Caribbean Marine Biodiversity Program

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Fishing Gear Exchange Pilot in Madras, Protected Area of Three Bays, Northeast Haiti

Submitted by Caroline Bissada, July 2019

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Introduction

Throughout Haiti, fish traps and seine nets with small mesh size are typically used by fishers who fish within the nearshore area. Fishing with this type of gear harvests large quantities of immature fish. It was clear from visual assessments of fisher's catch that continuing to harvest fish in this manner would soon decimate the nearshore fisheries, a resource many Haitians rely on as their sole source of subsistence.

The Gear Swap Pilot Project (GSPP) was implemented under the United States Agency for International Development (USAID) funded Caribbean Marine Biodiversity Program (CMBP). The pilot was led by The Nature Conservancy (TNC) in collaboration with La Fondation pour la Protection de la Biodiversite Marine (FoProBim) and aimed to promote sustainable fishing practices, improve abundance and species diversity within the Three Bays Protected Area (PA3B).

Over a period of ten months, the GSPP fisheries consultant along with students from the Université d'Etat d'Haïti, Campus Henri Christophe de Limonade worked with fishers to replace their small mesh traps with large mesh traps. This optimized their fishery resource production by substantially increasing the size of the fish caught in these traps while reducing juvenile catch and bycatch mortality.

Seine net fishers were also approached to exchange their seine nets for large mesh traps as part of the GSPP. However, seine fishers were reluctant to participate for fear that the use of traps would not be as profitable as their seine nets. Fishers were also concerned about the loss of their investment in the seine fishery by having already purchased expensive seine nets. Some seine fishers said they would have considered participation if the project bought back their nets as part of the incentive package. Some initial data collection on the seine fishery is presented in this report.

Fishers who participated in the GSPP agreed to exchange two small mesh fish traps for one large mesh trap, provide access to their catch for data collection, receive a weekly stipend to cover losses potentially incurred from adaption to fishing with new equipment as well as their (or a family members') participation in the CMBP's breadfruit flour production supplementary livelihood activity. This agreement was formalised through a contract between GSPP participants and FoProBim (Appendix 1)

Numerous discussions were held with fishers regarding the size of trap they preferred using (Figure 1) taking into consideration their varied boat sizes. Although the large mesh size of 6 cm x 5.5 cm (Figure 2) would remain standard, fishers expressed a need for two sizes of traps. This way, fishers with smaller boats could also participate (Figure 3). As such, two sizes of fish traps were provided (small: 86 cm in length and large: 186 cm in length) (Figure 4). The exchange ratio remained the same (2:1), irrespective of the size of fish trap chosen and fishers could choose to have one size or a mix of both sizes.

(a)

(b)

Figure 1. (a) Discussion with fishers, fisheries consultant and FoProBiM representative on the preferred fish trap size;(b) Assessing the size of the new large traps with increased mesh size.

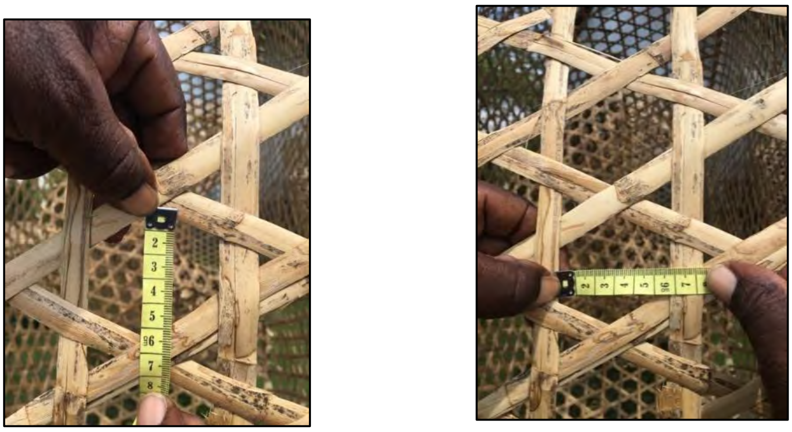

Figure 2. GPSS trap mesh with increased gap size of 6.5 cm x 6.5 cm.

Figure 3. GPSS fisher in Caracol with his pirogue that can only accommodate small size traps.

(a) (b)

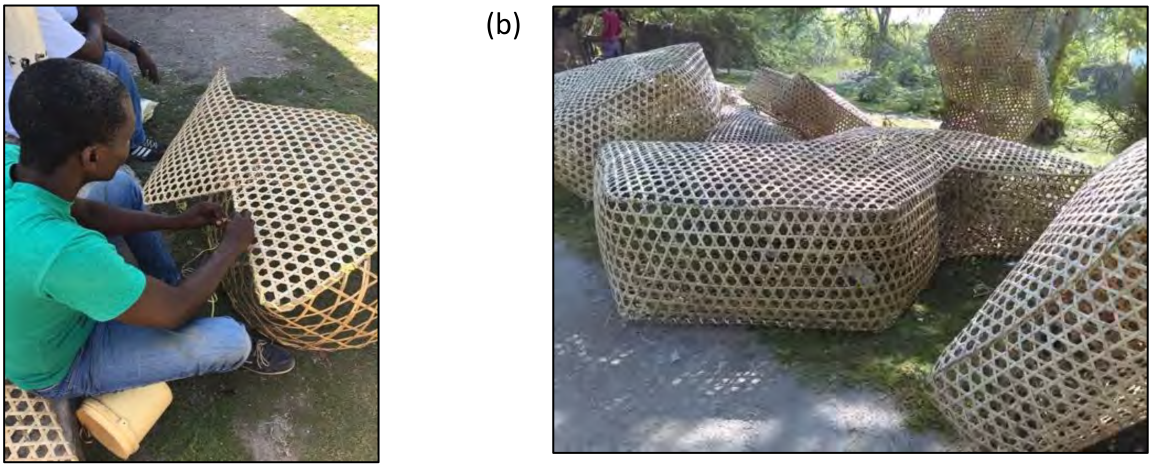

Figure 4. New fish traps with large mesh. (a) small traps and (b) large traps

Description of fishing area

Landing sites

Madras and Caracol Bay are both surrounded by thick mangrove and sea grass beds (Figure 5). The Caracol Bay landing site is located on a long stretch of beach, roughly 200 m in length. Many fishers land their catch on the eastern section of the beach close to the main road, mooring their boats slightly offshore. Other fishers land their catch at various sites along the beach. For the most part, fishers work with specific vendors (primarily women) who wait for them to return from sea each day. Upon their return, vendors wade out in knee high water to meet the fishers. Other vendors wait on the beach under the trees near the landing sites. Some fish are processed directly on the beach while others are taken away to market in ice boxes.

The Madras landing site is nestled deep within the mangroves and is a fraction of the size of Caracol Bay. There is a small broken concrete jetty that extends from an inlet within the dense mangroves. Fishers must traverse mud and muck to get to and from their landing site where some vendors sit, waiting for the boats to return. Other fishers have vendors which are located in town; their catch is quickly offloaded and transported via motorcycle to market.

Fishing grounds

The northern coast of Haiti is extremely exposed and is surrounded by a 20 km barrier and fringing reef system that extends from Bord de mer Limonade to Fort Liberté Bay. This reef system is estimated to be 1100 ha and cover approximately 10% of the shallow shelf area within the PA3B. Depths range from 1 m to 30 m. A deep 30 m channel separates the reef offshore of the Caracol Bay. Fishers have been observed using a number of distinct coral reef zones, including reef crests, backreefs, reef walls, patch reefs, and spur-and-grove reef habitats. Spur-and-groove reefs are found directly in front of Caracol Bay. On the backreef of the spur and groove lies a descending slope of complex rugose hard corals interspersed by sand. Reefs are subject to effluent from both the Grande Rivière du Nord and the Cap Haïtien rivers.

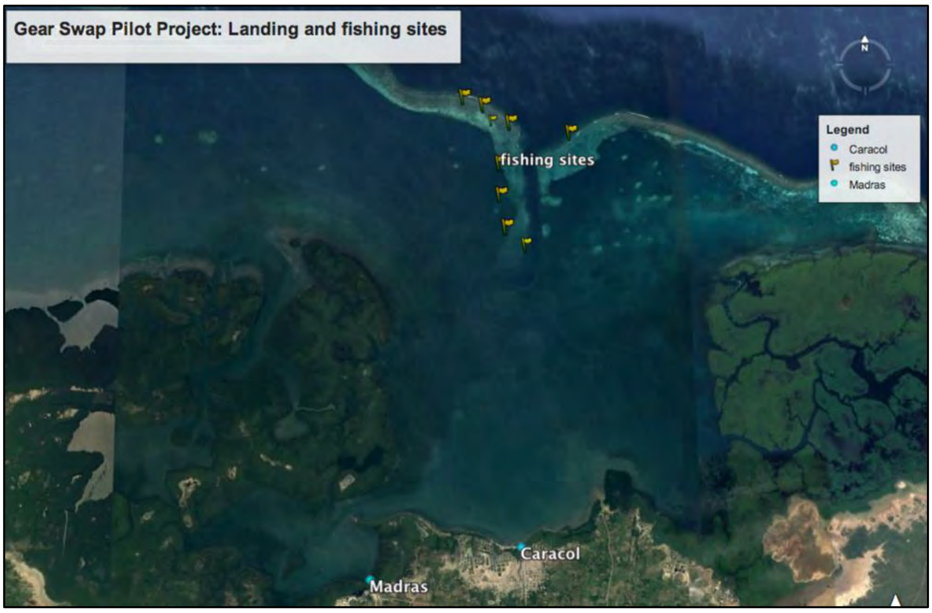

Figure 5. Map showing the Madras and Caracol landing sites (blue dots) as well as the trap fishing sites (yellow flags) located on the barrier reef. Dense mangroves can be seen surrounding the landing sites.

A total of 51 coral species, 43 octocoral species, and over 140 species of sponge have been identified within the PA3B reef habitats (Kramer et al 2016). The most frequent corals are mustard hill coral (*Porites astreoides*), lettuce coral (*Agaricia agaricites*), brain coral (*Pseudodiploria strigose*), and star coral (*Montastraea cavernosa*) (Kramer et al. 2016).

Also found within the shallow reefs of the PA3B is the cup coral (*Cladopsammia manuelensis*) which typically occurs as part of deep reefs (>50 m) systems in the Straits of Florida and the Gulf of Mexico (Kramer et al. 2016).

Caracol Bay has an estimated 4,030 ha of mangrove with an extensive network of channels occurring throughout. Mangrove stands include the black mangrove (*Avicennia germinans*), red mangrove (*Rhizophora mangle*), white mangrove (*Laguncularia racemose*) and buttonwood (*Conocarpus erectus*). The seaward border and hammock mangroves experience regular tidal action, whilst the landward basin mangroves only experience periodic flooding. Adjacent to the mangrove stands, are highly productive seagrass meadows.

Prior to the GSPP fishing took place adjacent to the thick mangrove forests in the Caracol Bay and Madras bay. Now, with the large mesh traps fishing takes place in deeper water near coral reef habitats.

Travel and trap placement

The closest coral reef is the barrier reef located approximately six km offshore from both the Caracol Bay and Madras landing sites (Figures 5). One fishing trip takes an average of seven hours. Fishers have small, open, wooden pirogue boats with makeshift sails and bamboo masts (Figure 7). Fishers primarily fish in groups of two to four persons, though there may be as many as six per boat. Fishers leave their landing sites in the dark between 4-6 am and row out to the barrier reef. This takes roughly three hours. Fishers then haul and re-set their traps (Figure 6). GSPP fishers were provided with one cooler (igloo) each and fish were placed directly into the cooler after hauling. Ice is a scarce commodity and comes in the form of a giant block. Most fishers try to obtain ice prior to setting out on their fishing trips to help preserve the freshness and integrity of the fish, though it is not always possible. The amount of time spent at sea then becomes crucial, as spoilage can occur, even when the harvest in placed in coolers when there is no ice available, as fishers often return to their landing sites by mid-day. Fishers sail back to their landing sites, which requires less manual effort but can be still be time consuming if the wind is light (Figure 7).

Large mesh traps were placed along the edge of the barrier reef on both the inner patch reef sections, the backreef as well as along the slope towards the channel.

(a) (b) (c)

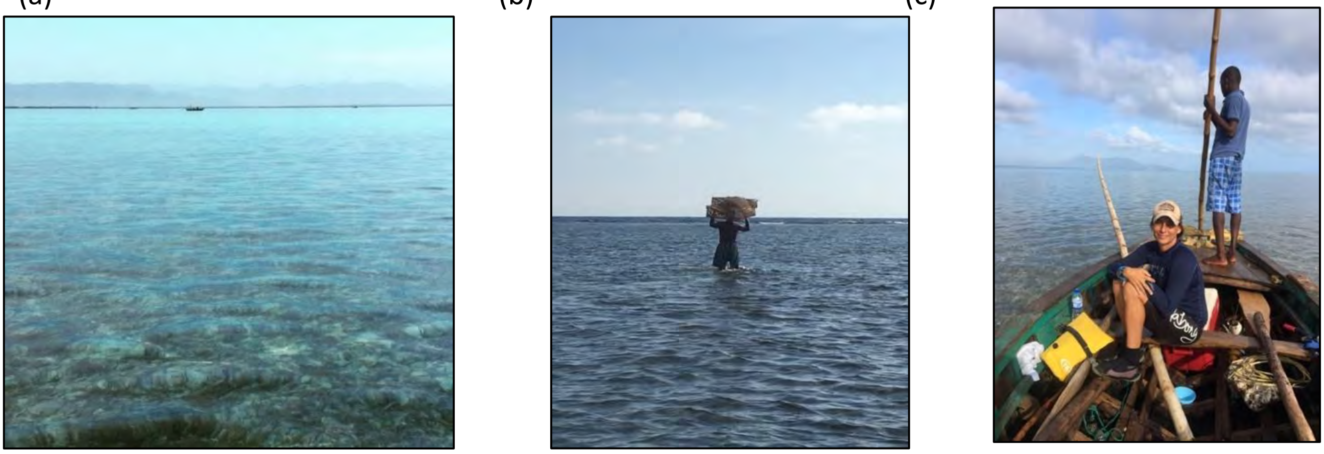

Figure 6. The shallow reef flat “atoll”. (a) Boats can be seen in the channel (La Pase), the edge of the barrier reef is seen in the distance (right), (b) a Caracol fisher walking on the barrier reef to place small mesh traps (right), (c) fisher navigates the boat on the shallow reef by pushing with an oar (bottom).

Figure 7. Fishers use wooden pirogues, bamboo oars and masts with sails sown together from pieces of material.

Bait

Fishers would use seasonal fruit such as mangoes as bait in their traps. However, once they switched to using large mesh traps the bait proved less efficient. This was likely due to the change in the target species from herbivorous species found in the mangrove and seagrass meadows to piscivorous species found on coral reefs and deep slopes. Fishers were counselled by the fisheries consultant to affix small to medium sized shiny objects to the bottom of their traps so that the reflective object would resemble prey fish with its movement in the water and attract piscivorous fish into the traps. Fishers reported a higher rate of success with this new bait type.

Methodology
Equipment

- Three 5- gallon buckets (5 or 6 buckets for seine net protocol)
- 1 x pulley scale 128 kg x 2 kg
- 1 x hanging hook fishing scale or flat kitchen type scale
- 1x fish measuring board
- Caliper or small measuring tape
- Small bucket to use in conjunction with hanging hook scale
- Slates made from cute Perspex, sanded with sand paper
- Extra sand paper
- Sharpie type permanent marker
- Pencils
- String or flagging tape to hold pencil to slate
- Sponge, soap to wash slates
- Camera (on phone) to record picture of slate prior to washing for permanent record of data

Trap protocol

Small mesh traps are the standard trap used in the Caracol and Madras bays. The size of the mesh opening is 3.8 cm x 3.8 cm.

For each day fishing, the catch was weighed to get the total biomass, then data was collected on the species composition, individual fish length and individual fish weight.

Weight (kg) of the empty large bucket using the pulley scale (128 kg x 2 kg)

1. The entire catch is placed in the bucket and weighed (kg) using the pulley scale

weight of bucket with catch (kg) – weight of empty bucket (kg) = total weight of catch (kg)

2. For each individual fish the following was recorded:
    a. The fish species (at minimum the family level).
    b. The total length (cm) using a measuring board.
    c. The weight (kg) for each fish using a hanging hook fishing scale.
3. For lobster the following was recorded:
    a. The carapace length (cm).
    b. The weight (kg) for lobster is weighed using a hanging hook fishing scale.
    c. The presence or absence of eggs was recorded.

4. Start and end time of the fishing trip (e.g. 5 am to 10 am) was recorded.
5. Soak time (number of days submerged) of the traps is recorded.
6. Number of fishers on each trip (e.g. 2 fishers).
7. A brief description from the fisher of the areas where the traps were placed (e.g. local name of the area, substrate type, depth) was recorded.
8. Gear type and size (large or small).

Seine net protocol

The number of fishers that operate one seine net varies between six and eleven depending on the size of net. A typical seine net is approximately 300 m wide with a mesh size of roughly 1 cm in diameter. Two boats are needed to place and haul the net and fishers on both boats haul continuously for over 5 hours. Fishing trips can last up to 11 hours, sometimes coming in with no catch at all.

The composition of the catch sample for seine nets was similar to that of the traps. However, the seine nets caught a much larger volume of small fish.

Data collected from seine nets was exceptionally time consuming because the fish caught were very small and their individual weight often did not register on the scale. One sample bucket could contain over 500 individual fish. Data on catch composition were collected from the catch of five seine nets on five separate days between June 5th and July 5th, 2018. at the family level and species level when possible.

Total length (cm) was recorded for each fish in the sample bucket and the weight was obtained when possible. Total biomass was captured by weighing the entire catch as well as the number of fishers and the total fishing trip time. Once the catch was landed it was evenly distributed amongst buckets. One bucket was chosen at random as a subsample to determine species identification and size.

Sampling occurred as follows:

1. All sea snakes, crustaceans, debris and seagrass were removed.
2. The weight (kg) of the empty buckets was taken.
3. The entire catch in all the buckets were equally and randomly distributed.
4. The weight of each bucket filled with fish was taken and the weight of each empty bucket subtracted (weight of bucket with catch – weight of empty bucket = weight of catch of bucket). All weights of buckets containing fish were then added to obtain the total weight of the catch.

weight b1 + weight b2 + weight b3 + weight b4 = total weight(kg)

5. One bucket was randomly selected to subsample the catch in detail

6. For each fish in the subsample:
    a. The fish was identified to the species level, at minimum the family level
    b. The total length was recorded on the measuring board
    c. The mass of the fish was weighed and recorded

With respect to Caribbean spiny Lobster measurements, the size of the lobster's carapace was recorded using a caliper or measuring tape. The front of the measuring gauge was place on the front of the carapace in between the eyes at the forward edge between the rostral horns and the gauge was extended back along the middle to the rear edge of the carapace.

Monitoring schedule

Monitoring occurred every time a fisher hauled traps from June 30th, 2018 to August 29th, 2018, then again from October 20th ,2018 to November 24th, 2018. For each fishing event, data was collected on species composition, fish length, the weight of individual fish, the weight of the total catch trap size, number of traps placed, number of traps hauled, the duration of the fishing trip, the number of fishers and the fishing site.

Student assistants

Education and partnership with the local university was a major component of the GSPP. The pilot project facilitated nine graduating students from the Université d'Etat d'Haïti, Campus Henri Christophe de Limonade to improve their capacity in fisheries and coastal ecology. Though there is no Natural Resource Management or Marine Biology stream, the Geography and Agronomy majors are required to understand the ecology and biogeography of Haiti's coastal systems as well as the socio-economic issues affecting the people of Haiti. Students were also required to write a final research report as part of their graduation requirement.

Students were given the opportunity to join the fisheries biologist and gain on-site experience receiving valuable training in field data collection methods, including learning to identify a variety of reef, mangrove and sea grass species and collect a range of metrics such as total length, fork length and weight. Students were also allowed to use extra data collected for their own research and the time spent with fishers to conduct their own additional interviews for their individual projects (Figure 8). A stipend was given to students to cover expenses such as daily travel to and from the landing sites and food. Students in groups of four rotated field days with the fisheries biologist. Many of the students also had an opportunity to experience the reef, mangrove and sea grass ecosystems by participating in excursions with the fisheries consultant and the fishers.

A database was created to house the large amounts of data collected on species composition, catch per unit effort and other allometric variables such as total length and weight. The students were trained in both data entry and data management of the large spreadsheets and were a part of the ongoing socio-economic discussions with fishers (Figure 8).

With the help of the students, a database of fish species was compiled with both English and Haitian creole names to facilitate the exchange of information and ensure accuracy of the data being collected. Some species have their own specific local name whilst others were grouped as families and a generic family name used (Appendix II, Table I). Students received certificates outlining their achievements which can be used by them to certify that they have undergone this type of training (Appendix III).

Figure 8. Training of students in field data collection, species identifcation and data management.

Fishers and warden training

Fishers, wardens, NGO personnel as well as other stakeholders were trained in in the field in fisheries management data collection protocols (Figure 9). Groups were kept small (no more than four persons) to be able to clearly exchange information and to be able to offer valuable hands-on practice without causing delays to fishers. Presentations on ecosystem processes, key species and invasive species were given to a variety of stakeholders including fishers, fisheries co-operative members, students, wardens and fish vendors from different areas of the PA3B.

A large number of fisheries stakeholders from Caracol, Limonade and Fort Liberte expressed interest in learning data collection methods but did not have the opportunity to participate. Ongoing capacity building in this area is recommended in the future.

Figure 9. Fishers and wardens acquire training in species identification, and allometric data collection of the fisheries resources.

Results

The GSPP was successful in promoting sustainable fishing practices and livelihoods to fishers by reducing the impact on their juveniles and providing a higher income to fishers, facilitating them fishing less to earn more money.

Figure 10. Typical catch from the Madras landing site from small mesh traps.

Figure 11. Typical catch from the Madras landing site from large mesh traps.

Species composition

Seine net fishery

Seine net data was collected from five seine nets early in the data collection period however, it was discontinued when no seine fishers officially signed up to exchange their nets for traps. Focus then shifted to compare the catch composition between the small mesh and large mesh size traps.

In one 10 kg sample bucket, 355 fish were identified and measured (Table 1). An extra 100 fish were not measured from the sample bucket as the fishers were pressed for time to go to market. Of the 355 fish sampled, 265 were molly millers of the Blenniidae family (Figure 12). Fish size ranged from 2 to 10 cm with the mean fish length being 6.44 cm. Molly millers inhabit sand bottoms and mudflat areas and grow to a maximum 12 cm in length.

Parrotfish were the second main family of fish caught (n =71) with seine nets. Most parrotfish captured were in the juvenile phase making it difficult to identify to the species level. Parrotfish ranged between 3.5 cm and 8.2 cm in length, with the mean being 5.57 cm. The average weight of fish sampled in the bucket was 0.03kg.

Table 1. Sample species composition by family or species caught in five a standard seine net between June 5th and July 5th2018. The table provides information on the mean fish total length (TL), the smallest fish's total length (Min TL) and the longest fish total length (Max TL).

Family / Species	Mean TL cm	Min TL cm	Max TL cm	Number of fish
Filefish	7.05	7.00	7.10	2
Flagfin mojarra	6.15	5.80	6.50	2
Groupers	5.00	5.00	5.00	2
Grunt	6.75	5.00	8.30	5
Jack misc.	7.30	5.90	8.70	2
Molly miller	11.22	5.00	24.90	265
Snappers	7.80	7.80	7.80	1
Parrotfish misc.	6.44	2.00	10.00	71
Blue tang	5.57	3.50	8.20	3

(a) (b)

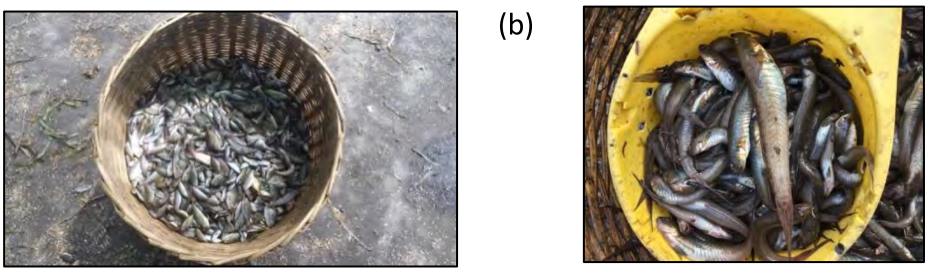

Figure 12. (A) Basket of catch from seine net; (b) handful of Blenniidae species from seine net catch.

Trap fishery

Between July and November 2018, small mesh traps were hauled and sampled 36 times. Each fisher usually sets and hauls between 5 and 25 traps per fishing trip. Data on catch composition including length (cm) and weight metrics (kg) were collected for all fish and lobster caught in the small and large mesh traps at the Madras and Caracol landing sites. Three thousand eight hundred and seven (3807) fish were identified and measured.

Small-mesh traps

Traps with small mesh openings are regularly placed in nursery grounds such as mangrove forests and seagrass beds as well as on the fringing reef itself. As a result, juvenile reef and mudflat species were primarily caught. Table 2 shows the diversity of fish caught in in the standard small mesh traps (grouped by family). Appendix II shows the breakdown of the fish family into species.

Table 2. Diversity of fish grouped by family caught in the standard small-mesh traps. Important ecological and/or economical species are highlighted in grey. The table provides information on the mean fish total length (TL), the smallest fish's total length (Min TL) and the longest fish total length (Max TL); as well as the mean mass/weight of all fish (kg), weight of the smallest fish (Min weight) and the mass/weight of the heaviest fish (Max weight).

Family	Mean TL (cm)	Min TL (cm)	Max TL (cm)	Mean weight (kg)	Min weight (kg)	Max weight(kg)	Number caught
Barracuda	28.82	21.40	38.50	0.15	0.04	0.31	11
Bonefish	21.50	21.50	21.50	0.06	0.06	0.06	1
Butterflyfish	6.67	5.50	7.50	0.01	0.00	0.02	7
Cichlids	18.11	13.40	22.00	0.10	0.04	0.17	11
Damselfish	12.86	9.50	16.50	0.06	0.03	0.09	16
Drum	26.30	26.30	26.30	0.29	0.29	0.29	1
Goatfish	15.87	10.30	19.00	0.05	0.02	0.08	11
Grouper	16.59	11.10	28.60	0.10	0.03	0.42	63
Grunt	12.98	10.00	23.00	0.04	0.01	0.20	124
Hamlet	10.80	10.70	10.90	0.03	0.03	0.03	2
Jacks	21.57	11.40	24.20	0.13	0.02	0.19	11
Mojarra	12.50	9.00	17.30	0.05	0.00	0.63	41
Mullet	12.92	7.84	18.00	0.44	0.07	0.80	2
Needlefish	36.15	33.90	38.40	0.08	0.06	0.09	2
Parrotfish	14.01	8.20	26.50	0.07	0.00	0.55	2707
Porgy	15.89	0.60	30.40	0.10	0.02	0.80	111
Scorpionfish	19.50	19.50	19.50	0.19	0.19	0.19	1
Snapper	15.08	7.70	28.00	0.09	0.02	0.90	90
Snooks	22.14	18.50	28.50	0.09	0.05	0.19	8
Spadefish	19.20	19.10	19.30	0.29	0.29	0.30	2
Squirrelfish	14.72	9.30	18.50	0.04	0.00	0.07	96
Surgeonfish	12.90	7.50	20.00	0.06	0.00	0.29	47
Trumpetfish	45.00	45.00	45.00	0.43	0.43	0.43	1
Wrasse	16.70	12.50	26.70	0.08	0.00	0.28	44
Total	14.25	0.60	45.00	0.07	0.00	0.90	3410

There were 2,707 fish of the parrotfish family found in the small mesh traps sampled. Parrotfish were found in every fishers' catch each time the catch was sampled. Parrotfish accounted for 79% of the total catch in the small mesh traps. The number of parrotfish caught per fisher on a sampling day varied between 1 and 347. On average fishers caught 9 parrotfish per small mesh trap, with a range of 1 to 19 fish per trap. Juvenile parrotfish ranged from 8.30 cm to 26.50 cm in length (mean total length of 14.01 cm) and had a mean weight of only 0.07 kg (Table 2). Only 11% of the sampled parrotfish from the small mesh traps were found to be sexually mature (Table 4), if a general L_{50} length at sexual maturity is used.

Other ecologically and economically important species caught in small mesh traps were porgies (n= 111), snappers (n= 90) and groupers (n= 63), see Table 1. The seabream porgy matures at small lengths, thus 47 % of the seabreams sampled in the small traps could have been mature individuals (see Table 4). On the other hand, 100% of all snappers caught in small traps were likely to have been sexually immature. The 11 Great Barracudas whose sizes ranged from 21.4 to 38.5 cm in length (see Table 4) that were caught were also likely to be sexually immature.

Reef species such as grunts, squirrelfishes and wrasses were harvested in abundance (n= 124, n= 96 and n= 44). Results show that all wrasses captured were likely to have been sexually mature. However, only 55 % of the squirrelfish and 5% of the grunts caught were sexually mature (see Table 4).

The use of small-mesh traps also caught non-targeted ornamental fish as bycatch such as Butterflyfish (n=7), Damselfish (n= 16), Drums (n=1) which were discarded by some fishers.

Large mesh-traps

Traps with the large mesh (6 cm x 5.5 cm) are designed to allow small and juvenile fish species to escape and the bigger, already reproductively active, adult individuals to be retained. The change in mesh size and subsequent change in fishing grounds was meant to relieve pressure off juveniles, allowing them to grow to maturity, spawn and hopefully maintain the fish stocks. Table 3 shows the diversity of fish (grouped by family) caught in CMBP GSPP traps that were designed with larger mesh openings. Appendix II shows the breakdown of the fish family into species.

Although some parrotfish are still caught in the traps there has been a significant decline from 79% of total catch in small mesh traps to 16% of the total catch in large mesh traps. Individuals caught in the new gear are on average 2 cm longer than the parrotfish caught in the small mesh traps. Even the smallest individual caught in the large mesh trap is 3 cm longer than the smallest fish caught in the small-mesh traps.

Approximately 30% of the parrotfish caught in the large trap had reached lengths at which sexual maturation occurs. While the large-mesh traps did not guarantee that only sexually mature parrotfish would be caught, the fish in the large-mesh traps were larger, and depending on the specific species of parrotfish, some could potentially be mature (see Table 4).

Like many reef species, parrotfish are protogynous hermaphrodites, changing from female to male once they reach a certain size. Females have been found to change to males at fork lengths ranging between 26.2 - 47.3 cm (Hawkins and Callum 2003). Overharvesting individuals below the change threshold could drastically alter the female-male ratios needed to sustain stocks. The large-mesh traps caught larger individuals and fewer of them potentially increasing the likelihood that the ratios of females to males would be at an optimal level (Hawkins and Callum 2003).

Porgies were the most harvested species in the large traps accounting for 35% of the total catch (n = 89), then parrotfish, 16.6% (n=44), then snappers, 13.5 % (n= 36). Of the porgies, 86% of the seabreams were likely to have reached sexual maturation (L_{50} = 8 cm) as were 66% of lane snappers (L_{50} = 20.6cm) (see Table 4). The Lane snapper is listed on the IUCN list as near threatened due to a decrease in the number of mature individuals across its range.

All Caribbean spiny lobster (n=11) harvested in the large traps were mature and had carapace lengths ranging between 5.5 and 9. 4 cm in length (see Table 4). Additionally, none were egg bearing at the time of capture.

The large-mesh traps eliminated the by-catch of ornamental fish species entirely.

Large-mesh traps are ineffective (mesh size results in no catch) when placed on the shallow spur and groove sections of the reef. The use of large-mesh traps has stopped fishers from placing traps directly on the reef and accordingly has reduced the walking on the reef by fishers.

Table 3. Diversity of fish grouped by family caught in GSPP traps with large-mesh. Important ecological and/or economical species are highlighted in grey. The table provides information on the mean fish total length (TL), the smallest fish total length (Min TL) and the longest fish total length (Max TL) and carapace length for spiny lobster*; as well as the mean weight (kg) of all fish, weight of the smallest fish (Min weight) and the mass/ weight of the heaviest fish (Max weight).

Family	Mean TL (cm)	Min TL (cm)	Max TL (cm)	Mean weight (kg)	Min weight (kg)	Max weight (kg)	Number caught
Barracuda	35.60	35.60	35.60	0.24	0.24	0.24	1
Billfish	29.70	29.70	29.70	0.10	0.10	0.10	1
Boxfish	27.82	20.00	38.50	0.48	0.18	0.89	5
Drums	23.35	22.70	24.00	0.18	0.16	0.20	2
Goatfish	25.63	23.60	29.00	0.25	0.16	0.32	3
Grouper	25.54	20.70	29.50	0.28	0.15	0.46	7
Grunt	18.41	12.00	30.70	0.11	0.02	0.39	14
Jacks	21.03	11.20	29.50	0.13	0.02	0.26	16
Mojarra	13.12	8.80	27.10	0.05	0.01	0.20	22
Panulirus argus	28.74	5.50*	90.40	0.40	0.15	0.67	11
Parrotfish	16.12	11.20	30.30	0.09	0.02	0.32	44
Porgy	17.06	11.60	32.20	0.10	0.03	0.32	89
Snapper	18.06	12.20	32.60	0.16	0.03	0.75	36
Spadefish	13.20	10.20	18.20	0.10	0.04	0.20	3
Squirrelfish	21.05	16.50	25.60	0.10	0.03	0.16	2
Surgeonfish	12.35	10.10	18.20	0.05	0.03	0.12	6
Scorpionfish	31.50	30.00	33.00	0.38	0.33	0.44	2
Pufferfish	15.00	15.00	15.00	0.07	0.07	0.07	1
Grand Total	18.18	5.50	90.40	0.13	0.01	0.89	265

Other economically important fish harvested in the large-mesh traps were groupers. Of the grouper and sea bass family caught, two were Nassau grouper or “barré” in Haitian creole (TL = 17 and 13.5 cm) and one was the red grouper (TL= 29.5). Though the Nassau groupers had not reached sexual maturity, the red grouper was likely mature (L_{50}=19.9- 19 cm). Other species of grouper such as the yellowfin grouper were also being caught in the large mesh traps (see Figure 13) though they were not present in traps during the sampling period. As with the parrotfish, groupers are protogynous hermaphrodites thus, it is important for individuals to reach large enough sizes in order to maintain female-male ratios and ensure continuity of local populations.

The Nassau grouper is listed as threatened across its biological range under the Endangered Species Act and is included in Annex III of the SPAW protocol which states that exploitation is allowed but should be regulated to ensure and maintain the population at an optimal level. Similarly, the yellowfin grouper (Figure 12), the mutton snapper which was captured in both small and large traps and the lane snapper are listed as near threatened on the IUCN red list. Fragmented populations and a decline in mature individuals could pose a threat to stocks in the near future. Currently there are no regulations protecting these important species in Haiti. As such harvesting these individuals is legal.

Fishers could benefit from trainings on the identification of species at risk and on maturation metrics such as length at maturity. Being able to identify key species and return them to the water (with minimum harm to fish) could help protect their stocks going forward. At the moment the large-mesh trap fishery is limited in scope, size and vessel power however combined with other fishing practices such as spear fishing, hookah and the use of small-mesh seine nets in the same habitat adds a cumulative and compounded impact; fishers do apply constant pressure to the fishery as it is their main source of subsistence.

Table 4. Percentage of sexual mature species sampled in traps. Sexual maturation is given as the size at which 50% of the sampled species have reached sexual maturation (L_{50}). If the L_{50} was different for males and females the female range was used. When studies obtained varying results, a range was used. The range of fish size (smallest and longest) is noted as the total length in cm. The number of individuals of each species found in both the small and large mesh nets is noted as well as overall sample size of each species.

Species	Size at L_{50} (cm)	TL length range (cm)		Number of mature individuals		Sample size		% mature individuals in the catch	
		small mesh	large mesh	small mesh	large mesh	small mesh	large mesh	small mesh	large mesh
Atlantic Spadefish	12	19.1 - 19.3	10.2 - 18.2	2	1	2	3	100	33
Banded Butterflyfish	12	5.5 - 7.5	-	0	0	6	0	0	-
Bar Jack	31	11.4 - 20.5	11.2 - 29.5	0	0	3	14	0	0
Blue tang	15	7.5 - 12.0	-	0	0	6	0	0	-
Bluehead wrasse	-	18	-	-	0	1	0	0	0
Bandtail puffer	-	-	15	-	-	0	1	-	-
Bonefish	40	21.5	-	0	0	1	0	0	-
Butterflyfi	-	6.5	-	-	0	1	0	-	-
Caribbean spiny lobster*	5 - 8	-	5.5 - 9.4	-	11	0	11	-	100
Coney	18.5	11.1 - 22.5	20.7 - 27.0	12	4	60	4	20	100
Flagfin mojarra	-	10.0 - 17.3	14.1 - 27.1	-	-	22	3	-	-
French grunt	15-17	10.0 - 20.7	13.2 - 29.2	6	3	101	3	6	100
Goatfish misc.	-	10.3	0	-	0	1	0	-	-
Gray snapper	33	13.0 - 26. 1	12.2 - 26.5	0	0	6	5	0	0
Great Barracuda	71.0 - 98.5	21.4 - 38.5	35.5	0	0	11	1	0	0
Grunts misc.	-	13.3 - 23	14.1 - 21.0	-	-	13	6	-	-
Honeycomb cowfish	22.2	0	20.0 - 38.5	-	4	0	5	-	80
Houndfish	51.7	33.9 - 38. 4	-	0	-	2	0	0	-
Indigo hamlet	-	10.8 - 10.9	0	-	-	2	0	-	-
Irish pompano	-	10.8- 16.0	9.0 - 17.9	-	-	8	11	-	-
Jacks misc.	-	22.5 - 24.2	19.4 - 20.0	-	-	8	2	-	-
Lane snapper	20.6	28	15.6 - 30. 5	1	4	1	6	100	67
Longspine Squirrelfish	13.5	11.0 - 18.5	25.6	33	1	85	1	39	100
Marlin	16.4	-	29.7	-	1	0	1	-	100
Majorras misc	-	9 - 14.4	-	-	-	10	0	-	-

Mutton snapper	45 - 47	12.8 -18.3	12.7 - 25.3	0	0	11	30	0	0
Nassau grouper	48	13.5 - 17	24.4 - 28.7	0	0	2	2	0	0
Oceansurgeonfish	15.1	7.8 - 20.0	10.1 - 18.2	10	1	34	6	29	17
Parrotfish spp.	17 - 23.	8.2 - 26.5	11.2 - 21. 5	252	12	2291	40	11	30
Princess parrotfish	20.1	13.2	20.3	0	1	1	1	0.00	100
Puddingwife	-	14.2 - 26.7	-	-	-	15	0	-	-
Lionfish	18.9 - 19.0		30 - 33	-	2	-	2	-	100
Red grouper	18.9 - 19	-	29.5	-	2	0	2	-	100
Red hind	-	28.6	-	-	-	1	0	-	-
Redband parrotfish	-	9.0 - 26 .1	-	-	-	130	47	-	-
Sailors choice	-	12.0 - 18.7	12.0 - 18.7	-	-	4	4	-	-
Saucereye porgy	-	20.5	13.8 - 20.6	-	-	1	6	-	-
Schoolmaster	25	11.0 - 19.0	14.2 - 32.6	0	1	47	4	0	25
Sea bream	8	9.0 - 30.4	11.6 - 32.2	52	63	110	73	47.27	86
Sergeant major	-	9.5 - 16.5	-	-	-	15	14	-	-
Silver jenny	11	14.5	8.8 - 13.8	1	1	1	8	100	12.5
Slippery dick	18.5	15	-	0	-	1	0	0	-
Smallmouth grunt	-	7.7 - 20.8	-	-	-	4	0	-	-
Snapper misc.	-	10.5 - 18.0	-		-	20	0	0	-
Snook	42	18.5 - 28.5	-	0	-	8	-	-	-
Spanish grunt	15 - 17	11.5 - 14.2	-	0	-	10	-	-	-
Spotted drum	-		22.7 - 24.0	-	-	-	2	-	-
Spotted goatfish	-	15.5 - 19.0	24.3	-	-	4	1	0	-
Spotted scorpionfish	-	19.5	-	-	-	1	0	-	-
Squirrelfishes misc.	14.5	9.3 - 17.3	16.5	6	1	11	1	52	100
Stoplight parrotfish	16.3	9.6 - 23.5	16.3 -30.3	90	3	283	3	32	100
Striped croaker	-	26.3	-	-	-	1	0	-	-
Striped mullet	-	7.84	-	-	-	1	0	-	-
Surgeonfish	15.5	10.9 - 16	-	2	-	7	0	29	-
Tilapia	-	13.4 - 22.0	-	-	-		0	-	-
Trumpetfish	-	45	-		-	11	0	0	-
White grunt	-	-	30.7	-	-	1	1	-	-
White mullet	-	18	-	-	-	1	0	-	-
Wrasse misc.	-	12.5 - 26.5	-	-	-	26	0	-	-
Yellow goatfish	11	15.0 - 16.7	23.6 - 29.0	5	2	6	2	83	100
Yellowtail snapper	19.7 - 26.0	27	26.6	1	1	1	1	100	100
Yellowtail damselfish	-	10.8	-	-	-	1	0	-	-

Figure 13. (a-f) Examples of the large mature fish caught in the large mesh traps Verne Pierre. (a and b) Madras GSPP fisher showing his catch from the large-mesh traps. (g) C. Bissada project fisheries biologist and University of Limonade students having an informal meeting with Caraol fishers Georges Bertteau and Florvil Emilien (standing).

Fishers regularly catch Caribbean spiny lobster in their large-mesh traps. Although finding lobster in the large-mesh traps was noted from the onset of the pilot, data collection with metrics did not begin until the data collection period in October 2018. Therefore, catch data does not reflect the true number of lobsters being caught in the traps. As lobster represents an economically beneficial fishery to fishers, continued data collection would prove valuable in identifying the pressure being applied to this fishery. Calipers to accurately measure carapace length were brought in and students and fishers were trained in their use (Figure 14). Discussions with fishers were held on assessing the presence and absence of eggs and fishers agreed of their own volition to return lobsters found with eggs to the sea. No egg-bearing lobsters were observed during the data collection periods. Eleven, lobsters were caught within the traps and carapace lengths were between 5.5 cm and 10.1 cm (mean 8.3 cm), with a mean weight of 0.4 kg.

Figure 14. Fisheries consultant demonstrating to the students how to correctly measure spiny lobster.

GSPP vs Independent surveys

Independent fish surveys and interviews with fishers at landing sites were conducted in the PA3B by the Atlantic and Gulf Rapid Reef Assessment (AGRRA) team and James Miller and listed in Henwood *et al* 2017. The extensive list of marine fish species listed in Henwood *et al* 2017 indicated a near complete absence of typical large predators such as groupers.

Similarly, the CMBP conducted AGGRA surveys of the reef's biophysical conditions across the seascape in the PA3B and indicated that "carnivorous fishes are scarce". Their surveys revealed 0 barracuda, 0 chubs, 0-3 groupers, 0-6 jacks, 0 porgies and 0 snapper.

However, the data collected for the GSPP in the large mesh traps shows that jacks, porgies and snappers and mojarras are routinely caught. In only a few weeks of sampling 16 jacks, 89 porgies, 36 snapper, 22 mojarras and 7 groupers were observed. The small mesh traps also saw barracuda caught, as well as the prior listed species. Observation from ongoing trap fishers using the large mesh traps continued to show the presence of large predators.

It is possible that the sampling depth (mean depth 7m in 2018) used by the AGRRA protocol does not represent the true picture of the species composition. Also, surveys conducted by divers may scare large predators away.

Continued monitoring of the catch composition of the trap fishery as well as the spearfish and hookah fisheries would provide more insight. The presence of these top predators in the catch composition of the fishers within the PA3B, highlights not only their presence, but the importance of the habitat for management. A sustained monitoring program should therefore be a priority.

The independent surveys by the AGGRA team refer to the Coney (*Cephalopholis fulva)* filling the space held by the top predators. While there is not enough data in this study to address that specifically, their survey showed far fewer predators than were observed in the catch composition of the GSPP fishers.

Other species present in the catch composition of the trap fishery and not observed during the independent surveys are listed in Table 5 below.

Table 5. Additional marine fish species found within the PA3B not listed in the Protected Area of Managed Natural Resources of the PA3B Management Plan by Henwood *et al* 2017.

Scientific name	**Common name**
Sphoeroides spengleri	Bandtail puffer
Albula vulpes	Bonefish
Eucinostomus malanopterus	Flagfin mojarra
Acanthostracion polygonius	Honeycomb cowfish
Tylosurus crocodilus	Houndfish
Diapterus auratus	Irish pompano
Caranx hippos	Crevalle jacks
Istiophoridae	Marlin
Epinephelus striatus	Nassau grouper
Pterois volitans	Lionfish
Epinephelus morio	Red grouper
Eucinostomus gula	Silver jenny
Centropomus undecimalis	Snook
Haemulon macrostomum	Spanish grunt
Parupeneus spilurus	Spotted goatfish
Scorpaena mystes	Spotted scorpionfish
Bairdiella sanctaeluciae	Striped croaker
Mugil cephalus	Striped mullet
Oreochromis niloticus	Tilapia
Aulostomus maculatus	Trumpetfish
Mugil curema	White mullet
Mulloidichthys flavolineatus	Yellow goatfish
Chrysiptera parasema	Yellowtail damselfish

Catch per Unit of Effort (CPUE)

Catch is a function of the biomass of fish in the water as well as the fishing effort used to harvest them ($C = B \cdot qE$ where q is a catchability coefficient). Often, catch can simply be divided by effort to get CPUE with the idea that $C/E = B \cdot q$. Effort however can often vary by factors such as fisher, area, or size/mesh of a trap. Catch therefore is a function of the different components that make up effort C = Traps + Soak Time + Fisher (dropping the $B \cdot q$). Linear models can then be used to standardize effort across the different factors.

Small mesh and large mesh data sheets were combined and a categorical variable denoting mesh size was added. The number of traps was considered the unit of effort that was then influenced by the mesh size, the soak time and the different fishers. Soak time was included as an offset meaning that the value was simply added into the intercept term in the linear model instead of having an estimated parameter. Including soak time as an offset recognizes that soak time is a part of the effort. The CPUE was standardized with a mixed-effects linear model in the freeware software R with package lme4. The mixed-effects enable the modelling of the individual fishers (called the random effects) while also producing a single population level estimate representing the expected value across all fishers (fixed effects). The response variable was CPUE, the total catch of a fisher (f) in a day (t) divided by the total number of small or large mesh traps hauled that day.

$\mathrm{Ln}\,(\mathrm{CPUE})_{f,t} = (\beta_0 + b_0) + \beta_1 \mathrm{Mesh\ Size}_{f,t} + \mathrm{offset}[\mathrm{Ln}(\mathrm{Soak\ Time})]_{f,t} + \varepsilon$ (1) In the model, β_0 is the intercept and b_0 are the deviations from the intercept to account for the impact of the different fishers. β_0 is the expected value across all fishers (fixed effect) and b_0 are the random effects for each individual fisher. To improve model diagnostics and produce a good fit to the data, the response variable was the natural log of CPUE and the natural log of soak time was used.

The model fit the data and had reasonable diagnostics. There was a lot of spread in the data resulting in a fit that was good, but not particularly tight. Soak time did not end up being an essential component of the model. Including it or removing it made relatively little difference to the overall fit of the model. This is likely because the majority of the data had a soak time of two days and the CPUE from a soak time of two days ranged widely. There was also not a clear relationship between catch and soak time. Fishers caught lots of fish with long and short soak times and fishers also caught few fish with long and short soak times. Soak time may be important, particularly with a larger data set and thus it was included in the final model, but it had limited influence with the current data.

With the estimated parameters, the average CPUE for a small mesh trap and a large mesh trap assuming a two-day soak time (two days was the most common soak time). The population level intercept (fixed effect) was used to account for the expected value across all fishers. The expected value of catch from hauling one small mesh trap is 0.14 kg (95% CI 0.08 - 0.23 kg). The expected value of catch from hauling one large mesh trap is 0.14 kg (95% CI 0.09 - 0.23 kg). The plot shows a box and whisker plot with the median value as the thick horizontal line and the 25% and 75% quartiles (Figure 15). The values are not significantly different suggesting that fishers using the large mesh traps are getting the same or more catch per trap and are also getting a higher valued catch for the same amount of effort.

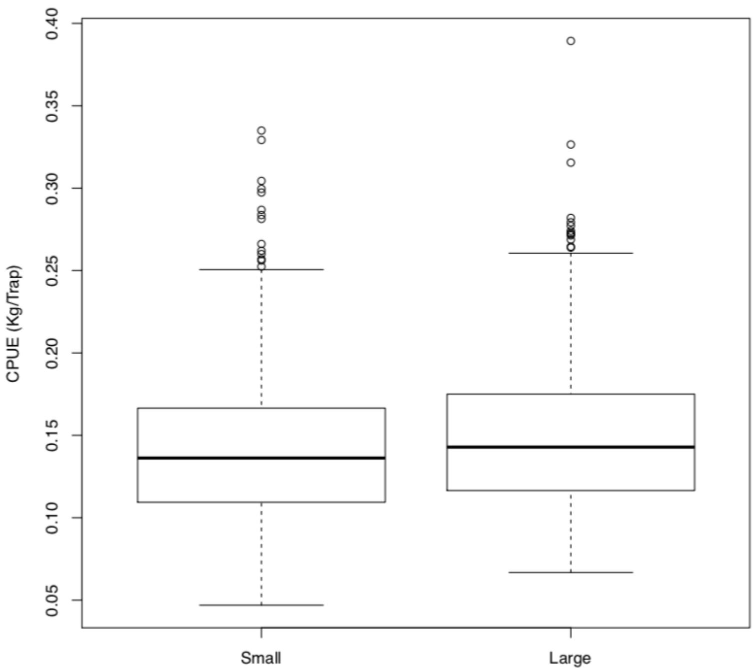

Figure 15. Box and whisker plot of the standardized Catch-Per-Unit-Effort for the small and large mesh traps with a two-day soak time.

The CPUE conducted using the initial catch data indicates no change in effort using the large mesh traps though it is thought that this is a result of the small sample size. Fishing using large mesh traps requires fishers to soak their traps for a longer period (7 days instead of 2 days), thus intuitively less effort is required for large catch of higher economical value. Continued monitoring of CPUE would shed more light on the actual values.

Economic value of catch

The size of the fish caught in each type of trap varied greatly. On average fish in the small mesh traps weighed 0.07 kg whilst fish caught in the larger mesh traps weighed nearly double at 0.13 kg. Though considerably more fish are caught in the small-mesh traps, they were often so small that they could not be cleaned and sold as food fish. Instead these fish were sold, dried and ground up in their entirety to be used in broths, fetching minimal profits (if any) for the fisher.

On the other hand, each large fish caught in the large-mesh trap is sold to restaurants or vendors in the market for 200 to 500 gourdes per pound of fish depending on the species.

One Madras fisher commented that although he may only get four to eight fish in his catch, each fish is now worth between 300 and 500 gourdes. Meaning, two weeks of fishing can earn up to 4,000 gourdes (approximately USD $ 52.00) using 10 traps which he hauls only once a week.

Another of the Madras fishers earns roughly 10,000 gourdes (approximately USD$ 130.00) every two weeks hauling ten traps compared to earning 3,000 gourdes per two-week period, hauling 25 small-mesh traps every two days. Though the fishers now spend a greater amount on higher quality rope for the traps, net profits earned still outweigh selling the catch from the small mesh nets.

Fishers have been catching large lobsters in their new traps weighing on average 0.55 kg each. Lobster sells for an average of 200 gourdes a pound in North East Haiti, earning fishers ~240 gourdes per lobster.

The majority of the GSPP fishers have been very pleased with the financial benefits of using the large-mesh traps out in deeper water. They now have the potential to earn as much as the government assigned minimum wage of 500 gourdes per 8-hour day for individuals working in private companies, financial institutions such as banks, insurance companies and those in telecommunications (Government minimum wage decree, 2018). Continued monitoring of the short- and long-term impact of the gear exchange on fisher livelihood would be beneficial.

Fisher perception

The overall perception by fishers of the CMBP GSPP was that it was successful, and they would like to see the project continue. Fishers were hesitant to join the project in the beginning as they were anxious to give up the gear they used in a fishery they had become accustomed to for fear of losing what little they earned. However, as the project progressed, fishers consistently returned with larger fish while spending less time at sea. Fishers noticed a remarkable and consistent difference in catch species with larger fish being caught and more income being accrued for each fishing event.

Other fishers soon took noticed and wanted to join the pilot resulting in10 more fishers (two from Caracol bay and eight from Madras) joining the project in December 2018. Even fishers without their own boats began grouping themselves with other fishers who had boats in order to participate. There was a learning curve for fishers as they now had to venture further out to sea, adjust their bait type and figure out a strategic number of soak days to leave their traps out. However, throughout the duration of the pilot fishers met with the fisheries consultant regularly to discuss technique, bait and fishing sites.

Fishers have expressed some concern regarding replacing old and broken traps and have yet to master the economic balancing act of maintaining the optimum number of traps. As a result, the overall number of traps dwindled as they became unusable from wear and tear. Fishers have asked for continued support in terms of obtaining new traps and/or repair of broken ones.

Recommendations

Traps & Limitations

Many fishers had lost traps or broken traps throughout the pilot and in the early stages of the pilot other fishers even appeared to be tampering with these new traps, perhaps as a territorial measure for fishing grounds. This behavior is not uncommon in trap fisheries. Over time it appeared that the trap tampering behavior was reduced and fishers were reporting less loss of equipment resulting from other fishers. Fish traps however do deteriorate over time, having a life expectancy of approximately 6 months after which they will need to be repaired or replaced. It is anticipated that fishers will use their own money to buy traps to either increase the number of traps they have and /or repair damaged traps. Each trap takes approximately two weeks to build and another day to assemble. There are two main trap builders in the Madras and Caracol area. Traps are costed according to the number of holes in the weaving along the trap's length. A length of 15 weaved holes goes for approximately 400 gourdes whilst a larger trap with 22 weaved holes goes for approximately 1850 gourdes. The cost of mounting the traps also varies according to the trap size. Smaller traps cost 100 gourdes to mount and larger ones cost 150 gourdes to mount (Table 6). Some fishers complained that the funnel within the traps was too narrow preventing larger fish from entering the trap. Suggestions were given to stretch out the mesh surrounding the funnel.

Table 6. The cost in gourdes to build and mount fish traps

	Number of weaves holes per trap (dimension)	Cost of trap (gourdes)	Mounting cost (gourdes)
Builder 1	15	600	125
	17	1000	200
	21	1250	200
Builder 2	15	400	100
	17	700	150
	21	1100	150
	22	1850	150

Funding & Incentives

Funding whether by grant, government stipend or outside source is needed to assist with repair or purchase of new traps until fishers can earn sufficient income to accommodate setting funds aside for repair and/or replacement of traps.

Capacity building

Fishers require assistance with long term planning and budgeting to help themunderstand the balance between the number of traps needed to harvest adequate fish to sustain their livelihood and the differences in seasonal catch and effort. It is important for fishers to maintain a miniumum number of traps at all times in order to sustain themselves and so when traps begin to deteriorate funds are needed to repair or replace traps. Currently fishers use traps until they are no longer viable and continue to fish with fewer and fewer traps, until they have none left.

Monitoring

Monitoring (ongoing data collection), control (regulatory conditions under which exploitation can be conducted) and surveillance form an integral part of fisheries management. Information from monitoring is needed to feed into a management system to assist in making management decisions.

The type of controls will influence the monitoring and surveillance methods used by the Haitian fisheries agency. Continued data collection on the trap fishery as well as on the other fisheries within the PA3B are needed for a comprehensive understanding of fish stocks within the MPA.

A possible strategy for implementing continued monitoring would be to have data collection by local staff (students, fishers, rangers) on a part time basis supported by a local supervisor or staff from the fisheries agency.
Training and refresher trainings for staff on fish identification and allometric analyses prior to each data collection event should be conducted. Data collected (including photographs) should be sent daily to the supervisor for review and input into the data base. This would allow the supervisor to ascertain whether errors in the data collection method had occurred and whether the standardized method was being employed.

Monitoring should be done biannually during the period of May through September and November through April to capture differences in catch, effort and site selection, seasonally. Monitoring should be on going for either two consecutive months (8 weeks) or a minimum of 8 hauls per fisher during that period. This would allow data to be captured should there be an unforeseen halt in fishing due to weather, boat malfunction or any other reasons.
Each fisher's catch could be sampled once per week over the four-week period and at a minimum twice during each sampling period. Fishers generally have a 3 to 7-day soak time, therefore data collection should occur once a week for each fisher. This would reduce the effort required by persons undertaking the monitoring.

Table 8: Monitoring schedule for data collection of fisheries

Sampling seasons	Frequency per fisher		Metrics collected
May - September	8 weeks	8 hauls	Species, Total length, Weight, CPUE metrics
November - April	8 weeks	8 hauls	Species, Total length, Weight, CPUE metrics

Species should be identified using the English name or in creole using the Haitian Creole/English species list provided to ensure correct identification of the species. Photographs should be taken of any unknown fish and sent to the supervisor for identification.

The strategic goal would be that by year three, quality catch and effort data would be available to allow for simple stock assessment and to aid in management decisions.

Summary

The project showed a 63% decline in the number of parrotfish caught in fisher traps. Fishers also consistently caught larger parrotfish, potentially reducing the number of immature parrotfish in their catch. The GSPP objective to reduce the number of this keystone species caught in fisher traps was also achieved.

The species composition changed with the increased mesh size. Less economically important reef fish such as Grunts, Squirrelfish, Mojarras and Damselfish were replaced with more economically profitable species such as Porgies, Snappers, Groupers, Barracuda and Jacks. Fishers also regularly caught Caribbean spiny lobster in their large-mesh traps which fetch higher financial returns. Furthermore, the large mesh traps eliminated the by-catch of ornamental fish species.

Overall the fish caught in the large mesh traps were bigger than the fish caught in the small mesh traps. On average, fish caught in the large traps were 18.21 cm TL while those caught in the small mesh traps were 14.25 cm TL. Though the size at which fish reach sexual maturation varies between species, larger fish will evidently be closer to maturation size than smaller fish. Thus, the project goal of optimizing the fishery resource production by substantially increasing the size of the fish caught in their traps and reducing juvenile catch was attained.

The project started with an initial 10 fishers. Once underway other fishers from the same landing sites began to notice the improved catch and through a collaboration with Initiative pour l'Envronnement Intégré en Haïti (IEDIH), a local NGO, 10 more fishers joined the project. Each fisher also received an incentive package (stipend and cooler). Qualitative data provided to the fisheries consultant that was collective after the end of the activity showed a continued increase in large piscivorous fish and crabs being caught.

Another successful outcome of the project was the move from fishing within the mangroves and seagrass meadows to fishing the outer reef and pelagic zones. Given that the large mesh traps allowed small fish to escape the traps, fishers were thus forced to fish further offshore.

Continuing the GSPP and increasing the participation, is seen as beneficial by fishers. Monitoring as well as fisher and stakeholder training should be considered as essential for the successful management of the protected area.

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Appendix I

Akò

Ant:

Fondasyon pou Pwoteksyon Biyodivèsite Marin (FoProBiM), ki reprezante pa prezidan li Mesye Jean W. WIENER, pwopriyete, ki idantifye ak nimewo 003-331-097-5, ki abite nan Pòtoprens

Ak: Valbrun Lucner et de # CIN/NIF: 01-01-99-06-1969-00341 ki abite nan Karakòl oubyen Madras.

Akò sa a gen kòm objektif pou devlope yon pwojè pilòt pou elimine ekipman lapèch ki ilegal epitou pou modifye pratik lapèch ki pa apwopwiye nan È Pwoteje Twa Bè (AP3B) a.

Kòm patisipan :

1. Mwen dakò pou patisipe nan aktivite sa a k'ap komanse 5 jiyè pou fini 30 out.
2. Pou patisipasyon'm, mwen pral resevwa:
   - Fòmasyon sou itilizasyon nouvo ekipman lapèch
   - 2 nas ak nouvo may legal la pou chak nas FoProBiM aksepte pran nan men'm
   - Priyorite nan fòmasyon/pwodiksyon/vann farin lam veritab pou yon manm nan fanmi mwen ke m'ap deziye nan aktivite sa ke mwen p'ap chanje pou jis pwojè a fini
   - Yon alokasyon 2,250 goud chak semèn, pandan peryòd pwojè a
   - 1 gwo glasyè de 113,6 lit
3. Bò kote pa'm m'ap:
   - Remèt FoProBiM nas ak may ki pa rekòmande yo ke mwen ap itilize kounye a (FoProBiM pap remèt nas yo, l'ap detwi yo).
   - Patisipe aktivman nan pwojè pilòt sa epi ede FoProBiM ak konsiltan li lè y'ap travay sou pwojè pilòt la

Sa se sèl kondisyon ki nan akò sa a e se sèlman benefis sa yo mwen pral resevwa; epi mwen pa gen dwa mande okenn lòt kalite benefis nan men FoProBiM nan nenpòt ki lè apre pwojè pilòt sa a fini.

Mwen antre nan akò sa paske mwen konprann tout kondisyon sa yo.

4. Youn ou lòt pati ka met fen nan kontra sa sèlman pa ekri 8 jou a lavans ak bon jan eksplikasyon rezon ki fèl vle koupe kontra a.
5. Si gen dezakò ant 2 pati yo epi yo paka jwenn yon antant, yo ka mande yon abitraj ak yon lòt moun ki pap pou ni youn ni lòt.

Jean W. Wiener
Direktè

Valbrun Lucner
Pechè
Pwopriyete nas

Appendix II

Table: Scientific name, family, species and local Haitian creole name of the fish species caught in trap fishery.

Scientific family name	**Family**	**Species**	**Local name (Haitian creole)**
Acanthuridae	Surgeonfish	Ocean surgeonfish	Sirijen
Acanthuridae	Surgeonfish	Blue tang	Sirijen
Albulidae	Bonefish	Bone fish	Banane/ Macabie
Balistidae	Triggerfish	Queen triggerfish	Bous
Belonidae	Needlefish	Houndfish	Zoble
Callinectes	Portunidae	Blue crab	Sirik
Carangidae	Jacks	Jack misc.	Karang piston
Carangidae	Jacks	Rainbow runner	Pilot kola
Centropomidae	Snooks	Common snook	Brochet
Chaetodontidae	Butterflyfish	Banded butterflyfish	Manmzel
Cichlidae	Cichlids	Tilapia	Borama
Clupeidae	Herrings	Redear hearing	Orange/sardine
Coryphaenidae	Dolphinfish	Dolphinfish	Dord
Diodontidae	Porcupinefish	Burrfish	Goumba
Ephippidae	Spadefish	Atalntic spadefish	Wonn
Exocoetidae	Flyingfish/halfbeaks	Ballyhoo	Balawou
Gerreidae	Mojarras	Silver jenny	Gran zèpon
Gerreidae	Mojarras	Flagfin mojarra	Blanch
Gerreidae	Mojarras	Irish pompano	Blanch
Haemulidae	Grunts	Grunts misc.	Kwo Kwo
Holocentrus	Squirrelfish	Squirrelfish misc.	Meryann
Labridae	Wrasse	Wrass misc.	Zirel
Lutjanidae	Snapper	Gray snapper	Sad Mang
Lutjanidae	Snapper	Mutton snapper	Woulèz
Lutjanidae	Snapper	Yellowtail	Kola
Lutjanidae	Snapper	Lane snapper	Sad Dore
Lutjanidae	Snapper	Schoolmaster	Sad Jaune
Lutjanidae	Snapper	Small mouth	Sad dan Chen
Lutjanidae	Snapper	Snapper misc	Sad kout
Monacanthidae	Filefish	Orange filefish	Bous
Mugilidae	Mullets	Striped mullet	Mile
Mugilidae	Mullets	White mullet	Makambi
Mullidae	Goatfishes	Spotted goatfish	Balbaren
Mullidae	Goatfishes	Yellow goatfish	Balbaren

Scientific family name	Family	Species	Local name (Haitian creole)
Ostraciidae	Boxfish	Spotted trunkfish	Kof
Ostraciidae	Boxfish	scraweled cowfish	Kof
Polynemidae	Threadfins	Barbu	Wonn
Pomacentridae	Damselfish	Yellowtail damselfish	Kaka Poul
Pomacentridae	Damselfish	Threespot damselfish	Matlo
Pomacentridae	Damselfish	Sergeant major	Matlo
Pomacentridae	Chromis	Chromis	Bous
Priacanthidae	Bigeye	Glasseye snapper	Sad soleil
Pterois	Pteroi volitans	Lionfish	Juan juan
Scaridae	Parrotfish	Parrotfish misc.	Boutou
Scartella	Blennies	Molly miller	Dwet
Scombridae	Mackerels	Little tunny	Bonit
Scorpaenidae	Scorpionfish	Spotted scorpionfish	Eskopyon
Serranidae	Groupers/ sea basses	Coney	Fen
Serranidae	Groupers/ sea basses	Groupers misc.	vierge
Serranidae	Groupers/sea basses	Coney	Vennkatre
Serranidae	Groupers/sea basses	Red hind	Gris fer
Serranidae	Groupers/sea basses	Red grouper	Bare
Serranidae	Groupers/sea basses	Black goruper	Bare
Serranidae	Groupers	Grouper misc	Savonèt
Serranidae	Hamlets	Indigo hamlet	Makorel
Sparidae	Porgies	Sea bream	Mayonbe
Sparidae	Porgies	Knobbed porgy	Djol
Sphyraenidae	Barracuda	Great barracuda	Bekin
Tetradontidae	Pufferfish	Checkered puffer	Crapo lanme

Appendix III

Table with list of participant students and the criteria outlining their training. Certificates have been given to the students outlining their accomplishments and can be used by them to certify that they have undergone the training

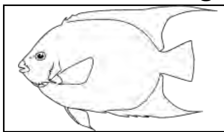
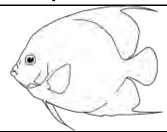
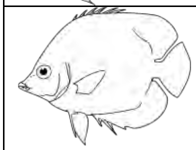
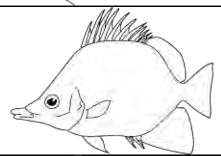
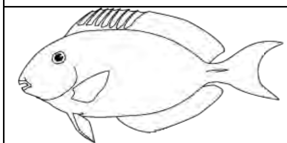
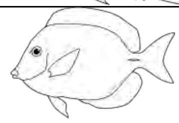
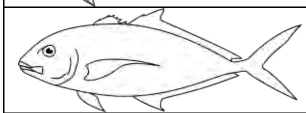
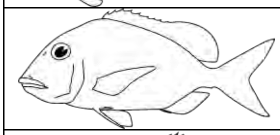
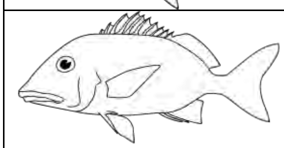
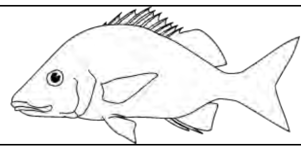
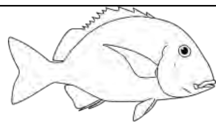
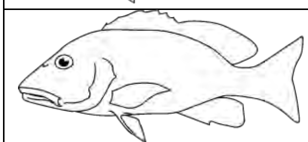
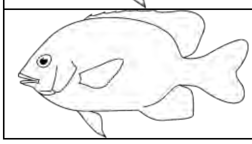
	Prénoms	Noms	Certificat dans la surveillance des activités de pêche dans les récif coralliens				Durée
1	Chrisla	Ceneus	Identification des espèces de pêcheries de récif coralliens	Collecte de donnes *in situ* des pêcheries de récif	Liaison technique /socio-économique dans le domaine de pêche	Introduction à la gestion des bases de données	200 heures
2	Marie Renée	Taloute	Identification des espèces de pêcheries de récif coralliens	Collecte de donnes *in situ* des pêcheries de récif	Liaison technique /socio-économique dans le domaine de pêche	Introduction à la gestion des bases de données	200 heures
3	Jeff	Georges	Identification des espèces de pêcheries de récif coralliens	Collecte de donnes *in situ* des pêcheries de récif	Liaison technique /socio-économique dans le domaine de pêche	Introduction à la gestion des bases de données	140 heures
4	Jovenel	Jeadore	Identification des espèces de pêcheries de récif coralliens	Collecte de donnes *in situ* des pêcheries de récif	Liaison technique /socio-économique dans le domaine de pêche	Introduction à la gestion des bases de données	200 heures
5	Gérald	Hyppolite		Collecte de donnes *in situ* des pêcheries de récif			80 heures
6	Ludwill Emile	Roll		Collecte de donnes *in situ* des pêcheries de récif			80 heures
7	Johnny	Pierre	Identification des espèces de pêcheries de récif coralliens	Collecte de donnes *in situ* des pêcheries de récif		Introduction à la gestion des bases de données	200 heures
8	Markly	Philemond		Collecte de donnes *in situ* des pêcheries de récif			80 heures
9	Sandelyn	Georges	Identification des espèces de pêcheries de récif coralliens	Collecte de donnes *in situ* des pêcheries de récif	Liaison technique /socio-économique dans le domaine de pêche	Introduction à la gestion des bases de données	250 heures

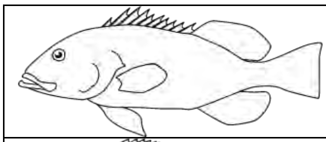
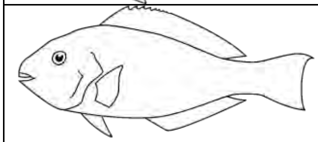
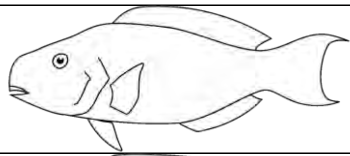
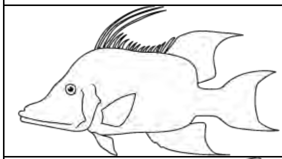
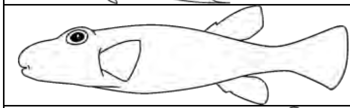
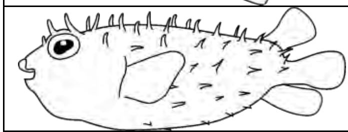
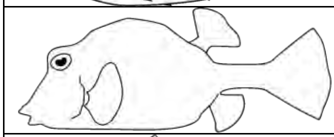
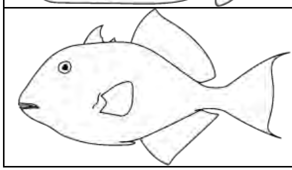
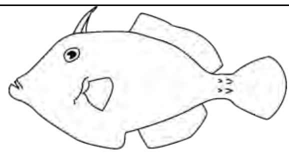
Appendix IV

Student Training material included a variety of methods. Students were first given the general body size of the most common fish families which was created for them (see below). They were also given the AGGRA Fish ID and flash power points. The Reef Fish Identification book by Paul Humann was always on hand for referencing. Fish length using the fish measuring board was taught in situ on site as was measuring fish weight.

- Fish family (general body type) identification chart created by C. Bissada
- AGGRA Fish ID ppt
- AGGRA Fish Flash 1, 2 & 3

Student training material created by C. Bissada

			**Angelfish**
			**Butterflyfish**
			**Surgeonfish**
			**Jacks**
			**Porgy**
			**Chub**
			**Barracuda**
			**Grunts**
			**Snappers**
			**Damselfish**

		**Groupers** **Sea Basses**
		**Parrotfish**
		**Wrasses**
		**Pufferfish**
		**Porcupinefish**
		**Boxfish**
		**Triggerfish Filefish**

Appendix V

Names of fishers, rangers and stakeholders trained in some aspects of sustainable fisheries, invasive species, ecosystem health and data collection protocols.

Name	Site	Association	Contact info	Training hours	Training type (Presentation, Field, Both)	Interested in more training
Mathieu Lumina	Derac	ASMED	32838285	2	Presentation	Yes
Pierre Franklin	Caracol	BMA	38939138	6	Presentation & Field	Yes
Oscar Fadius	Phaeton	ASPF	43588228	2	Presentation	Yes
Joacard Maudebela	Fort Liberte	APF	41989986	2	Presentation	Yes
Jean Baptiste Jose	Bord de Mer/Limonade	OPPBL	36427977	6	Presentation & Field	Yes
Elot Jaques Innocent	Madras	APIPD	43262623, 46022594	6	Presentation & Field	Yes
Pierre Garlande	Caracol	APDK	34493126	2	Presentation	Yes
Thimothe Evans	Bor de Mer/ Limonade	OPPBL	38359015	2	Presentation	Yes