PORT HONDURAS MARINE RESERVE: SPINY LOBSTER STATUS REPORT

2020

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1.0 INTRODUCTION

The Port Honduras Marine Reserve (PHMR) is a unique coastal protected area that spans estuarine areas where watersheds exit into the coast, to lagoonal coral reef communities inside the main barrier reef. This marine protected area was established in 2000 with an area of 40,468 Ha and co-managed by the Toledo Institute for Development and Environment (TIDE). It extends approximately 8 km out to sea in the southern barrier lagoon. The PHMR includes a range of ecosystems from coastal wetlands to mid lagoonal reefs (a unique reef type along the Belize Barrier Reef). It also contains extensive seagrass beds and surrounds over 100 mangrove cayes (Wildtracks 2017). It supports important artisanal commercial fisheries for spiny lobster and queen conch, in southern Belize. It serves as an important buffer between the southern mainland and the main barrier reef, with five majors watersheds exiting in the area.

The focus of the marine protected area is fisheries management with the majority of this marine reserve a general use zone (95%), open to fishing, where commercial, subsistence and recreational fishing are allowed. Four replenishment or no-take zones are designated (4%) around West, East and South Snake Cayes and West Cane Cayes, where non-extractive recreational activities are allowed. There is a preservation zone (1%), 0.8 km radius around Middle Snake Cayes, where only research activities are allowed (Figure 1) (Wildtracks 2017). One of the main management goals of the PHMR is to return the abundance of commercial fishing species to sustainable levels by reducing pressure. The primary conservation target related to this is that by 2020, Fisheries Department and TIDE will identify and improve at least three responsible and effective fishing techniques in collaboration with PHMR fishers. In order to achieve this target one of the important management strategies is to have an established and sustained research and monitoring program, that can provide the scientific data needed on commercial population status and trends to inform adaptive management and decision making.

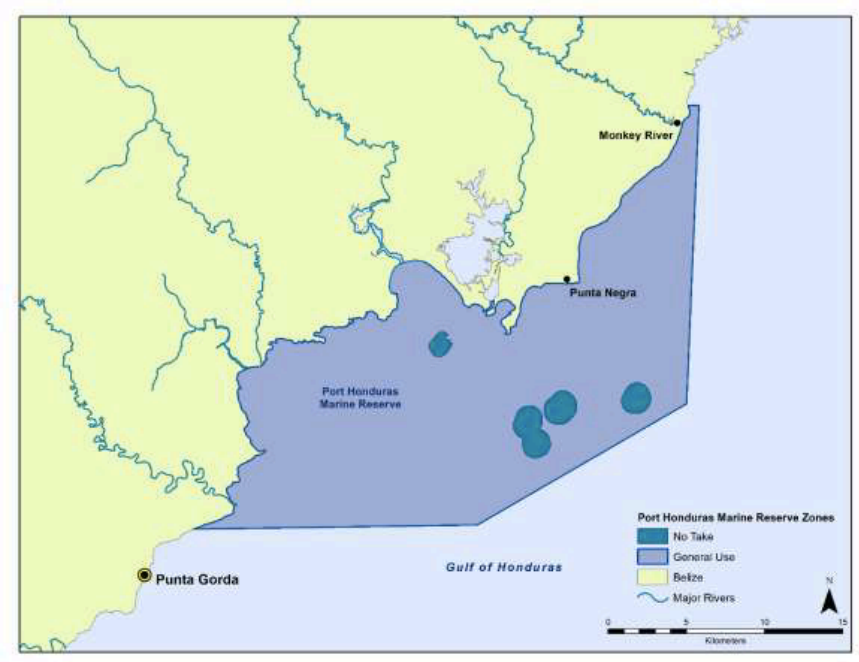


Figure 1 PHMR Zones, from the PHMR Management Plan 2017-2021 (Wildtracks 2017)

2.0 METHODOLOGY

Since 2004 TIDE has been monitoring the populations of the commercially important species, spiny lobster (*Panulirus argus*), across twenty-one sites within the management zones of the marine reserve and a few outside, adjacent to the marine protected area (Figure 2). This long-term monitoring has produced information on population abundance, population structure, size and reproductive state of this important species. In 2013 TIDE produced a Benthic Commercial Species Audit 2009-2013 to inform adaptive management for Managed Access, which provided a comprehensive report on the health of commercially exploited species in the PHMR. In 2019, TIDE completed a comparative assessment on spiny lobster for the period 2009-2019 highlighting trends in population abundance, size and reproductive status as a means of assessing the effectiveness of the Managed Access as a fisheries management tool.

This current report gives an update for 2020 and in comparison, with 2019 results. Data was collected just after the open season near the end of February 2020, and then again near the end of the closed season in late May 2020. Data collection followed previous methodology used with spiny lobster population surveys, that of timed swims to estimate abundance using catch per unit effort (CPUE) estimates. At each site, two divers swam and searched reef patches for approximately 30 minutes. Some sites with larger patches

took a little longer and some with very small patches took less. At a few sites up to 4 divers searched for lobsters. For each lobster caught or found, the species, carapace length (CL) and gender were determined by visual examination, where it was possible to capture the lobster without harm (TIDE 2019). Females were checked for the presence of eggs and tar spots. During February 2020, only twenty sites out of twenty-two were surveyed. In May 2020, twenty-one sites were surveyed. In total, there were 8 within the replenishment zones (RZ), 10 in the general use zones (GUZ) and 4 outside the reserve (OUT) (Figure 2).

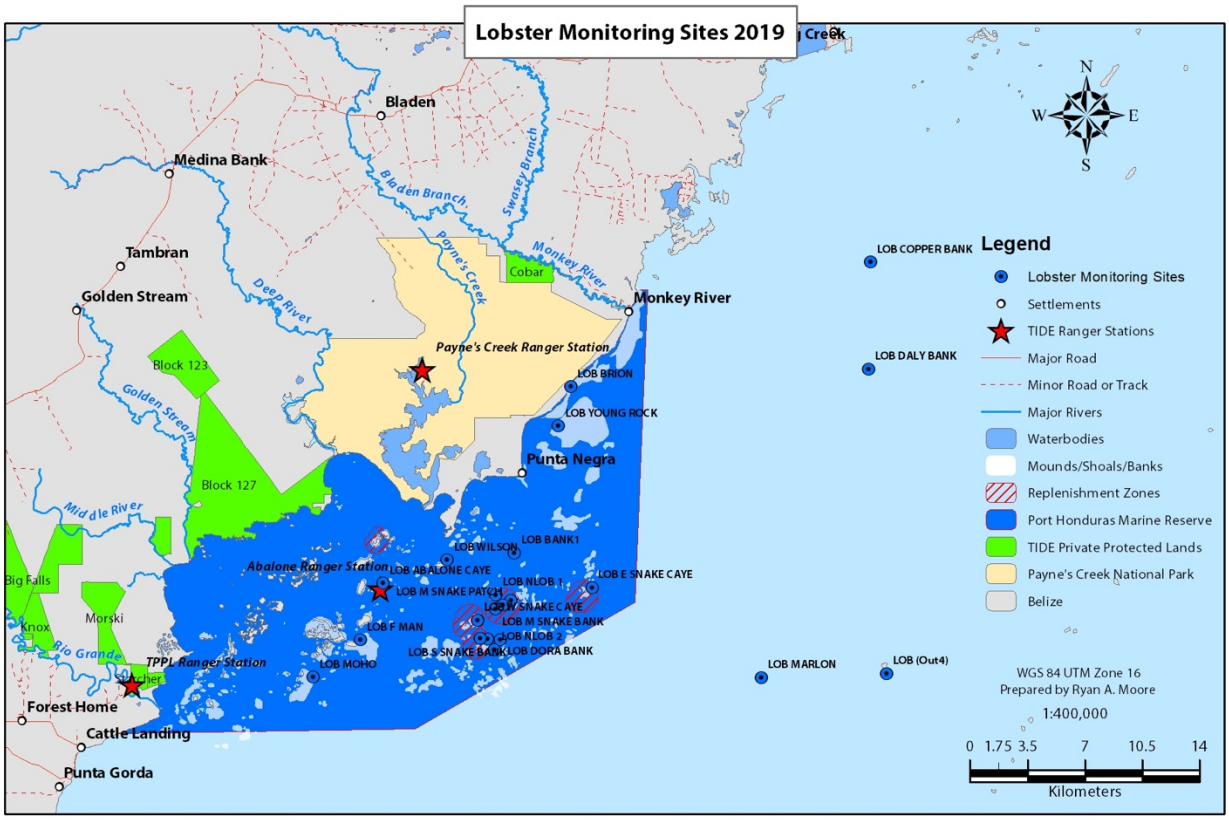


Figure 2 Spiny lobster monitoring sites within the PHMR and adjacent buffer area (TIDE 2019)

3.0 RESULTS

In 2020, TIDE conducted its annual population surveys of spiny lobsters across twenty-two (22) of its long-term sites, between February 21-24, 2020 just after the end of the open season and again between May 25-28, 2020 near the end of the closed season. These results provide information on the status of the lobster population in PHMR and indicate whether there was any recovery during the closed season, February 15th to June 14th. Assessment of spiny lobster population status focuses on four main variables: abundance,

size, gender and reproductive status. Abundance is measured as Catch Per Unit Effort (CPUE), which is the number of lobsters encountered per unit of fishing effort, usually a man hour. For spiny lobsters, the standard body measurement used to record size is carapace length, which is the length of the upper half of the body from between the eyes to just above the start of the tail, measured in cm. The legal size for harvesting is a carapace length of 3 inches or 7.6 cm. Gender, whether male or female, is determined based on anatomical features, and maturity and reproductive status of the females is recorded based on the presence of eggs and/or tar spots.

Mean spiny lobster abundance, expressed as mean CPUE, from all sites at the end of the open season was very low at 1 lobster hr^{-1} (±0.2 Standard Error, S.E.), and only slightly higher at end of the closed season, with a mean CPUE of 1.6 lobsters hr^{-1} (±0.3 S.E.). The mean carapace length (CL) at the end of the open season was 9.0 cm (±0.5 S.E.) and at the end of the closed season was 7.8 cm (±0.6 S.E.). Of the twenty sites surveyed at the end of the open season, seven had no spiny lobsters encountered. Of the twenty-one sites surveyed near the end of the closed season, six sites had no spiny lobsters encountered (Table 1).

At the end of the open season, at sites that had lobsters, abundance ranged from 1 lobster hr^{-1} at Frenchman Caye to 3.3 lobsters hr^{-1} at Bank 1 (Figure 3). After three months, near the end of the closed season in May, abundance had increased slightly with CPUE ranging from 0.6-3.5 lobsters hr^{-1} (Figure 3).

Mean carapace length (CL) was similar between the open and closed seasons. At the end of the open season, it ranged from 5 to 11 cm and at the end of the closed season mean carapace length ranged from 4.5 to 11 cm (Figure 4). While the mean carapace length in February was higher than that in May (9.0±0.5 S.E. cm vs. 7.8±0.6 S.E. cm), it was not a significant difference between the two seasons*, p-value = 0.077416* (one-tailed Student T-test, at significance level of 0.05). The size difference between males and females was compared for both seasons. In February, at the end of the open season, females were larger than males, with mean CL of 9.6 cm (±0.6 S.E.) and 8.1 cm (±0.6 S.E.) respectively (Figure 5). This size difference was not significant, *p*-value of *0.064229* (one-tailed Student T-test, at significance level of 0.05). At the end of the closed season in May, however, both females and males had the same mean CL of 8.4 cm (±0.55 S.E.) (Figure 5).

Size frequency charts for all lobsters were plotted and showed that in February, 83% of lobsters encountered were over the legal-size limit of 7.6 cm (Figure 6a). In May, near the end of the closed season, 64% were over the legal-size limit (Figure 6b). Size frequency of female lobsters showed that majority were in the 7.6-10 cm and 10.1-12.5 cm size ranges at the end in February 2020, but in May 2020 size distribution was more evenly split

among the various size ranges (Figures 6c, d). Male lobsters had a majority in the 7.6-10.1 cm size range at the end of the open season (February 2020) and then were also more evenly distributed during May 2020 (Figures 6c, d).

In terms of sex ratio, in February at the end of the open season, there were more females than males with 52%:33%, female to male lobsters, and 14% unknown or undetermined. In May, at the end of the closed season, there were more males than females with a ratio of 64%:36% or 16:9 males to females (Figure 7). At the end of the open season there was a high proportion of female lobsters found with eggs and tar spots, 63.6% and 54.5% respectively (Figure 8). At the end of the closed season, significantly less females were found with signs of reproductive activity, 6.3% with eggs and 12.5% with tar spots (Figure 8).

When the data was compared by management zones, it was observed that the replenishment zone had the highest mean CPUE of 2 lobsters/hour at the end of the closed season (±0.5 S.E) but the lowest mean CPUE at the end of the open season, 0.8 lobsters/hour (±0.4 S.E.) (Figure 9). The area outside the marine reserve had the highest mean CPUE at the end of the open season, 1.2 lobsters/hour (±0.5 S.E.) (Figure 9). The general use zone had the lowest mean CPUE at the end of the closed season with 1.3 lobsters/hour (±0.5 S.E). Mean spiny lobster carapace length (CL) was compared among management zones also, with the replenishment zone generally having the larger sized lobsters (9.7 cm and 8.1 cm) followed by the sites outside the PHMR (9.3 cm and 8.5 cm) (Figure 10). The general use zone had the smallest sized lobsters for both periods surveyed, 7.6 and 7.1 cm respectively. It was observed that mean carapace length was larger for all zones at the end of the open season than at the end of the closed season but were not significantly different (*p-values >0.05*, one tailed Student T-test) (Figure 10).

Mean abundance and mean carapace length from 2020 were compared with previous years' data (2017-19) using TIDE's 2019 Port Honduras Marine Reserve Benthic Commercial Species Update Report. Based on trends from over the last four years, spiny lobster abundance showed a gradual decline in all management zones from 2017-2019 (Figure 11) and the decline continued in 2020, with CPUE of 1.3-2.0 lobsters hr^{-1} (Figure 9). Mean carapace length however showed a steadier trend and in 2020 was similar to the previous years, ranging from 7.6-9.7 cm (Figures 12 and 10).

Overall lobster abundance was very low with most lobsters measuring just above the legal size and in general larger lobster being present at the end of the open season, in February. Whereas in previous years male lobster were the more abundant, in 2020 males were more abundant only at the end of the closed season in May. There were also a lot more mature and reproductively active females in February than May.

Table 1 Summary of Catch Per Unit of Effort (CPUE: # lobsters hr^{-1}) and Mean Carapace Length (CL) in cm, from twenty-two monitoring sites in the Port Honduras Marine Reserve

		Feb-20	May-20	Feb-20		May-20	
ZONES	*SITE*	*CPUE (# lobsters/ hour)*	*CPUE (# lobsters/ hour)*	*Mean Carapace Length, CL (cm)*	*Standard Error*	*Mean Carapace Length, CL (cm)*	*Standard Error*
GUZ	Abalone Caye		0.6			5.0	0.0
	Bank 1	3.3	1.8	-	-	4.5	0.5
	Brion Bank		0.0			-	-
	Dora Bank	2.7	2.7	9.8	0.6	9.3	1.2
	East of South Snake Caye	0.0	2.7	-	-	11.0	0.6
	Frenchman Caye	1.0	2.4	8.0	0.0	5.5	0.3
	Moho Caye	0.0	2.9	-	-	7.3	1.1
	NLOB 2	0.0	0.0	5.0	0.0	-	-
	Wilson Caye	1.0	0.0	-	-	-	-
	Young Rock	0.9	0.0	-	-	-	-
OUT	Copper Bank	1.8	1.0	8.0	0.0	5.0	0.0
	Daly Bank	1.0	3.1	10.0	0.0	9.6	0.4
	LOB (OUT4)	2.0	0.0	U	U	-	-
	Marlon Bank	0.0	2.4	10.0	0.0	11.0	1.1
RZ	East Snake Caye	2.8	2.7	10.5	0.5	6.2	2.5
	Middle Snake Bank	1.7	3.5	-	-	9.5	0.3
	Middle Snake Caye	0.5	1.8	8.0	2.0	7.5	2.5
	Middle Snake Patch	0.0	0.0	8.0	0.0	-	-
	NLOB 1	0.8	2.9	11.0	0.0	10.0	0.7
	South Snake Bank	0.0	1.9	-	-	9.5	3.5
	West Snake Caye	0.8	1.0	11.0	0.0	6.0	0.0
	South Snake Caye	0.0		-	-		

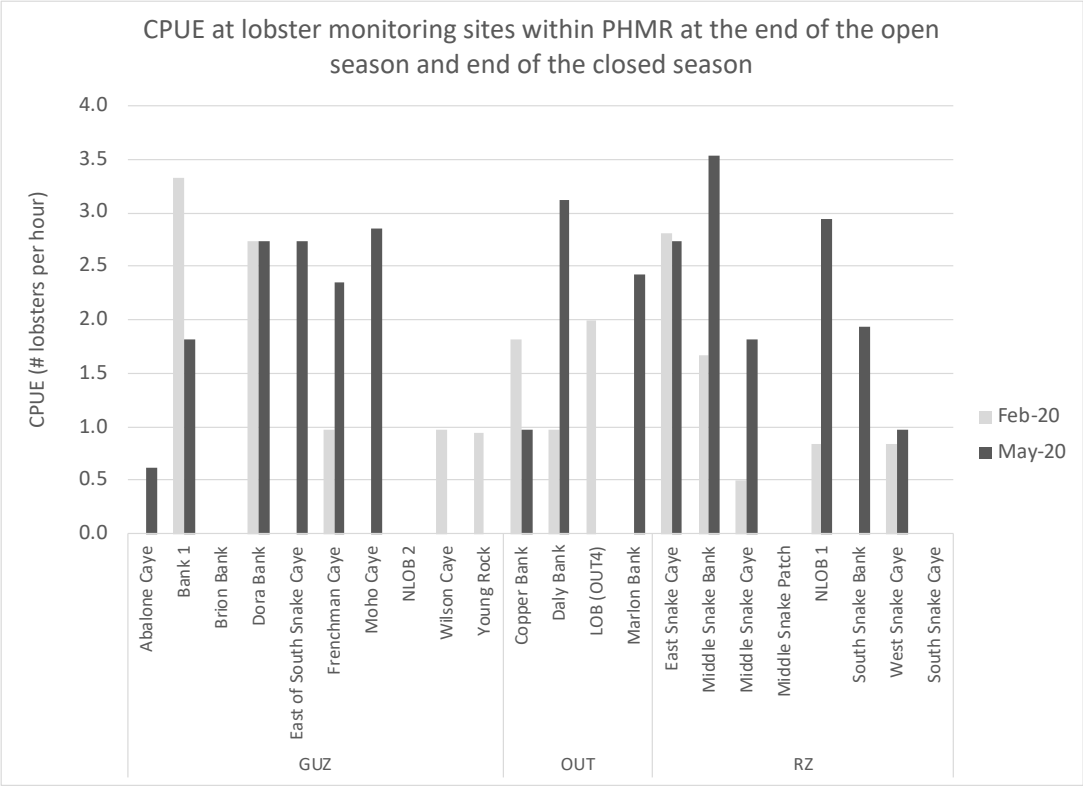


Figure 3 Abundance of spiny lobster as Catch Per Unit of Effort (CPUE) at twenty-two sites surveyed within the PHMR in February and May 2020 (GUZ-General Use Zone, RZ-Replenishment Zone, OUT-Outside Reserve)

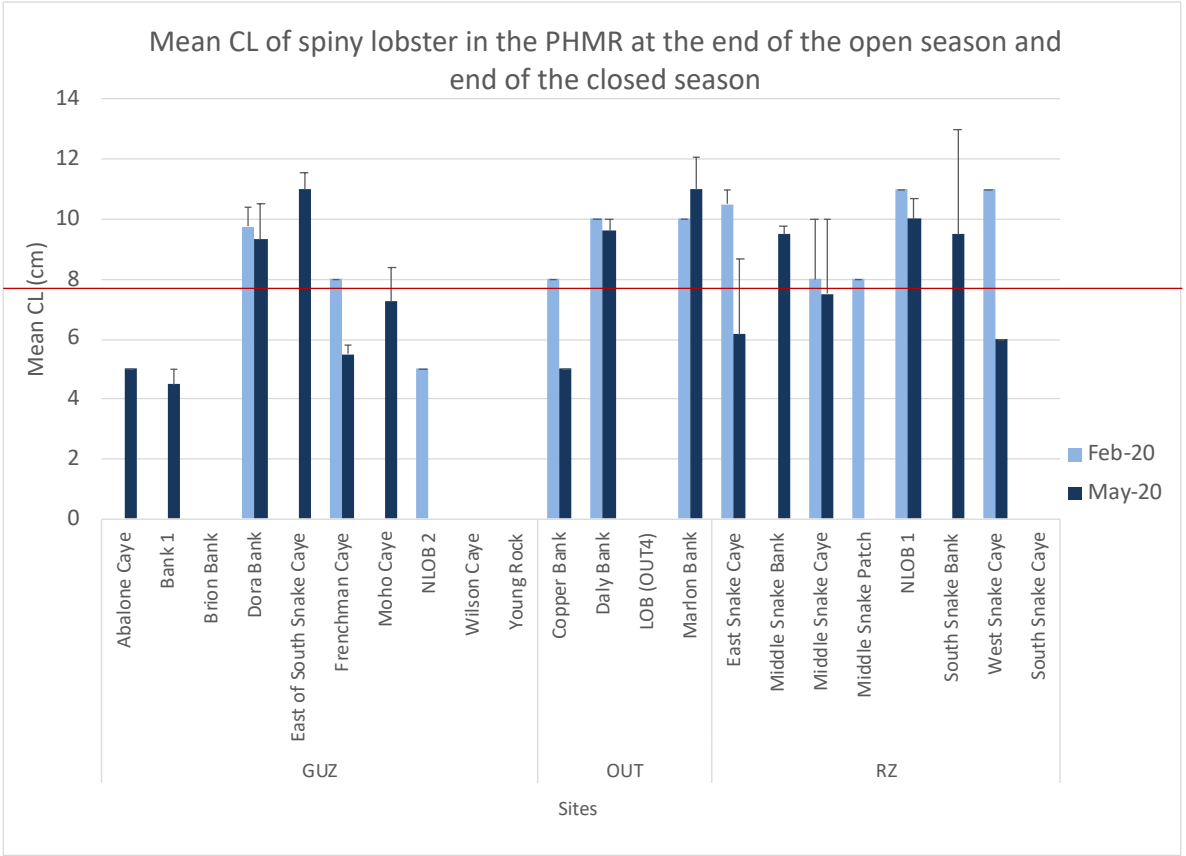


Figure 4 Mean carapace length (CL) in cm of spiny lobster, surveyed at sites within the PHMR during February and May 2020 (GUZ-General Use Zone, RZ-Replenishment Zone, OUT-Outside Reserve) (±Standard Error Bars, S.E.); red line indicates legal size limit of 7.6 cm.

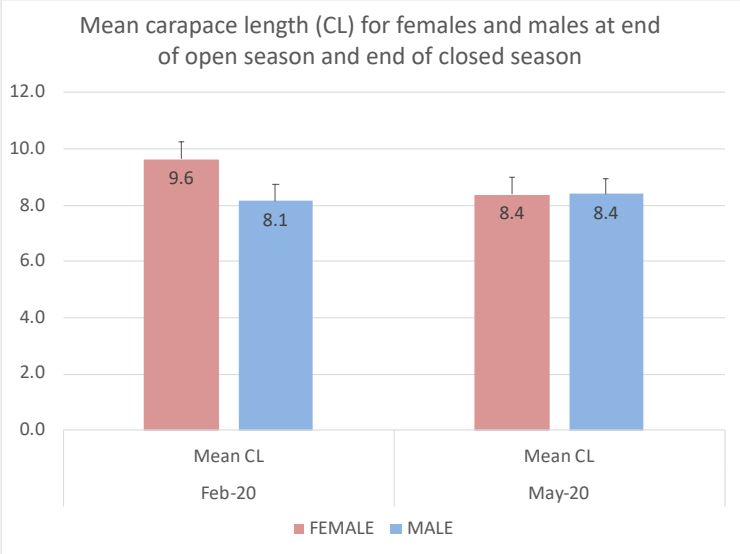
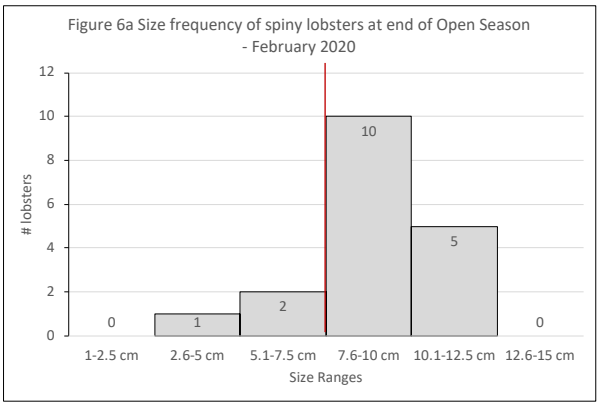


Figure 5 Mean carapace length (CL) in cm for female vs. male spiny lobsters, surveyed at sites within the PHMR during February and May 2020 (±Standard Error Bars, S.E.)



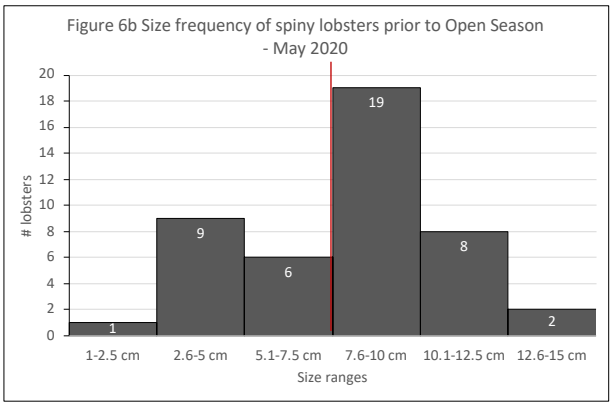
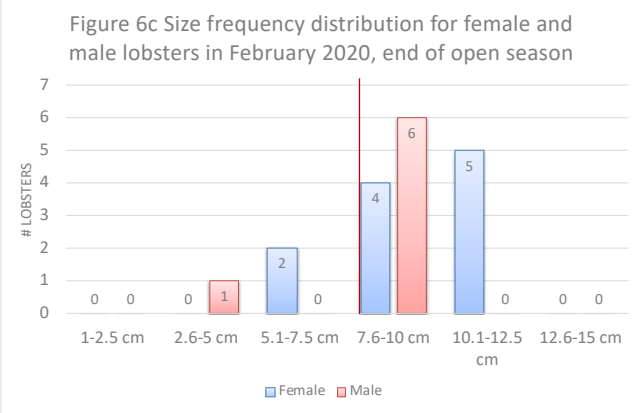


Figure 6a and b Size frequency distribution (cm) for all spiny lobsters surveyed within the PHMR, in February and May 2020, vertical line denotes legal size limit of 7.6 cm



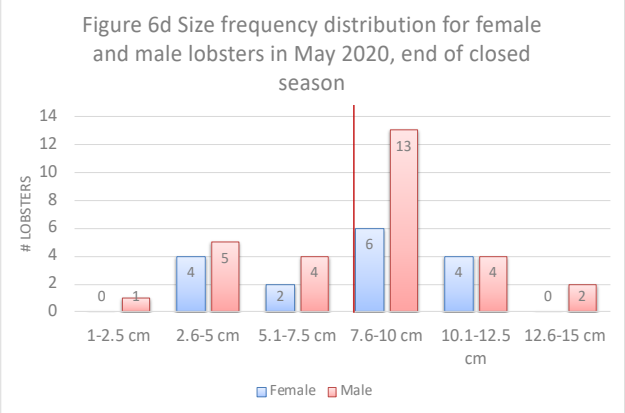
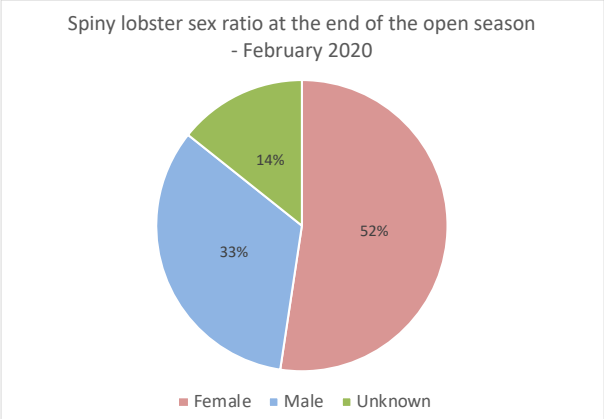


Figure 6c and d Size frequency distribution (cm) for female and male lobsters surveyed within the PHMR, in February and May 2020, vertical line denotes legal size limit of 7.6 cm



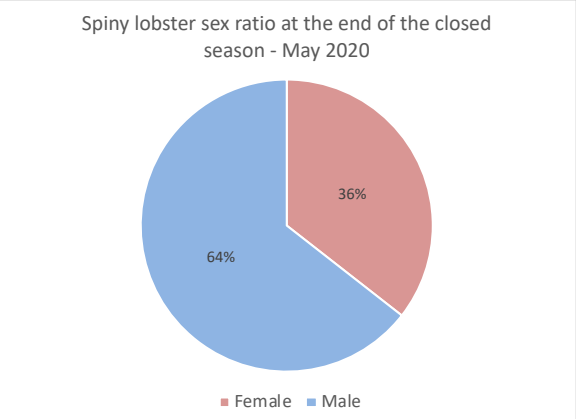


Figure 7 Sex ratio for spiny lobsters surveyed within the PHMR at the end of the open season and end of the closed season, Unknown are lobsters that were sighted but not caught nor the sex determined

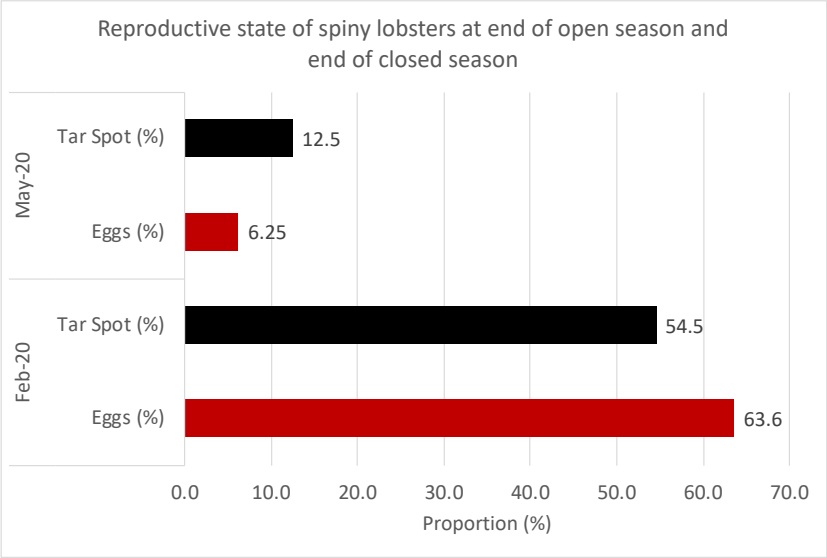


Figure 8 Proportion of female spiny lobsters encountered with tar spots and eggs from sites surveyed within the PHMR

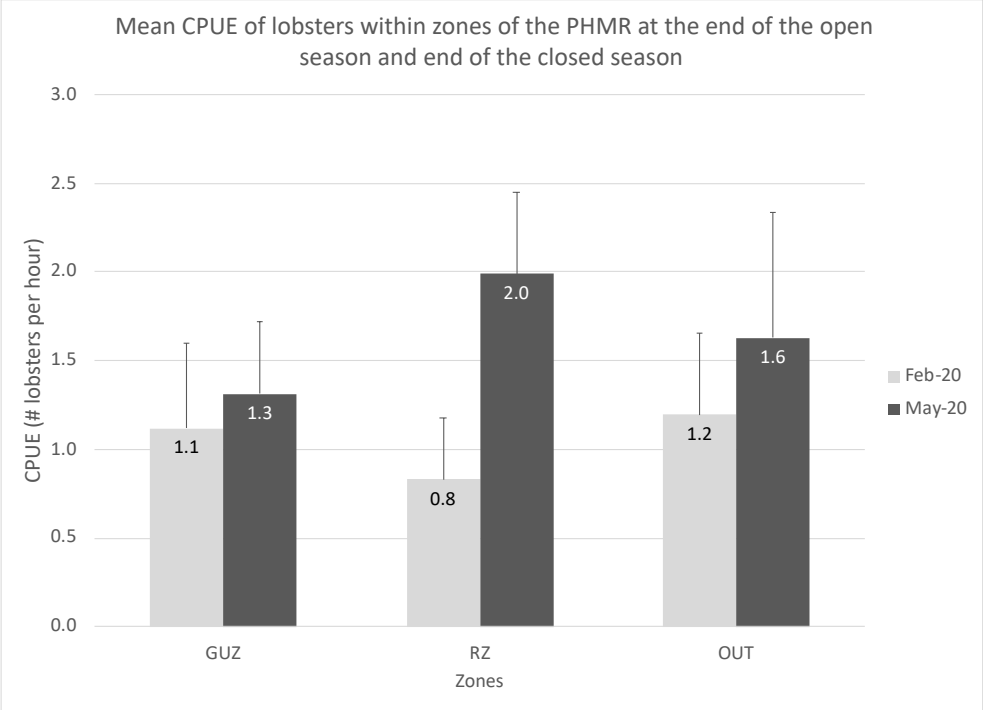


Figure 9 Mean Catch Per Unit Effort (CPUE) of spiny lobsters, among management zones of the PHMR (GUZ-General Use Zone, RZ-Replenishment Zone, OUT-Outside the Reserve) (±Standard Error Bars, S.E.)

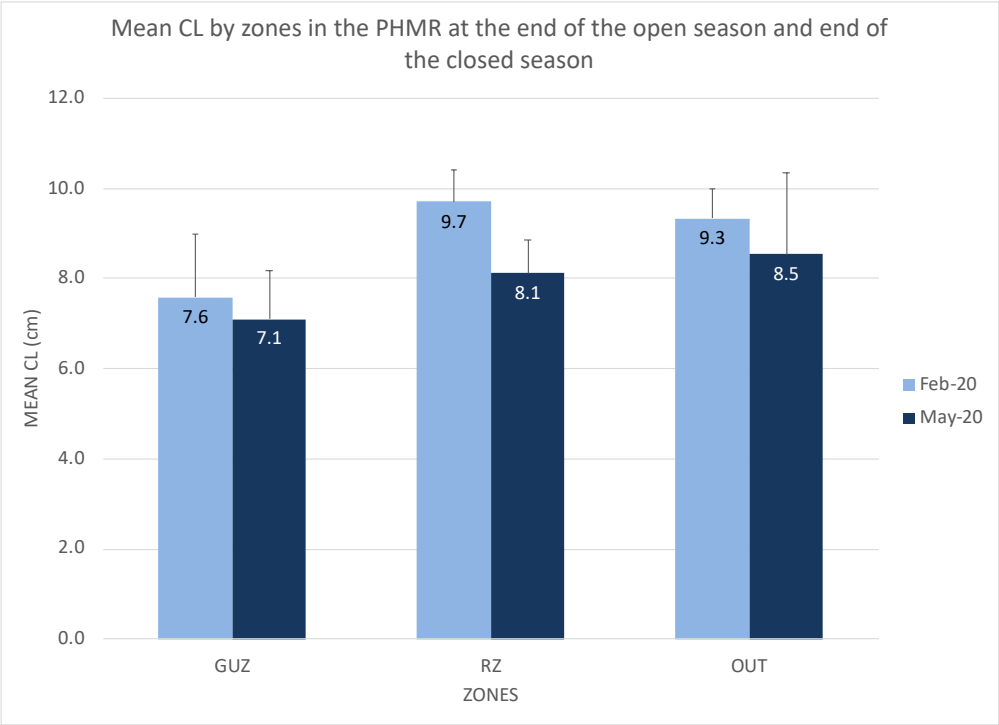


Figure 10 Mean carapace length (CL) in cm of spiny lobsters, among management zones of the PHMR (GUZ-General Use Zone, RZ-Replenishment Zone, OUT-Outside the Reserve) (±Standard Error Bars, S.E.)

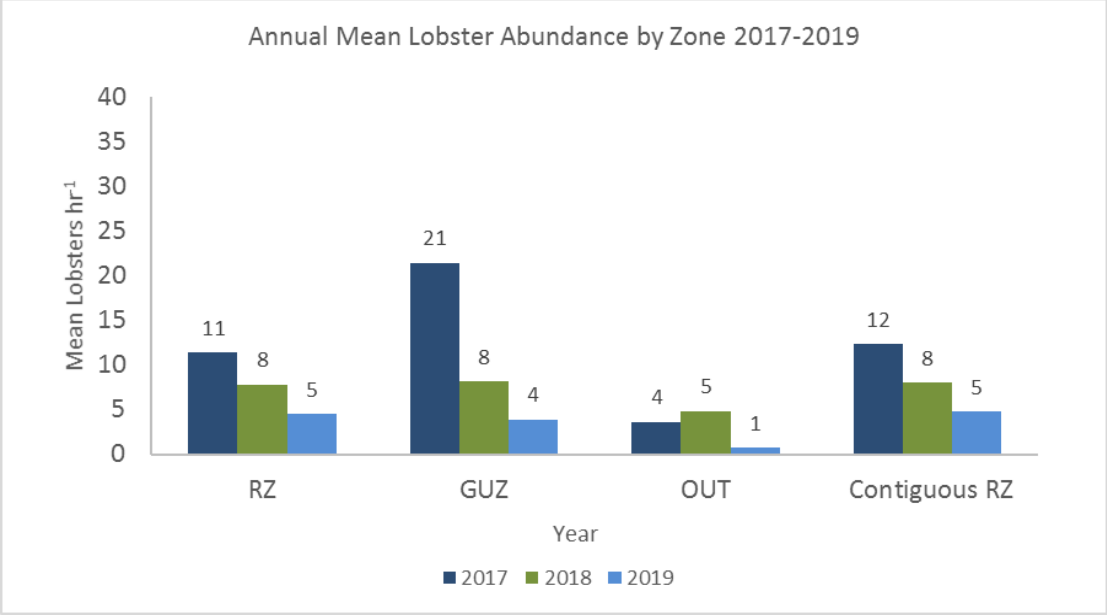


Figure 11 Annual mean spiny lobster abundance (lobster per hour) by zone for 2017-2019 (GUZ-General Use Zone, RZ-Replenishment Zone, OUT-Outside the Reserve) Excerpted from Port Honduras Marine Reserve Benthic Commercial Species Update (TIDE 2019)

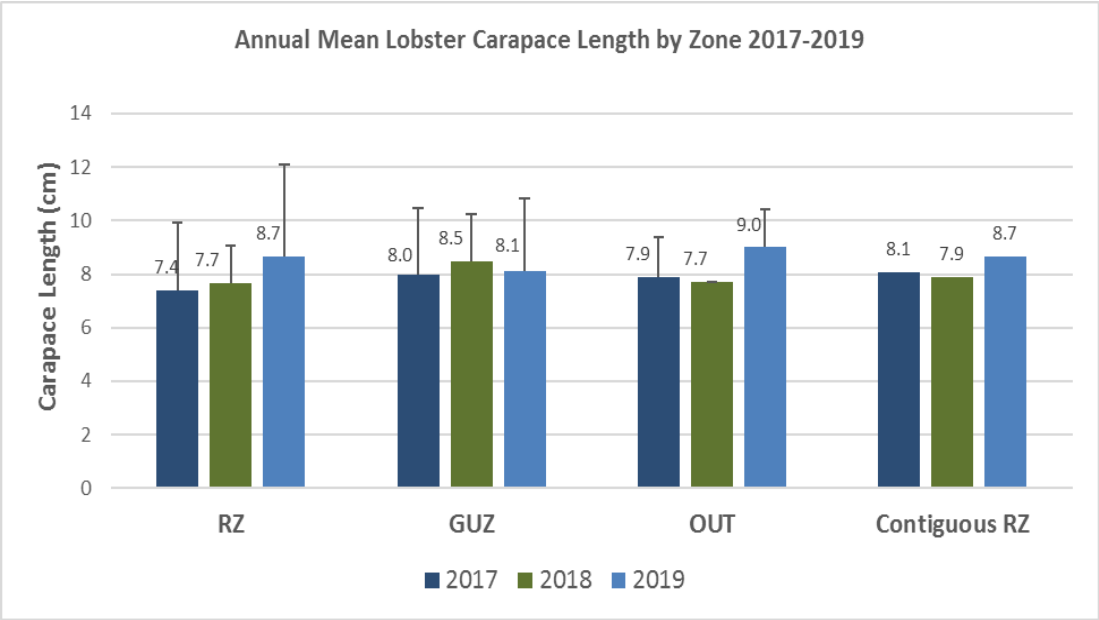


Figure 12 Annual mean spiny lobster carapace length (cm) by zone for 2017-2019 (GUZ-General Use Zone, RZ-Replenishment Zone, OUT-Outside the Reserve) [±Standard Deviation], Excerpted from Port Honduras Marine Reserve Benthic Commercial Species Update (TIDE 2019)

4.0 DISCUSSIONS AND RECOMMENDATIONS

The spiny lobster data for 2020 showed very low and declining abundance from a mean of 3.75 lobsters hr^{-1} across all zones in 2019 to 1.3 lobsters hr^{-1} in 2020. While lobster abundance varies seasonally depending on the timing of recruitment and lobster movement from deep to shallow areas (Acosta, 1999; Acosta 2002, Acosta and Robertson, 2003), a decline in abundance from year to year can be as a result of other factors, including overharvesting, habitat decline or whether the areas surveyed are primary lobster habitat and/or fishing grounds. Density and biomass are known to vary with habitat heterogeneity for spiny lobsters. Adults move between shallow and deep habitats throughout the year (Acosta, 1999; Acosta 2002). They favor reef habitats while juveniles favor seagrass habitats (Acosta and Robertson, 2003).

Based on anecdotal records, PHMR has 120 registered fishers for whom lobster fishing, using traps and shades in seagrass habitats, is the major type of fishing activity. Shades are usually placed outside the reserve along banks and inside the reserve on seagrass flats. Fishers from Monkey River tend to use the northern part of the PHMR to set their traps. What is clear is the need for a full inventory of lobster fishing, number of fishers, gear and

fishing areas within the PHMR and adjacent area (TIDE's Science Director, Denise Garcia pers comm., 23/03/2021). Therefore, monitoring within patch reefs may not be providing a complete assessment of the population given the strategy employed, whereby seagrass areas are actively fished potentially capturing juveniles. As expected, there is some recovery of the population in the closed season. This is evidenced by the small increase in numbers in all the zones near the end of the closed season in May 2020, with the replenishment zones having the largest increase, suggesting that these zones are acting as a refuge for lobsters. Lobsters may be moving from deeper habitats to shallow patch reefs during the closed season under the shield of protection from fishing and may also migrate out the replenishment zones into fished areas (Acosta and Robertson, 2003).

Carapace length was fairly similar between 2019 and 2020. While the majority of lobsters in February and May meet the legally regulated size limit of 7.6 cm (with a mean of 8.9 cm and 7.9 cm respectively), they may not all be mature lobsters. This is because the legal-size limit may not be the size at maturity for individuals. The size limits are based on regional recommendations of size at maturity that rely on outdated studies from the 1960s and 1970s (Gongora, 2010). More recent studies, from the region, indicate that size at maturity is higher than 7.6 cm, and is between 7.9-8.9 cm for females depending on geographic location (Ehrhardt, 2005; Cruz and Bertelsen, 2008). A very recent study on long term and multiple data sets from Belize (Tewfik *et al.*, 2020), suggests that 50% size of maturity occurs between at 9.8 cm for males and 8.6 cm for females. Based on this, only 34% of males and 64.5% of females would be sexually mature, with a higher proportion of females (73%) in the open season. Since male spiny lobsters are known to be larger than females, and therefore more readily targeted, this explains the lower proportion of males during the open season and increase during the closed season, when they are protected from fishing and allowed to recover.

It was also observed that near the end of the closed season, there was a greater amount of smaller sized lobsters suggesting that not enough time had passed for sufficient recruitment to the fishery or larger lobsters had not yet migrated from deeper areas on the reef. Additionally, the surveys from the end of the open season (February) show a significantly larger proportion of reproductively active females, suggesting more reproductive activity occurring within the open season. Hence a larger proportion of females was present since they cannot be harvested due to regulations that protect "berried females". Studies in other marine protected areas in Belize show that spiny lobster reproductive activity occurs throughout most of the year (Acosta and Robertson, 2003). The closed season doesn't protect year-round breeding but may only allow for recolonizing of shallow habitats by lobsters from deeper reefs.

The replenishment zones within the PHMR seem to provide some level of protection for spiny lobsters with generally higher abundances and larger lobsters within these zones,

which suggests that the zones are allowing refuge from fishing and some level of replenishment. This has been a function observed in the replenishment zones or no-take areas of other protected areas (Acosta 2002; Acosta and Robertson 2003). It is also important to note, however, that the replenishment zones of the PHMR also have the best lobster habitat in terms of more developed patch reefs, which is the preferred habitat for larger sized adults (Acosta and Robertson, 2003).

Overall, the spiny lobster data for the Port Honduras Marine Reserve suggests that the populations are overexploited based on decreasing abundance over the years, even with a relatively fixed level of effort with managed access licenses in place within the PHMR since 2012. This is combined with smaller sized individuals and a potentially larger proportion of immature individuals than recognized, based on recent studies on maturity.

Since the spiny lobster is Belize's most important commercially harvested species, it is critical to have fishery dependent monitoring of the spiny lobster population through the use of catch data. This will require establishing a catch monitoring program and working with lobster fishers to collect morphometric data from their catch, including mean CL, tail length (TL), weight of whole and tailed lobsters, by gender and morphological features that signal reproductive state. It will also require obtaining data on fishing effort from fishers in terms of CPUE for each gear type (shades vs traps), fishing gear per fisher, mapping fishing areas (i.e. where traps and shades are placed) and quantifying the fishing effort with regards to number of traps and shades per fisher, among others, in and around the PHMR. Only with this complementary data from the fishery can a more complete picture of the state of the spiny lobster population in the PHMR be established and management actions taken. Regular fisheries independent monitoring, using LAMP protocol, of spiny lobsters should be continued during both the open and closed seasons to assess the effectiveness of closed season and the management zones. Consideration should be given to expand monitoring to include new sites in areas where traps and shades are used to assess the population there. Current monitoring sites are only in and around coral reef patches.

A combination of annual fisheries dependent (catch data), along with fisheries independent (LAMP surveys and other population surveys) will allow TIDE to assess the structure of the harvested portion of the population on a long-term basis. This would then enable more accurate trends on how the fishery may be impacting the population, and thereby better inform adaptive management of the spiny lobster fishery within the PHMR. Establishing monitoring sites in areas where lobster traps and shades are used will help determine if these fishing tools help increase abundance or simply attract lobster from out the replenishment zones and other parts of the PHMR, as highlighted in previous monitoring reports. Given the fact that lobster abundance and behavior is affected by environmental factors such as temperature (Davis, 1977) among other

physical factors, the monitoring of physical factors such as sea surface temperature, salinity, pH and dissolved oxygen should be included in seasonal surveys and regular monitoring. Finally, similar to the queen conch fishery, studies to ascertain lobster spawning and recruitment areas should be conducted as previously recommended.

5.0 REFERENCES

Acosta, C.A. 1999. Benthic dispersal of Caribbean spiny lobsters among insular habitats: implications for the conservation of exploited marine species. Conserv Biol 13:603–612.

Acosta, C.A. 2002. Spatially explicit dispersal dynamics and equilibrium population sizes in marine harvest refuges. ICES J Mar Sci 59:458–468.

Acosta, C.A., Robertson, D.N. 2003. Comparative spatial ecology of fished spiny lobsters *Panulirus argus* and an unfished congener *P. guttatus* in an isolated marine reserve at Glover's Reef atoll, Belize. Coral Reefs 22: 1–9.

Cruz, R., Bertelsen, R. D. 2008. The Spiny Lobster (*Panulirus argus*) in the Wider Caribbean: A Review of Life Cycle Dynamics and Implications for Responsible Fisheries Management. Proceedings of the 61st Gulf and Caribbean Fisheries Institute, pp 433-446.

Davis, G. E. 1977. Effects of recreational harvest on a Spiny Lobster, *Panulirus argus* population. Bull Mar. Sci. 27. 223-236.

Ehrhardt, N.M. 2005. Population dynamic characteristics and sustainability mechanisms in key Western Central Atlantic Spiny Lobster, *Panulirus argus*, fisheries. Bulletin of Marine Science, 76(2): 501–525.

Gongora, M. 2010. Assessment of the Spiny Lobster (*Panulirus argus*) of Belize based on fishery-dependent data, pp 38. Belize Fisheries Department, Belize City.

Tewfik, A., Babcock, E.A., Phillips, M. 2020. Spiny lobster fisheries status across time and a mosaic of spatial management regimes. ICES Journal of Marine Science, doi:10.1093/icesjms/fsaa008.

Toledo Institute for Development and Environment. 2019. Port Honduras Marine Reserve Benthic Commercial Species Update 2019. 35 pp.

Wildtracks. 2017. Port Honduras Marine Reserve - Management Plan 2017-2021. 236 pp.