida, Estados Unidos

Disponibilité de post-larves pour l'aquaculture de la langouste des Caraïbes *Panulirus argus*, en Floride, États-Unis

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EXTENDED ABSTRACT

Aquaculture of tropical lobsters from the collection of naturally settling post-larvae, also known as pueruli, is well established for several species of spiny lobster (Phillips and Matsuda, 2011). There is considerable interest in commercial scale grow-out of the Caribbean spiny lobster *Panulirus argus*, and the availability of pueruli was demonstrated for many locations throughout the species range (Butler *et al*., 2009). However, there has been little consideration of the effect of the removal of pueruli on lobster fisheries or the ecosystem. Herein, we measure the catch rate of pueruli using a frayed-rope modification to Witham style collectors relative to pueruli abundance in the Florida Keys.

In Florida, pueruli of the Caribbean spiny lobster, *Panulirus argus*, are relatively easily collected using Witham style or frayed rope collectors (Hutchinson *et al*., 2024). However, the abundance of pueruli on collectors varies between years, across months, and within months. Recent research has indicated that pueruli recruitment during a few key months each year was highly correlated with subsequent landings (Hutchinson *et al*., 2024). This research established a relationship between pueruli recruiting to the Florida Keys and future landings, but it also identified the potential that pueruli recruitment during some months may be underrepresented in the adult population due to natural mortality or other post-settlement processes. If pueruli recruiting in certain months are not represented in the adult population, these animals might be captured and diverted to grow-out aquaculture with little or no impact on landings in the lobster fishing industry.

With the support of an aquaculture grant from the Atlantic States Fisheries Management Commission Award Number: NA17NMF4720269, we measured the efficiency of collectors at catching settling pueruli from the environment. To do this, we needed to know (among other things) how many pueruli the collectors "have a chance" to sample; that is, how many pueruli were there in the water mass that moves past the collectors. Though the real value of this number is impossible to determine, we could estimate the relative efficiency of pueruli collectors (a biased sampling tool) compared to plankton nets (an unbiased sampling tool).

Nearly all previous research on the dynamics of pueruli settlement and recruitment indicates that pueruli recruitment peaks following the new moon. Pueruli selectively utilize nocturnal flood tides for transport to nearshore waters. We began our experiment February 23, 2020, during the new moon and sampled nightly through the week. We deployed 16 frayed rope collectors near Long Key in the Florida Keys and allowed them to soak in the water for about four weeks before pueruli collections. The day before the experiment began, 10 of the 16 collectors were cleaned of any lobster pueruli and juveniles that might have settled during the collectors' seasoning period. Each of the cleaned collectors was randomly assigned to one of two groups: 1) collectors to be checked daily during the experiment; or 2) collectors to be checked once, one week after the new moon. The six collectors that were not cleaned at the start of the experiment were checked one week after the new moon, on the same day as group two above, and thus constituted one entire month of post-larval settlement. By checking collectors daily following the new moon, one-week post-new moon, and one- month post-deployment, we could compare the nightly, weekly, and monthly pueruli catches on collectors to look for performance differences. We towed plankton nets from our 8m research vessel during the nighttime flood tide during the week of our experiment. Every night, net tows began a half hour before the start of the flood tide and ceased a half hour after the end of the flood tide. Nets were towed continuously throughout the tide, but every half hour the nets were brought onboard the vessel, their contents emptied into a sorting tray, and then returned to the water. On average, nets were on board the vessel for no longer than a minute before being returned to the water. We measured the volume of sea water filtered placing a flow meter in the mouth of the plankton net and placed another flow meter co-located with the collectors. The volume of filtered seawater was determined by calculating the "distance" traveled by the flow meter and multiplying that by either the cross-sectional area of the net opening (for plankton net samples) or by the cross-sectional area of the post-larval collectors. Thus, we can volume-normalize the pueruli catches for the nets and collectors for comparisons. For collectors assigned to the weekly and monthly groups, volume filtered was calculated as the sum of the nightly volumes measured at the collectors during the week of the experiment.

The maximum number of pueruli collected by net in one night during our experiment was 65, and the maximum number of pueruli was 73 on monthly collectors and 64 off the weekly collectors. Therefore, comparing the volume of water needed to collect 65 pueruli using nets (~7,000 cubic meters) versus the volume filtered by the collectors to catch similarly (~30,000 cubic meters)indicating that the collectors function at roughly 26% of the efficiency of plankton nets.

We can also estimate this efficiency ratio by dividing the total number of pueruli caught on the weekly collectors (64) by the sum of number of pueruli caught every night during the experiment (210), and that yields an efficiency estimate of 30%.

We estimated the effect of collection of lobster pueruli on natural recruitment dynamics by comparing catch rates of plankton tows and deployable frayed rope collectors. We considered the amount of plankton-tow caught pueruli a proxy for the total number of postlarvae in a water mass. Collectors caught roughly 26-30% of the pueruli caught with plankton tows representing a small but not negligible fraction of the pueruli in the sampled water volume. However, from a larger perspective the consideration of the lobster life history, the Caribbean-wide distribution of the lobster population, and the volume of water transporting pueruli nightly into nursery grounds appear to remain the principal factors to consider regarding the effect of pueruli capture on the lobster population. Specifically, the over 90% estimated natural mortality rate of pueruli and early-stage juveniles before they reach maturity, current modelling that suggests the Keys may be a sink for lobster larvae (Kough et al., 2013), and the negligible fraction of nocturnal flood tidal water a collector or even thousands of collectors would sample. suggesting collection of lobster pueruli in the Florida Keys poses little risk to the pan-Caribbean population. Alternatively, grow-out aquaculture of pueruli has been considered for fishery enhancement or at least mitigation in other lobster fisheries that have aquaculture sectors (Gardner *et al.*, 2006).

KEYWORDS: *Panulirus argus*, spiny lobster, pueruli, Florida, aquaculture

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