



**Project Report**

**Caribbean Spiny Lobster (*Panulirus argus*) Juvenile Recruitment Study  
Port Honduras Marine Reserve, Belize 2014**

Pruski S, Foley JR 2014



James R. Foley, MSc.  
Science Director  
Toledo Institute for Development & Environment

# Project Report

## Caribbean Spiny Lobster (*Panulirus argus*) Juvenile Recruitment Study

### Port Honduras Marine Reserve, Belize 2014

Conducted by Toledo Institute for Development and Environment, Belize 2014

Funded by KfW

Project carried out by Ms. Sarah Pruski, Undergraduate, Texas A&M University

Project design, supervisor, editor: Mr. James R. Foley, MSc, Science Director, Toledo Institute for Development & Environment

Field & technical support: Dr. Daryl Smith, Visiting Researcher, Toledo Institute for Development & Environment

## Table of Contents

<b>1. Abstract</b> .....	<b>3</b>
<b>2. Introduction</b> .....	<b>3</b>
<b>3. Background and Rationale</b> .....	<b>4</b>
<b>4. Materials and Methods</b> .....	<b>4</b>
<b>5. Results</b> .....	<b>7</b>
<b>6. Discussion</b> .....	<b>9</b>
<b>7. Conclusion</b> .....	<b>10</b>
<b>8. Acknowledgements</b> .....	<b>11</b>
<b>9. References</b> .....	<b>11</b>

## 1. Abstract

*Panulirus argus*, the Caribbean Spiny Lobster, is an essential fishery product for Port Honduras Marine Reserve (PHMR) area. It is crucial to study these crustaceans to develop management practices that foster sustainable population density and avoid potential decline or collapse of local lobster fisheries. Replenishment Zones (RZs) in PHMR are protected from any form of extraction, theoretically protecting adult spawning lobsters and enabling larval recruitment via 'spill-over' into the General Use Zone (GUZ). The Toledo Institute for Development and Environment (TIDE) is being required by the Belize Fisheries Department to expand the area of RZs in PHMR in accordance with contemporary fisheries science recommending at least 20% of marine reserves to be under full protection to promote fisheries sustainability. This study aimed to i) determine population abundance of pueruli in different areas of PHMR under different management regimes (RZs and GUZ) using Lobster Attraction Devices (LADs), to determine which areas foster the highest densities of juvenile lobsters and ii) provide evidence to determine effectiveness of different management zones at promoting lobster recruitment and replenishment. This information will increase the understanding of the impact of management zones on the PHMR lobster fishery, enabling adaptive management designed to sustain the crucial lobster fisheries and livelihoods of stakeholders who rely on the fishery as their livelihood. This study compared the GUZ, current RZs, and new RZs agreed to between TIDE, BFD and fishers during 2013 consultations but not yet legally established. A subsequent study will be carried out in the same areas after enforcement of the newly proposed RZs to determine if they have had a beneficial effect on lobster recruitment and maturation or if new RZs need to be implemented in other areas of PHMR. This will feed into the wider RZ expansion project being carried out by TIDE and TNC in 2014 to develop a new zoning strategy for the reserve. Unfortunately, LADs placed in RZs were damaged and stolen, so this experiment was unable to compare the juvenile lobster recruitment in the GUZs and the RZs. However, the LADs that were placed in the GUZs were found to foster pueruli which increased our understanding of the habitats and areas that juvenile lobsters are likely to recruit in PHMR.

## 2. Introduction

The Caribbean Spiny Lobster generates 60% of the revenue produced by all fisheries in Belize, making it the most economically important harvested species in the country (Wade et al. 2011). With increasing numbers of fishers in recent years (Wade et al. 2011) the lobster population is at risk of not being able to sustain the increasing fishing pressure as indicated by decreasing size and age of the lobsters and local fisher feedback (Foley, 2012). The monitoring of lobster juvenile recruitment can provide early warning signs of potential fisheries decline in the future, enabling adaptive fisheries management based on sound scientific evidence. Juvenile lobster recruitment can be monitored by the placement of Lobster Attraction Devices (LADs) in areas throughout the reserve in locations that harbor juvenile lobster habitat. These areas were chosen using local ecological knowledge (LEK), remote sensing, and habitat ground-truth surveys.

In order to mature, postlarval lobsters must live in a habitat where they will find shelter and nourishment. Pueruli migrate during the new moon towards shore and settle in hard-bottomed, shallow areas with complex structured habitats such as macroalgae, seagrass, and mangrove edges

(Phillips, 2013). The complex nature of their shelter shields the lobsters from predators, and provides a habitat to many prey of the lobster such as gastropods, isopods, and amphipods (Herrkind et al, 1997).

### 3. Background and Rationale

PHMR is a collection of mangrove cayes, seagrass beds, coral reefs, mudflats and submerged banks covering over 414 km<sup>2</sup> of the Maya Mountain Marine Corridor (Robinson et al, 2004). The surrounding buffer communities of Monkey River, Punta Negra, and Punta Gorda rely on the reserve and its marine fauna for their livelihood. There are currently three management zones in place to sustain the fisheries of the surrounding communities. The General Use Zone (GUZ) constituting 95% of PHMR, is where regulated extractive activities are allowed. The No Take Zones or Replenishment Zones (RZs) are areas where only non-extractive activities are allowed and make up 4% of PHMR. The last 1% of PHMR is the Preservation Zone (PZ) where only research activities are allowed (Foley, 2013). In 2013, TIDE held numerous stakeholder consultations in the three buffer communities, resulting in consensus among stakeholders to expand the RZs. The increase in RZ size however falls short of the recommended 20% of the reserve necessary to achieve fisheries sustainability, and it is therefore necessary to demonstrate the positive effects of the small increase in order to build confidence among stakeholders that expansion of RZs results in higher productivity of commercial species in the longer term.

In the past, there has been a deficiency in the information about the lobster population in PHMR. TIDE identified the need to better promote healthy numbers of juvenile lobsters reaching maturity by determining when and where juvenile lobster recruitment is high in PHMR and recommending that these areas become RZs. This information will also facilitate understanding of the relationship between adult spawning lobsters in the existing RZs and the larval dispersal into the rest of PHMR.

This information has provided a better understanding of juvenile lobster recruitment in PHMR and will aid in proposing future areas for RZs and maintain the fisheries of the Monkey River, Punta Negra, and Punta Gorda communities.

### 4. Materials and Methods

#### *Lobster Attraction Devices*

The LADs were made into a modified Witham style collector (Withman et al., 1968) using hog's-hair air conditioning filters and ¾ inch thick PVC pipes. PVC L-bars and T-bars were used to construct the PVC pipes into a collector frame measuring approximately 26 cm x 25 cm x 24 cm for sunken devices and 26 cm x 25 cm for the floating devices. All of the PVC pipes, L-bars, and T-bars were connected using waterproof glue.

Each LAD had 12 "pages" of hog's-hair filters attached to the frame. To attach the filter, a line of rope was strung across the LAD frame to create 4 horizontal lines. The pages were attached by cutting a 50 cm x 26 cm piece of hog's-hair filter, folding it in half across a line of rope and then two zip ties were used to secure the filter in place. Pueruli often seek shelter in habitats with a high abundance of *Neogoniolithon* spp. or *Laurencia* spp., both species of red algae, during their maturation into adulthood





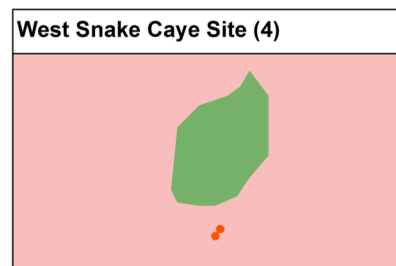
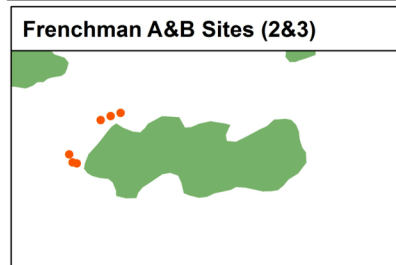
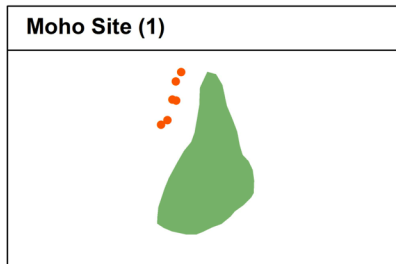
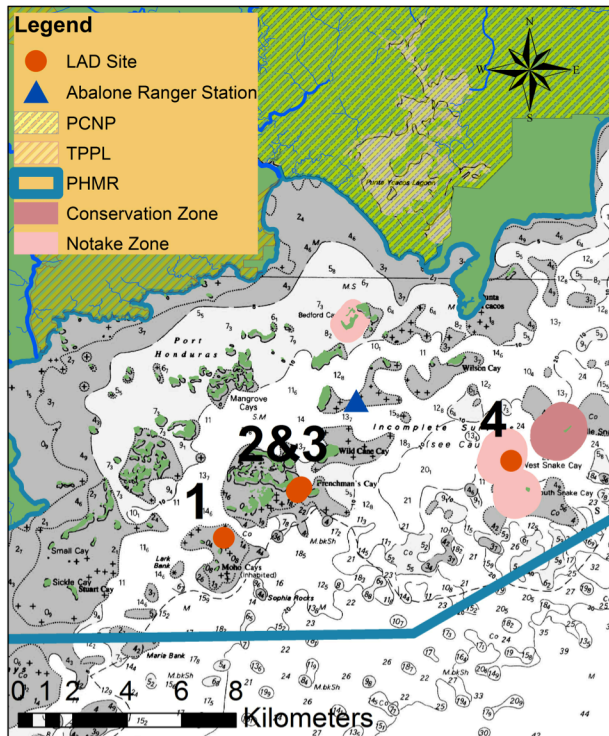
Figure 1. Top: Profile and aerial view of floating LAD; Bottom: profile and aerial visual of sunken LAD.

(Bos, 2003). Therefore, the hog's-hair filters are designed to imitate the architecturally complex structure of these macroalgae to encourage the pueruli to seek the LAD for shelter. Once each LAD was constructed, the LADs were placed into the ocean at a depth of 3m for 14 days to rid them of any manufactured chemical odors that might deter recruitment, and to allow algae and smaller organisms to inhabit the LADs in order for them to have a more natural appearance before deployment. When we retrieved the LADs after 14 days, many had begun to deteriorate already, so we cleaned the LADs of any current organisms and repaired them before deploying them. In future studies, a shorter amount of time in the water and setting the LADs at a deeper depth may reduce the deterioration of the LADs. For deployment, each LAD was attached to a cinderblock by a rope so that the LAD would stay in place, and floating LADs were tied to the rope halfway between the buoy and the sunken LAD. All LADs were buoyed with floats, in order for the floating LADs to remain buoyant and for them to be easily located.

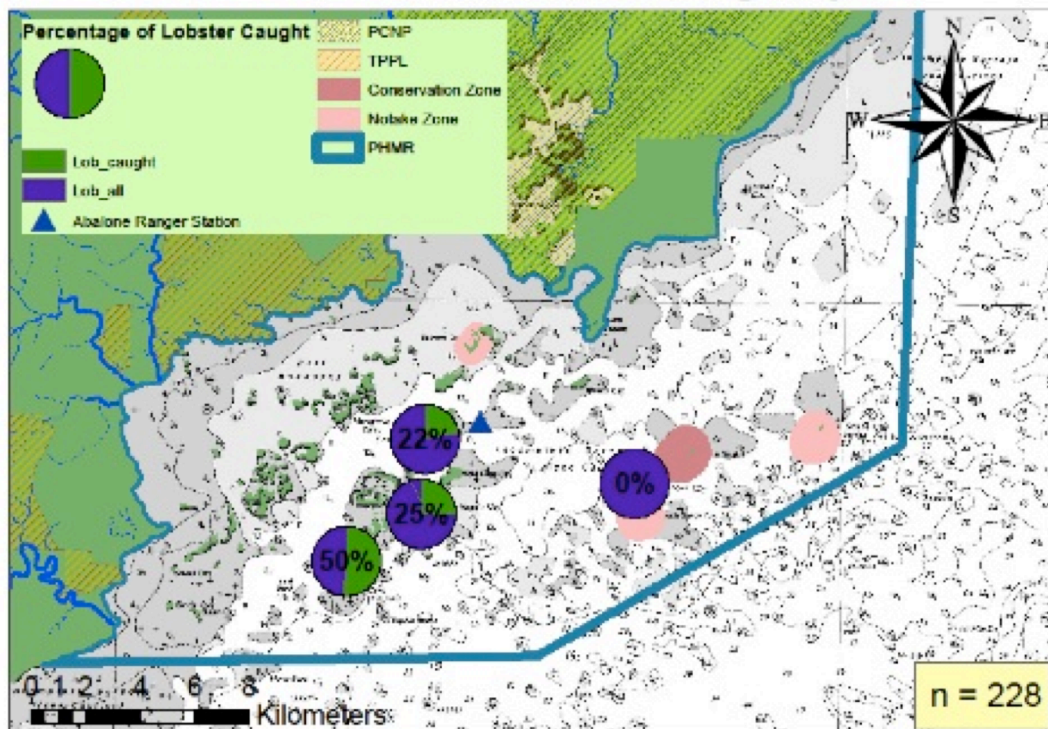
### **Study Site**

A total of 26 LADs were deployed, 14 sunken LADs and 12 floating LADs. Two sunken LADs were deployed inside the existing RZ at West Snake Caye. Twenty-four LADs were deployed in the GUZ to determine which areas are most important for juvenile recruitment. Six sunken and six floating LADs were deployed behind the TIDE pilot seaweed farm near Moho Caye; each floating-sunken LAD pair was placed at 30m apart. Six sunken and six floating LADs were deployed at Frenchman Caye, three floating and three sunken on the west side of Frenchman Caye and the remaining on the South side of the caye.

## Site Description - LAD Locations



## Distribution of Total Lobster Caught by Site



Again each floating-sunken LAD pair was placed at 30m apart. All of these areas are shallow (3-5m) where juvenile lobsters have been noted by fishermen and contain red algae, mangroves, and sea grass, *Thalassia testudinum*, which are habitats where juvenile lobsters are often found (Bos, 2003). Each LAD was placed in an area where the sea would be most calm to avoid further deterioration. After each LAD was deployed, the coordinates of its location were taken using a GPS.

### *Surveying Methods*

Post-larval lobsters exhibit mass-migration towards shore from the open ocean during the new moon period, therefore the LADs were deployed June 21, six days before the new moon on June 27<sup>th</sup>, so that the largest amount of pueruli could be collected (Herrkind et al., 1997). Due to resource and scheduling restrictions, each site was sampled only twice. The first sampling was on July 5<sup>th</sup> and 6<sup>th</sup>, two weeks after initial deployment. The LADs were untied from their rope and cinderblock and brought onto the boat. Then, each page of the LAD was searched through thoroughly and each organism found was placed onto a tray. Once the LADs were clean, the LADs were redeployed at their original locations. The organisms found were then counted and then placed back into the ocean at a location a distance away from the LAD. At each sampling the location, date of retrieval, coordinates, depth, condition of the trap, and number of lobsters and other organisms were recorded. The LADs were sampled again 5-6 days after re-deployment and the process was repeated, with the exception that the LADs were kept and not re-deployed.

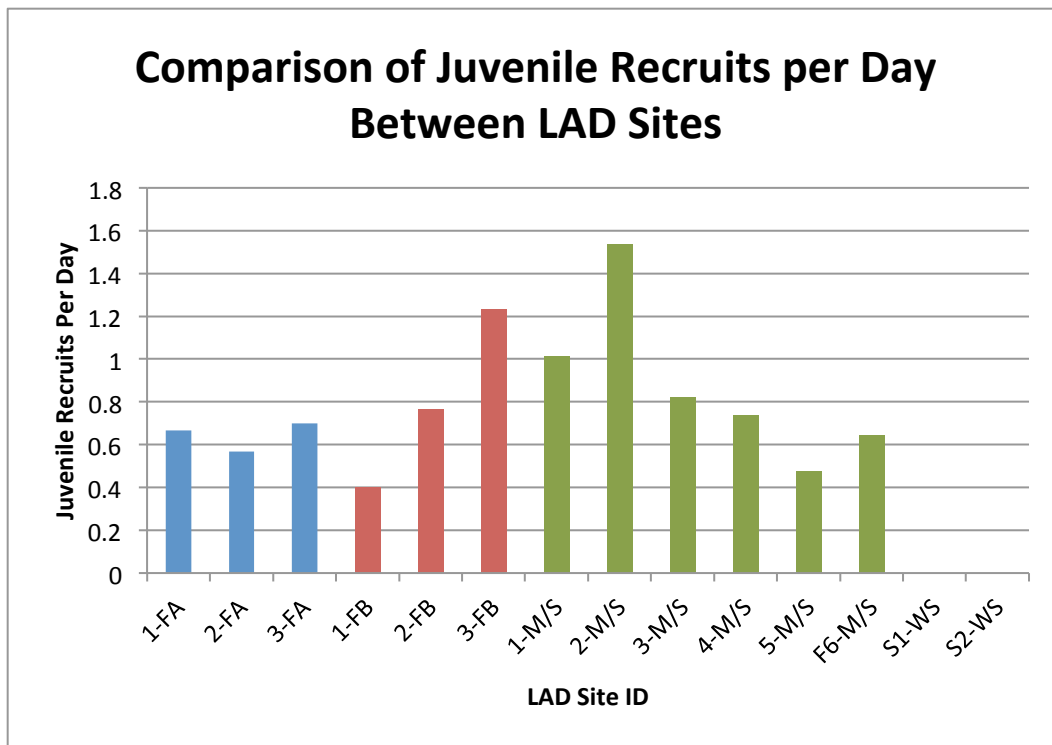
## **5. Results**

A total number of 179 post-larval *P. argus* were collected in this study. 40 juvenile lobsters were collected from Frenchman A, 44 from Frenchman B, and 94 from Moho/Seaweed. Because of the lost trap at West Snake and damage to the remaining trap, no juvenile lobsters were collected at that location. The LADs at both Frenchman Caye and Moho/Seaweed Caye were deployed for a total number of 20 days.

Comparing the values from Frenchman A and Frenchman B using a t-test, there is not a statistically significant ( $p > 0.05$ ) difference in the total juvenile lobster recruitment between those two locations, so for comparison to Moho/Seaweed, Frenchman A and B were combined as “Frenchman” data. Using an unpaired t-test the Lobsters Recruited per Day was compared between Frenchman and Moho/Seaweed locations. The calculated value was  $p = 0.4594$  ( $p > 0.05$ ), therefore there is not a statistically significant difference between the Lobsters Recruited per Day values of these two sites.

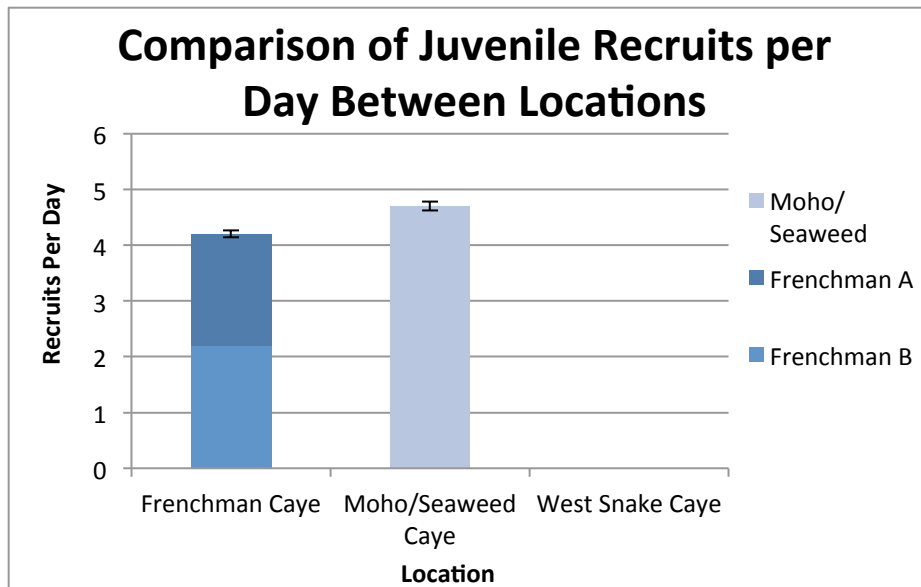
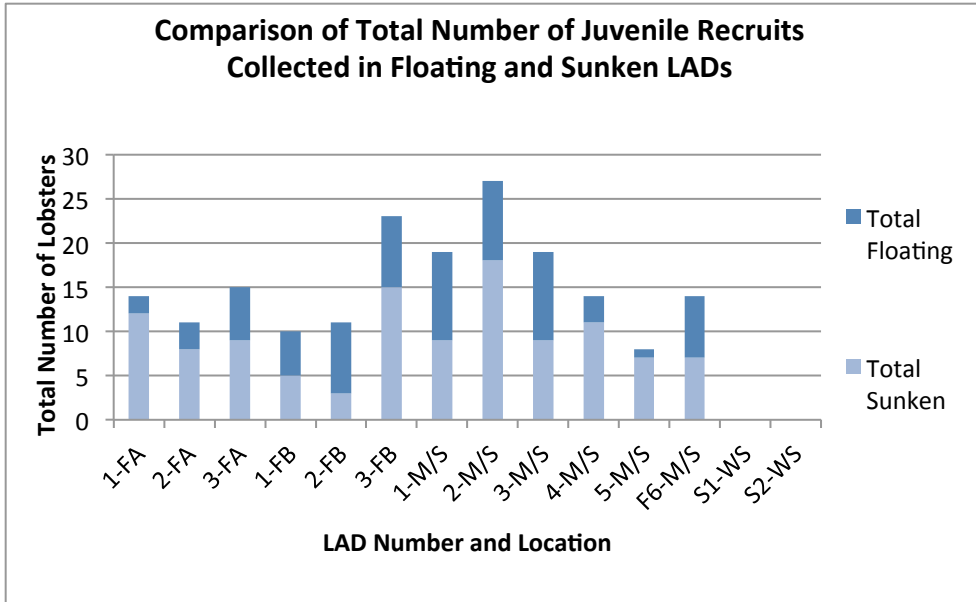
Table 1: Total juvenile lobster recruits collected at each site

Site	LAD	Total Lobsters Collected	Total Number of Days	Lobsters per Day
Frenchman A	Site 1	14	20	0.70
	Site 2	11	20	0.55
	Site 3	15	20	0.75
Frenchman B	Site 1	10	20	0.50
	Site 2	11	20	0.55
	Site 3	23	20	1.15
Moho/Seaweed	Site 1	19	20	0.95
	Site 2	27	20	1.35
	Site 3	19	20	0.95
	Site 4	14	20	0.70
	Site 5	8	20	0.40
	Site 6	14	20	0.70
West Snake	Site 1	N/A	22	0.00
	Site 2	N/A	N/A	0.00



A total of 113 pueruli were collected in the sunken LADs, and 72 were collected in the floating LADs. There was a statistically significant ( $p < 0.05$ ) difference between the total number of lobsters collected in floating and sunken LADs using an unpaired t-test.





## 6. Discussion

High numbers of pueruli were collected at Frenchman Caye sites and Moho/Seaweed Caye with a mean of 4.45 juvenile lobsters per day. This suggests that both of these areas are important for the recruitment of post-larval *P. argus* most likely because of their shallow, calm waters and hard, sea grass inhabited bottoms. However, the scope of our study was narrow; therefore, other areas in PHMR may be equally as important to the growth and recruitment of juvenile lobsters. Further studies and

monitoring of these areas should be put into place to determine if these areas truly have the highest frequency of juvenile lobster recruitment.

Unfortunately because of the condition on the LADs at West Snake Caye, we cannot draw any conclusions on the recruitment of juvenile lobsters to the area. Therefore, we cannot determine the recruitment capacity of existing RZs with the newly proposed RZ expansion areas. For future studies, in order to prolong the life of the LAD, we recommend locating areas within the RZs that have calmer waters to deploy the LADs and securing the pages to the LAD more solidly to prolong the life of the LAD. Another recommendation would be to design an LAD that would be able to withstand stronger currents. Additionally, signs should be placed on the buoy of the LAD to ensure that passing fishermen know not to disturb the LADs.

Although the floating LADs were found to have sunken to the bottom at several of the sites because of an improper amount of floats, there was still statistically significant evidence to support that sunken LADs are more preferred to juvenile lobsters for recruitment. This suggests that pueruli take shelter in the sea grass and algae on the ocean floor. When using floating LADs in the future, tie small floats onto the LAD to ensure that it remains floating throughout its entire deployment period for a more accurate comparison between sunken and floating LADs.

## 7. Conclusion

The data from the study suggests that areas of PHMR are very important for the post-larval settlement of the Caribbean spiny lobster. High numbers of pueruli were found in both Frenchman and Moho/Seaweed areas with a substantial lobster per day ratio. Many areas of the reserve still remain to be studied to verify that these areas offer the most effective juvenile lobster recruitment.

The use of LADs proved to be an efficient technique in the collection of pueruli, and should be used again in the future. Many of the LADs only lasted up to two weeks without air filter deterioration; therefore, repair materials for the LADs should be factored into the budget for future studies. Additionally using a mesh net to retrieve the LADs from the water would provide a way to trap any loose pueruli that could fall off of the LAD. This would ensure accuracy in the collection data for each site.

For future studies, we would recommend broadening the scope of the project and testing all areas throughout PHMR that foster juvenile lobster habitat, calm waters at 3-5m depth with sea grass bottom (Bos, 2003). Sampling the LADs before and after the new moon could provide evidence to verify the time of month that juvenile lobsters are more likely to recruit. This information would further the understanding of juvenile lobster recruitment and aid in determining which areas would be most beneficial for RZ expansion.

## 8. Acknowledgements

- **Dr Daryl Smith PhD** – Technical support
- **Ms. Julia Baker** – Fieldwork and GIS support
- **TIDE Marine Rangers** – Fieldwork assistance
- **TIDE Community Researchers** – Fieldwork assistance
- **PHMR Fishers** – Local ecological knowledge on lobster recruitment

## 9. References

- Bos, Arthur R., Clark, Sascha, & Gore, Shanon.** (2003). Preliminary observations on habitat use of juvenile Caribbean spiny lobster (*Panulirus argus*) in South Caicos, Turks & Caicos Islands. In *Proceedings of the Gulf and Caribbean Fisheries Institute* (Vol. 54, pp. 230-40). Gulf and Caribbean Fisheries Institute.
- Foley, James** (2012). Managed Access: Moving Towards Collaborative Fisheries Sustainability in Belize. *Proceedings of the 12<sup>th</sup> International Coral Reef Symposium, Cairns, Australia.*
- Herrnkind, W. F., & Butler IV, M. J.** (1997). A test of recruitment limitation and the potential for artificial enhancement of spiny lobster (*Panulirus argus*) populations in Florida. *Canadian Journal of Fisheries and Aquatic Sciences*, 54(2), 452-463.
- Phillips, Bruce.** (2013). *Lobsters: Biology, Management, Aquaculture & Fisheries*. Edition 2. John Wiley & Sons, 189-192.
- Robinson J, Cushion N, Coleman R, Gomez L, Diamond E, Villafranco J, Garbutt D, Martin L, Muschamp M.** (2004) A Biological Study and Resource Value Assessment of the Port Honduras Marine Reserve. Toledo Institute for Development and Environment
- Wade B, Gibson J, Mahung C, Epstein L, Castaneda A, Maaz J, Requena N.** (2011) Managed Access for Glover’s Reef and Port Honduras Marine Reserves – Managed Access Design and Framework. *International publication, Belize Fisheries Department.*
- Witham, R., Ingle, R. M., & Joyce, E. A.** (1968). *Physiological and ecological studies of Panulirus argus from the St. Lucie estuary* (Vol. 53, p. 31). Florida Board of Conservation Marine Laboratory.