Small-Scale Fisheries in Haiti

English synthesis

IRD's multidisciplinary scientific assessments at the request of the Ministry of Agriculture, Natural Resources and Rural Development (MARNDR in French).

Under the leadership of Gilbert DAVID

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Small-Scale Fisheries in Haiti
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INTRODUCTION

The Republic of Haiti is located on the island of Hispaniola, the second largest Caribbean island after Cuba. Its 27 750-km2 surface in 2020 housed a population of close to 11.5 million inhabitants. A major mountain range, of which the summit – the "Pic la Selle" – reaches 2 680 m, separates it to the east of its neighbour: the Dominican Republic. The country is shaped like a U, with a peninsula that is longer in the south and four large islands (Turtle Island, Cow Island, Gonâve Island, the Cayemites) as well as a number of small islands (figure 1).

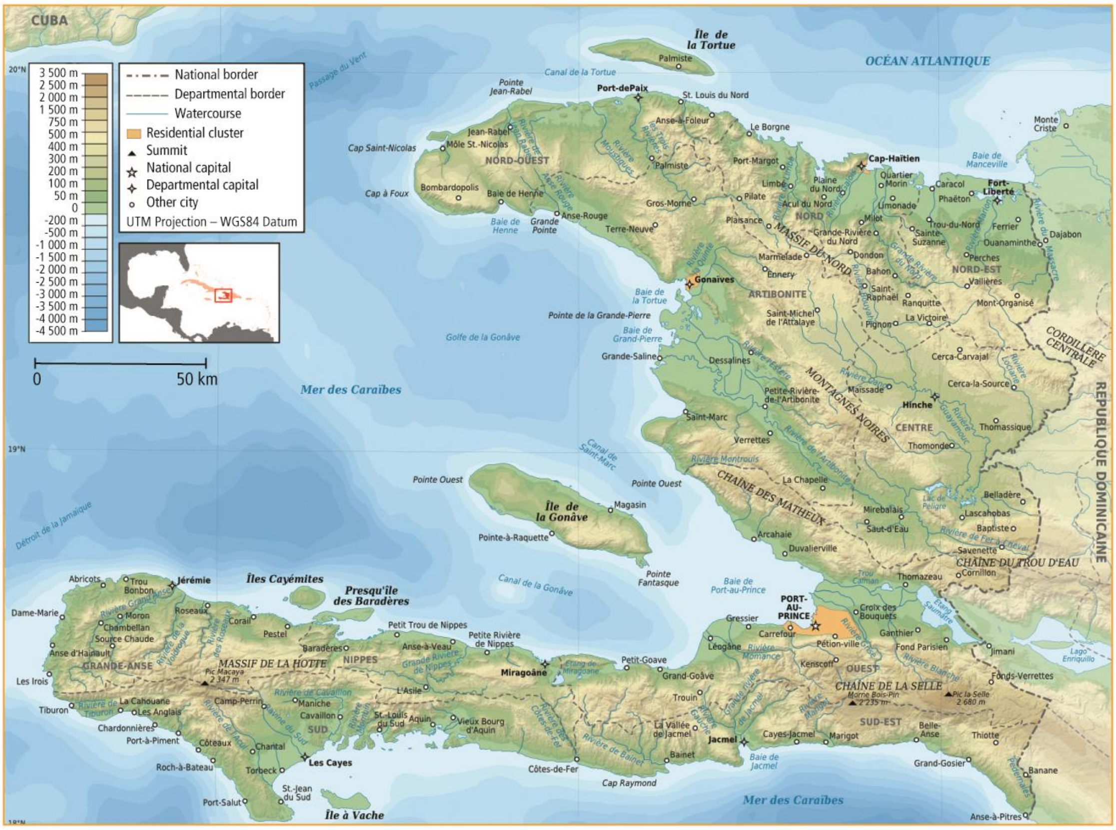


Figure 1 – The Republic of Haiti
Source: Rémi Kaupp, CC-BY-SA, Wikimedia Commons.

Haiti is particularly exposed to natural risks. The earthquake of 12 January 2010, of a magnitude of 7.3, resulted in more than 550 000 victims, including between 230 000 and 300 000 fatalities, depending on reports. An earthquake of similar magnitude struck the south west of the country on 14 August 2021. The country ranked third on the list of states on earth most exposed to climatic risk for the period 1999-2018 (Eckstein *et al.*, 2019). On average, 14 tropical depressions and 8 hurricanes affect the Grand Antilles every year. They generally move from east to west. Depending on exposure the annual rainfall in Haiti varies between 3 000 mm on the northern slopes and up to 1000 mm on the western ones. Precipitation is particularly strong during cyclone season between June and November. The rainfall pattern is thus capable of transfering large quantities of terrigenous sediment, torn from watersheds by erosion and runoff, toward the sea. The northern winds blow almost the whole year, raising waves which contribute to the reshuffling of coastal water circulation, thus allowing for both the dispersion of the deposited soil and the recycling of coastal waters by deeper ocean waters.

Haiti is the only country of the American continental landscape finding itself on the list of 47 least developed countries on earth. Its human development index of 0.495 places it 170th on a list of 189 underdeveloped countries identified by the United Nations in 2020. Among its numerous humanitarian and developmental challenges, food security occupies a foremost place. More than half its nutritional needs are met via imports and food aid. Three-quarters of the Haitian population live under the poverty line (2 US$/day) (FAO, 2013), and more than half the population under the line of extreme poverty (1 US$/day). The rural population, making up 40% of the total[1], is the most vulnerable (Action Against Hunger, 2017). The population density, at 428 inhabitants/km², is high. The birth right is 2.4% per year, but population growth is only 1.5% per year due to mortality (0.8%) and emigration. The population is characterised by its youth, 60% being under 25 years of age. For purposes of comparison, we note that the population density of the Dominican Republic is two times less (212.5 inhabitants/km²), and it sports a birth-rate of 1.98% per year and a natural population growth of 0.95% (0.6% mortality per year).

Every year in Haiti demographic growth accentuates problems related to food security for a population for which a food intake of 50 g/day is recommended for persons of both sexes and all ages, and 70 g/day for an active adult in order to meet its nutritional needs (Kayser, 1970). Figure 2 shows that rice makes up the primary food source in the Haitian population's diet. However, in order to be fully digestible by the human body, these rice-derived proteins have to be supplemented by lysine-rich foodstuffs, lysine being an amino acid notably obtained from fishery products, even if the latter is only consumed in the form of condiments such as dried fish crumbs (see part III). The role of fishery products in maintaining the nutritional balance of the inhabitants of Haiti is therefore essential.

[1] http://www.fao.org/faostat/fr/#country/93

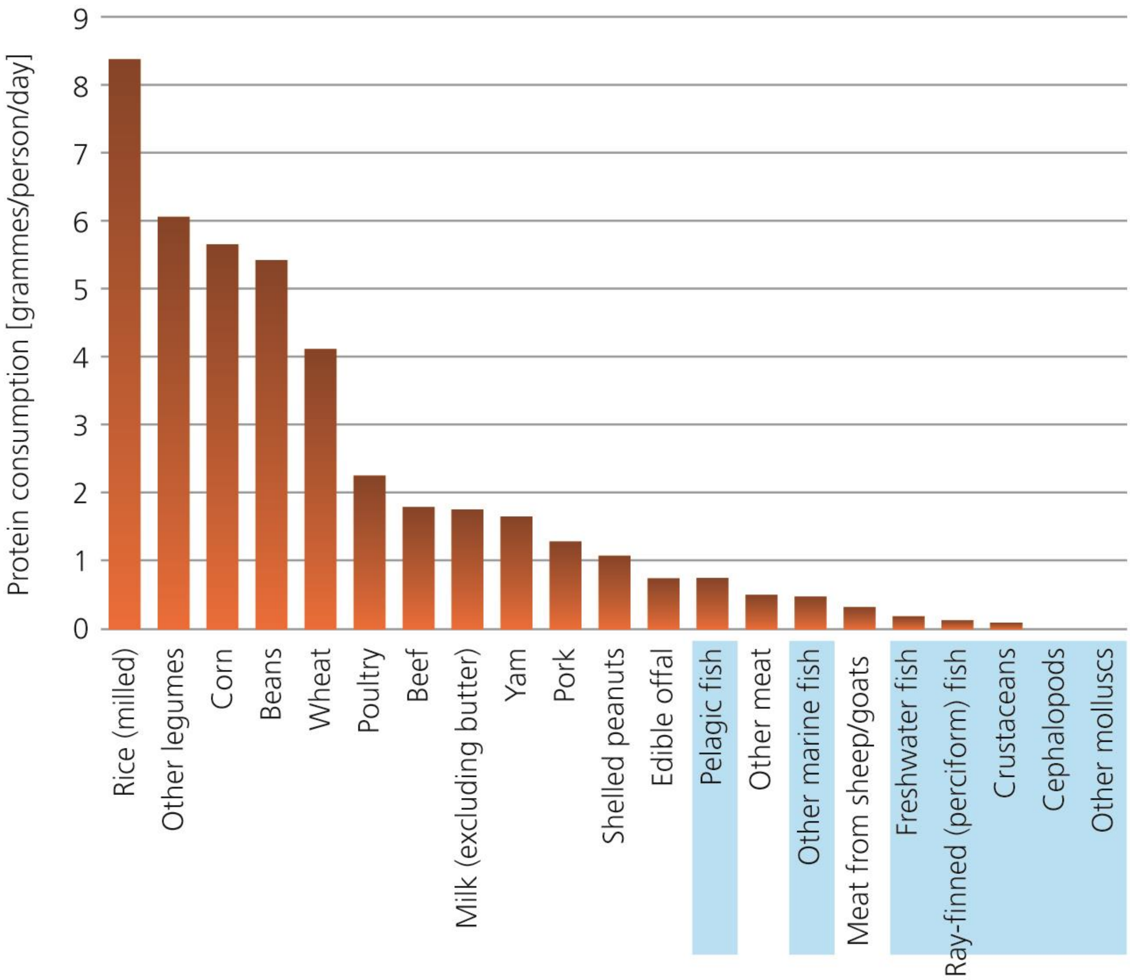


Figure 2 – Average consumption of protein in relation to food sources appropriate for Haiti. Seafood is highlighted in light blue (source: FAOSTAT 2019).

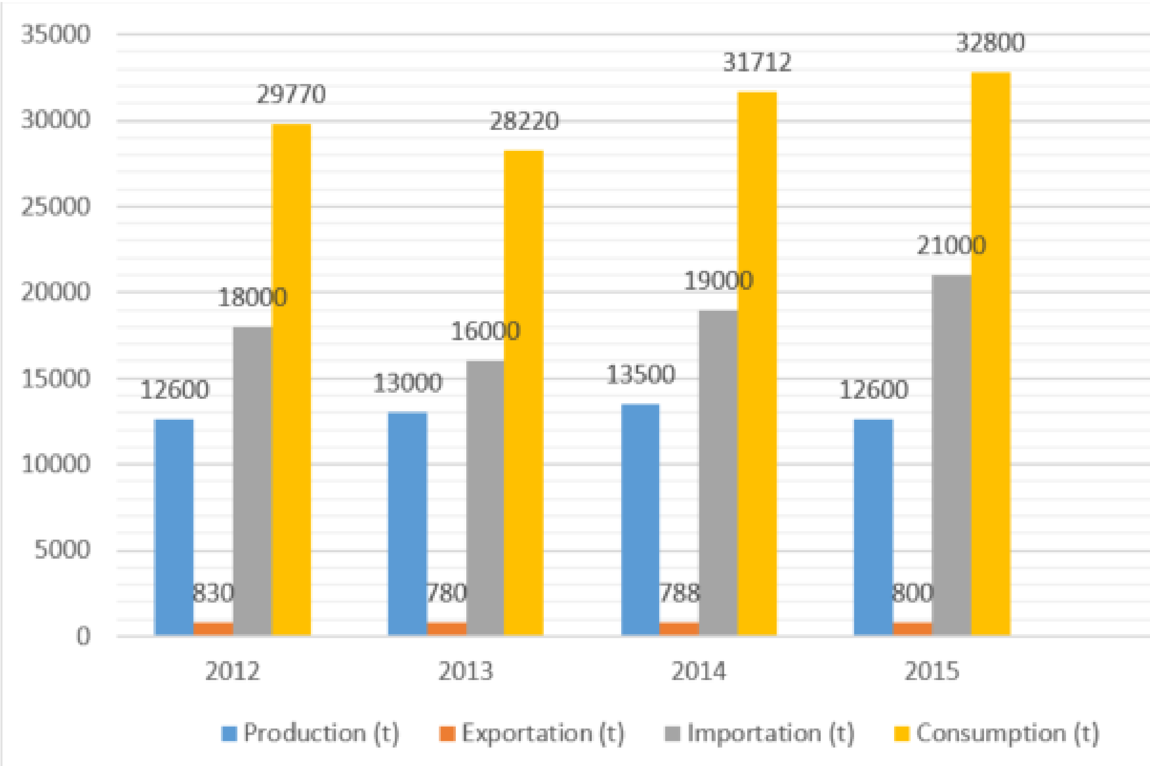
Rice, a rarely-imported commodity until the 1990s (7 000 tonnes in 1985) has become the chief import, replacing other cereals and local production which has stagnated at between 70 000 and 75 000 tonnes each year. The average consumption per inhabitant is 51 kg of rice per year (source USDA) and, in order to meet demand, close to 500 000 tonnes were imported in 2020 (90% from the United States).

The fishery sector has not escaped this evolution. Average estimated consumption is slightly less than 5 kg per inhabitant (Badio, 2018; FAO, 2015)[2], i.e. an amount significantly less than the global average, which was 20.5 kg in 2018 according to the UN Food and Agriculture Organisation (FAO) (II.1)[3]. Nevertheless, it is still higher than the average Cuban consumption, which has decreased from 16 kg per person in 1989 to 4.3 kg in 2014 (Moralès, 2019). According to the FAO (2010, 2011), the consumption of fish at the beginning of the decade was around 4 kg/inhabitant/year

[2] The 2020 edition of the FAO's annual directory of statistics on fishery and acquaculture's alimentary appraisal indicates a higher consumption rate, estimated at 6.5 kg/inhabitant/year (FAO, 2020).
[3] These references correspond to detailed expertly-edited contributions attached to the electronic version of the asessment.

(FAO, 2010, 2011). For some years therefore, we have been witnessing a displacement of fishery- and aquaculture products in the diet of the Haitian population.

The fishery sector occupies an important place in the island's economy. At the end of the 1990s fishery accounted for 13.6% of GDP and provided close to ¾s of the amount of fish consumed locally. Since then importation has increased significantly. During the period 2012-2015, between 16 000 and 21 000 tonnes of fish had to be imported, whereas national fisheries production aimed at local consumption (between 11 770 and 12 712 tonnes) was able to meet only 36% to 43% of the Haitian population's demand for seafood (figure 3). It should be noted that between 780 and 830 tonnes were exported every year, of which an average of 160 tonnes of lobster.



Local supply/ consumption	**2012**	**2013**	**2014**	**2015**
(Local supply = Production – Exportation)	**39.5**	**43.5**	**40.1**	**36**

Figure 3
Contribution of national sea fishing to the consumption of seafood in Haiti (according to Badio, 2018).

According to the Haitian authorities, in the mid-2010s, 52 000 families participated in fishing (21 000 professionally) located in more than 420 areas (Badio, 2018), with 60 000 people working in the processing and commercialisation sectors. Thus, the sector employs a number of role-players in Haiti. Firstly, there are the fishers and those who buy their product – situated at the upstream end of the sector's production chain – i.e. *traders* who operate their own business or commercial venture, *Madam Sarahs* (a colloquial term for itinerant peddlers) and *local agencies*. The first two are almost exclusively female, whereas agencies are generally operated by men. The role-players located at mid-level in the sector transport the fish from fishing boat-docking points to places of consumption (*regionally operating agencies*, *wholesalers*, and *Madam Sarahs*). Downstream the sector consists of *retailers*, *restaurants* and *supermarkets* dealing directly with consumers.

Despite the place it occupies in the country's economy and the numerous role-players it employs, Haitian small-scale fishing remains relatively unproductive compared to other island nations in the Caribbean zone. It remains dominated by oar-driven or sail-fitted canoes and wooden skiffs, even though since the 2000s glass-fibre motorboats were introduced in order to exploit pelagic resources identified by Fish Aggregating Devices (FAD) anchored a few kilometres offshore. In 2018 the Directorate of Fisheries and Aquaculture in Haiti estimated the number of fishing vessels at 26 000 – 14 800 canoes, 10 000 sail-fitted boats and 1 200 motorboats (Badio, 2018). The limited range of activity enabled by the vessels explains why fishing effort is mainly apply Box within a narrow coastal space, of which the resources are considered over-exploited, as the small size of fishing hauls attests (Damais *et al*., 2007; Favrelière, 2008; CRFM, 2010). At the same time, commercialisation and the general organisation of the distribution of fishery products constitute a second bottleneck, notably as a result of a lack of means of preservation storage and the limited financial capacity of the various role-players in the sector. As a result, as noted by Macias *et al.*, 2014 (p. 2): *"Post-haul losses are very steep and a significant part of the value of income obtained from the resources is lost."*

Significant steps towards the improvement of small-scale fisheries in Haiti can therefore be envisaged to optimise its sustainable development, to develop an aquaculture less costly in input, and to overcome the three big challenges, which Haiti will be facing with regard to its fishing- and aquaculture sectors in the coming years:

- feeding its people by ensuring a regular provision of animal protein;
- providing employment in coastal areas and along the entire value chain of the fishery sector;
- reducing the importation of fish and optimising exportation of high-value commercial species such as lobster, sea cicada and queen conch in order to balance the commercial scale in Haiti, all the while respecting the management of resource exploitation.

Within this context, in 2016 the government of Haiti, through its Ministry of Agriculture, Natural Resources and Rural Development (MARNDR in French), launched an ambitious small-scale fisheries development policy (Macias *et al*., 2014) with the support of the Inter-American Development Bank (IDB). Priority was placed on eight activities (Badio, 2018):

- a census of small-scale fisheries including notably a register of fishers, means of fishing, fishing boat docking points and production, and boats; the results of the

third phase of this census showed that 45 728 fishers were active in the country[4], i.e. double the number estimated by the MARNDR in the mid-2010s, among whom 21 000 operated professionally (Badio, 2018);
- creating an inventory of the primary resources of economic importance;
- updating the legal framework;
- reconstitution of the mangrove forests;
- creation of a health inspection- and certification service;
- arrangement of seafood stockage-, processing- and commercialisation centres;
- putting in place crushed ice factories in fishing zones;
- installation of trading posts for communal fishing.

It is within this context that the MARNDR, at the end of 2017, commissioned the French National Research Institute for Sustainable Development (IRD in French) to undertake a joint scientific assessment (ESCI in French) around the theme of small-scale fisheries . For several months a multidisciplinary team of Haitian and French scientists and professionals uniting agronomists, fishery experts, anthropologists, economists, educators, geographers, environmental managers, all specialists in island fishery, worked to create an analysis of existing information on the state of fishery and aquaculture in Haiti. Their analyses focused on the work of previous scientific research as well as on recent studies (both academic/commercial and non-academic/commercial publications) related to the fishery sector and its ecosystem. While the relevance of these studies is self-evident, it should be noted that the experts did identify numerous gaps or shortcomings with regards to available scientific data. The inaugural workshop for the assessment was held in Port-au-Prince from 16 to 18 January 2018 with the totality of role-players in the fishery sector represented. This allowed for the definition of the thematic scope and the guiding principles of the joint scientific assessment. In total, seven thematic axes, each narrowly linked to the others, are examined in this assessment, including the exploitation of marine resources (coastal, pelagic, i.e. deep oceanic and demersal, i.e. subsisting close to the ocean floor), their distribution and commercialisation, and their management. They are structured around 21 questions addressed by the 17 experts involved and regarding which the outcomes have been compiled together in the present work[5].

The assessment also identified solutions implemented at an international level, notably in island states similar in nature to Haiti with regards to the exploitation of their fisheries resources. This multidisciplinary evaluation of the state of knowledge around small-scale fisheries in Haiti and in other regions of the world enabled recommendations to be made to the government of Haiti regarding the assurance of the sustainable development of small-scale fisheries . Only those suggestions directly related to Haiti were presented, or else those of which the applicability to the Haitian context constituted the very objective of field studies undertaken by the experts. One

[4] Source in the Directorate for Fisheries and Aquaculture (DPAQ in Fench) of the Ministry for Agriculture, Natural Resources and Rural Development (MARNDR), interviewed on 11/05/2021. Unpublished RNAP census – 3rd phase. (https://haitistatagri.com/index.php)

[5] For more information on the expert panel; the oversight committee; the list of themes and initial questions of the expertise; the list of all contributions as well as their access; please refer to the French version of the synthesis

shouldn't forget that the economic and political situation in Haiti differs from that of its neighbour islands, and that reliance on generally-accepted norms and practices (at an international level) regarding conservation, fishery capacity development and management may not be appropriate or applicable to the Haitian case. This field research consisted of *in situ* observations and interviews with local role-players.
Detailed investigations have also been carried out in the departments Sud and Sud-Est, notably in the townships of Chardonnières, Bainet and in the Aquin neighbourhood with regards to knowledge and know-how related to fishery and its management (box no. 4), the feasibility of putting in place artificial reefs (IV.3) or pond aquaculture in salty, swampy mangrove depressions known as "tans" (IV.2).

This "state of the scientific art" aiming to strengthen the existing knowledge regarding fishery in Haiti is structured according to a systematic perspective, namely the Fisheries system ("le système Pêche" in French) (Rey Valette *et al*., 1997). A concept connecting geography, fishery studies, the biology of fishery and the economy, the Fisheries system proposes an approach that extends beyond the "traditional" vision of fishery limited to the study of predator/prey relations (i.e. fisher and fish, respectively). According to Corlay (1979), the Fisheries system is made up of a number of different elements: biological (production of marine biomass), technical (means of production at sea and on land) economic (financial structure of material, practice and purpose related to hauls, commercial partners), social (implication of producers and consumers), cultural (dietary and religious practices), and legal (regulations). All these elements closely depend on one another, and are linked by complex networks of fluctuation determining the state of systemic balance or imbalance. Together they give rise to a specific space of operation, namely the fisheries space. This systemic approach was widely used by IRD researchers in the 1990s (David, 1991; Chaboud and Fontana, 1992; Quensière *et al.*, 1994; Ferraris and Le Fur, 1995; Le Fur, 2000). Focusing on the economic and social elements relating to fishery, it has proven itself more integrative than the more recently developed ecosystemic approach, which focuses essentially on the effects of fishery on marine biocenosis (an association of different organisms forming a closely integrated community) and its digital modelling (FAO, 2008 ; Heymans *et al*., 2016).

From this point of view, the existing corpus of knowledge around small-scale fisheries in Haiti has been collected and set forth here in three parts: environment, ecology of species and fisheries (part I); modernisation of instruments and management (part II); and the social and economic system within which this sector operates (part III). These three parts are followed by a final part containing expert recommendations, clustered into 11 groups (part IV). These recommendations apply both to the present situation and the coming decade. They attempt to take into account the demographic and socio-economic evolution of the country, as well as such constraints as are imposed on it by global climate change. They are also aimed at decision-makers and role-players within the field of fishery, being the ones who will have the responsibility of managing the sustainable and equitable development of marine biodiversity and fishery resources for millions of people.

PART I: ENVIRONMENT, SPECIES AND FISHERY

1. The coastal and maritime space

Haiti sports a coastline of 1 770 km (Badio, 2018)[6] and an island base (the equivalent of a continental plateau for non-island states) of around 6 600 km (Saffache, 2006), constituting a Exclusive Economic Zone (EEZ) comprising a surface area of 103 818 km^2 (Flanders Marine Institute, 2018)[7]. It should be noted that 13 934 km^2 surrounding Navassa Island (with a surface area of 5 km^2 and situated some fifty km west of Hispaniola) are also claimed by Haiti. The degree of insularity, also referred to as the degree of oceanic envelopment (Doumenge, 1984), corresponds to the relation between the EEZ and the terrestrial surface area – for Haiti, this figure is 3.74. If Navassa were to be added to the Haitian territory, the EEZ/land ratio would rise to 4.2[8]. In terms of the Caribbean as a whole, Haiti has the lowest EEZ/land ratio other than Cuba (3.19) (table 1).

	Land surface (km^2)	EEZ (km^2)	Ratio EEZ/land
Cuba	109 884	350 751	3.19
Dominican Republic	48 734	255 898	5.25
Haiti	27 750	103 818	3.74
Bahamas	13 880	654 715	47.17
Jamaica	10 991	258 137	23.48
Trinidad and Tobago	5 128	74 199	14.4
Dominica	754	28 985	38.44
Saint Lucia	616	15 617	25.35
Antigua and Barbuda	442	110 089	249.07
Barbados	431	189 898	440.60
Saint Vincent and the Grenadines	384	36 302	94.53
Grenada	349	27 426	78,58

Table 1
Oceanic envelopment index of Caribbean island states (source: UN, Flanders Marine Institute).

6 Coastal length depends mostly on the scale in which it is expressed. When the scale decreases (i.e the relation between the size of a feature and the represented reality decreases) coastal length increases, notably along the rocky coastlines sporting indented upper sides. The figure given here does not take into account the coastline of the small Haitian islands.

[7] Surface area not including the part attached to Navassa Island, under United States jurisdiction, of which the current EEZ is 13 934 km². The Flemish marine institute VLIZ (Vlaams Instituut voor de Zee) is the international autority with regards to the limits of maritime zones and legal rights related to them. According to the FAO, the surface area of the Haitian EEZ is 86 398 km² (FAO, 2005) and 126 760 km² according to Wikipedia. (https://fr.wikipedia.org/wiki/Zone_%C3%A9conomique_exclusive)

[8] For comparative purposes one may note that an island state like the Salomon Islands, of which the land surface area is slightly greater (29 785 km^2) has an insularity rating of 45.

Figure 4 shows that Haiti's EEZ is situated primarily in the south. Its reduced size constitutes a significant obstacle to the development of an industrial fishing fleet targeting tuna resources, the latter being extremely mobile – a tuna fish can cover several dozen km per day – and with availability subject to extensive seasonal fluctuation; hence fishing boats are obliged to operate outside the Haitian EEZ for large parts of the year. This requires the implementation of numerous bilateral agreements between the countries of the region, as only a small part of the ocean within the Caribbean gulf is classified as international waters.

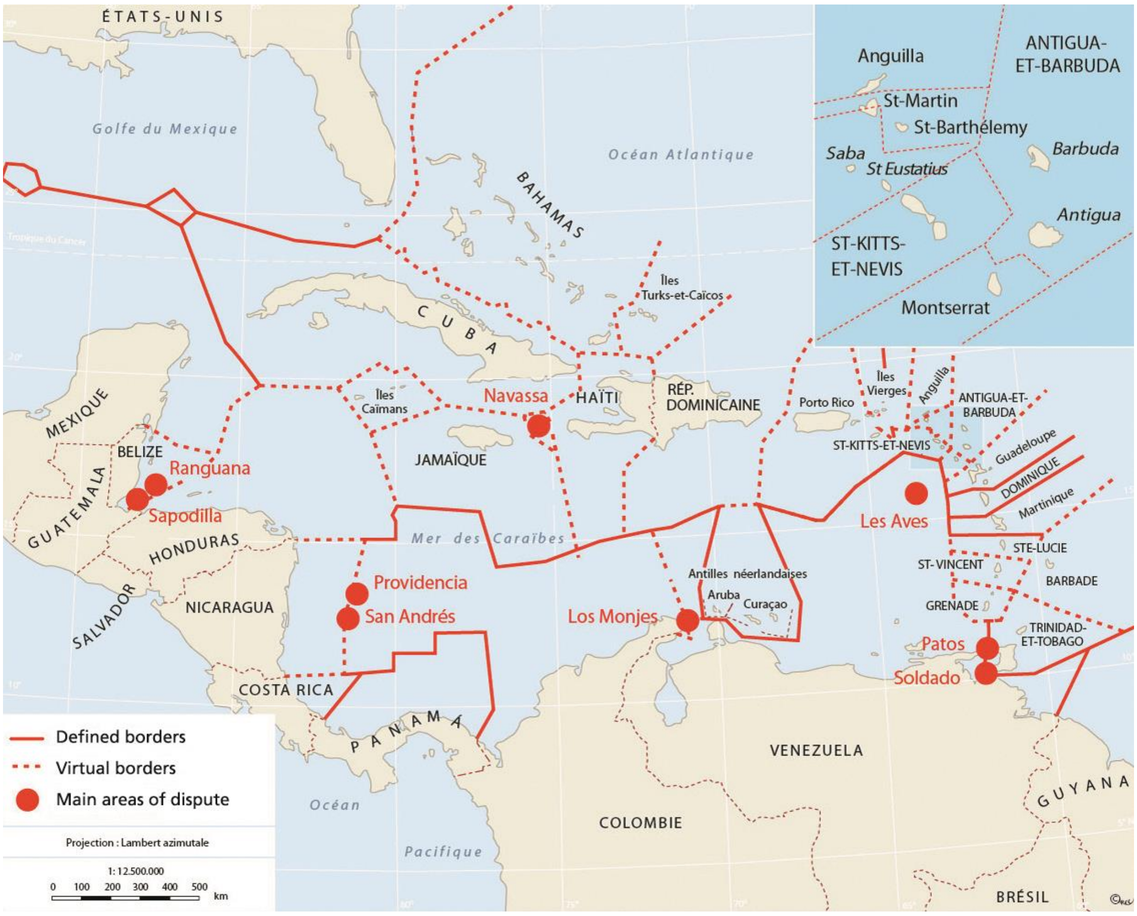


Figure 4
EEZ in the entirety of the Antilles, including Haiti (source: Atlas des Caraïbes).

2. The seascape

In order to make up for the lack of data specifically related to the Haitian seascape, this assessment relies on analyses conducted on a larger scale. The spatial frame of reference is that of international organisations working in the region: zone 31 of the Food and Agricultural Organisation of the UN (FAO), of which the Western Central Atlantic Fisheries Commission (COPACO in French) oversees fishing activities. The investigative zone of this assessment focuses on the Haitian EEZ as well as that of the Navassa enclave, of which marine species are also found in Haiti. The cartographic representations of the spatial distribution of species have been extended to the rectangle including the EEZs of Cuba, the Cayman Islands, Jamaica, the American enclave of Navassa, Haiti and the Dominican Republic, i.e. the area contained between 14.0833° and 25.2246° north latitude, and between 65.8219° and 86.9397° west longitude, corresponding to our zone of study. The boundaries of these EEZs, as well as the boundaries of Haitian territorial waters are always indicated on the maps presented here. (figure 5).

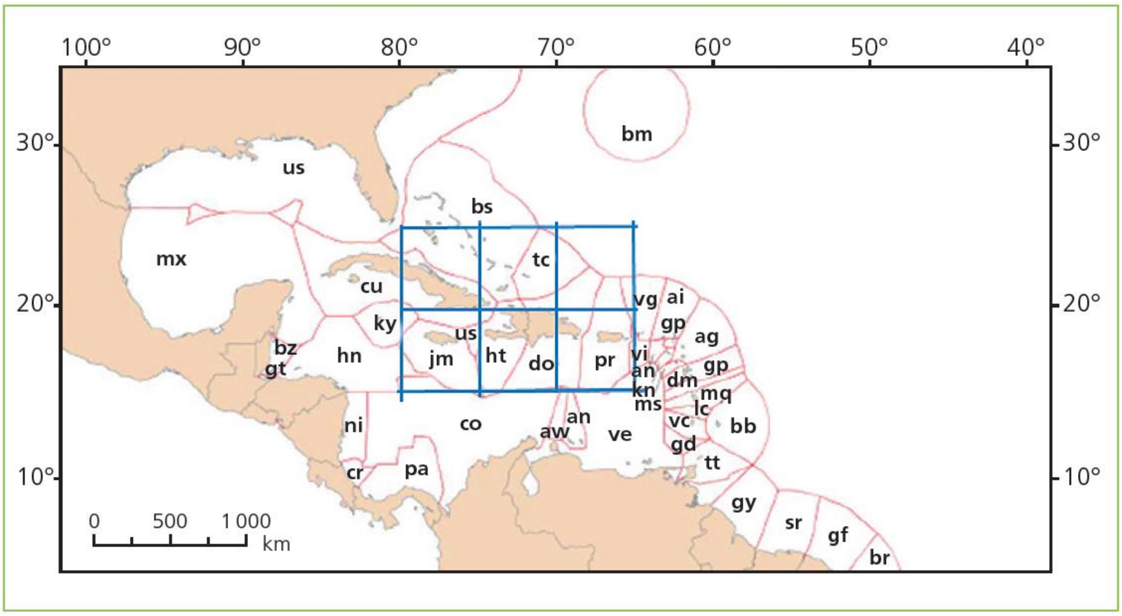


Figure 5
Map of FAO zone 31 countries, notably showing the Haitian EEZ (ht) (Carpenter, 2002.) and the 5 degree-a-side statistical rectangles used for databases recording activity and hauls by CICTA[9] (blue lines). Sources: CARPENTER (2002) ; Cicta.

Because of its limited range of activity, the Haitian fishing fleet rarely operates outside territorial waters, i.e. more than 12 nautical miles off the coast. Only a few motorboats range as far as the edges of Navassa Island and outside of this area. The entire zone within which customs legislation, and in some cases policing (e.g. in the fight against drug- and human trafficking) operates, extends from the edge of the territorial waters 24 miles into the ocean beyond; its surface area measures 18 944 km².

A/ Regional hydrographic context and ocean currents

From a tectonic point of view, the region is peculiarly situated, at the point where the North American plate meets the Caribbean one. This meeting point runs across the Greater Antilles; Cuba is situated on the former plate, whereas the island of Hispaniola (Haiti, Dominican Republic), Jamaica and Puerto Rico are located on the latter, In the east, the burrowing of the North American plate under the Caribbean plate created the island chain of the Lesser Antilles. The North American plate extends to the mid-Atlantic ridge, an underwater chain rising to 2 350 m above the ocean floor, and which within this area bends towards the southwest. On its northeast side is found the Nares abyssal plain, the deepest, and that of Hatteras, out of which rise the Bermuda

[9] The International Commission for the Conservation of Atlantic Tunas (ICCAT or CICTA in French)

islands. In the northwest, hedged by Florida to the east, extends the Gulf of Mexico, sporting a wide continental plateau on its eastern side – off the Florida coast – north and east of the Bay of Campeche to the Yucatan strait which separates the Central American isthmus from the island of Cuba. The central and eastern part is made up of several basins surrounded by troughs or ridges: the Yucatan Basin and the Cayman Trough; the Colombia Basin separated from the Venezuela Basin by the Beata Ridge, the latter in turn separated from the Grenada Basin by the Aves Ridge (figure 6).

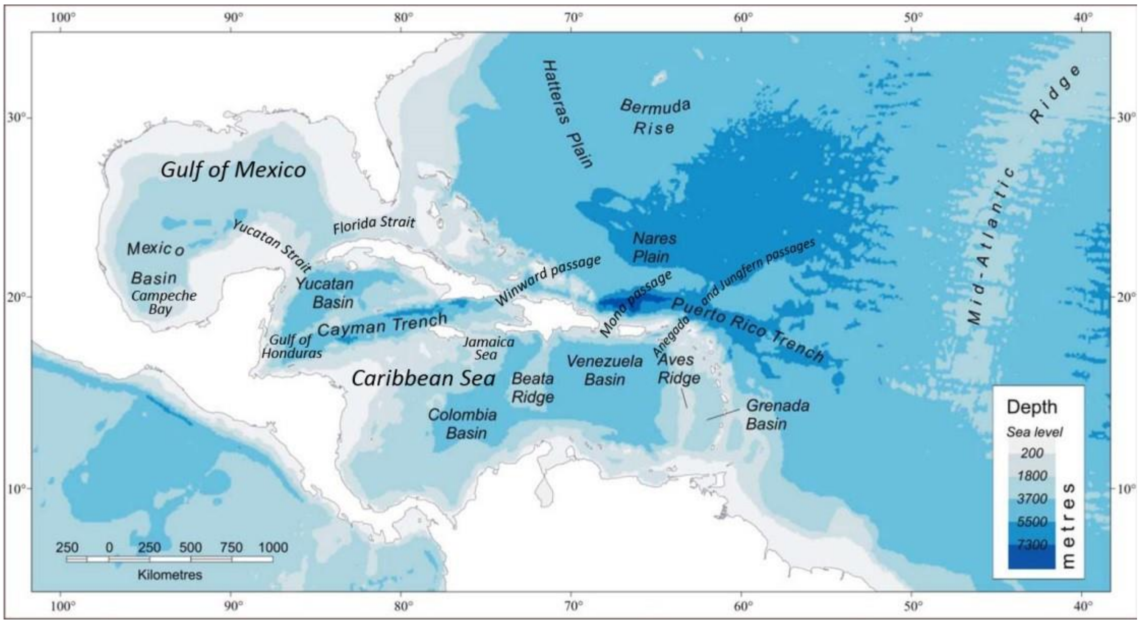


Figure 6
The hydrographic context of the Caribbean zone (source: FAO, 2002a).

The Caribbean Sea constitutes a large peripheral sea of the Atlantic Ocean, twice as wide as the Mediterranean. It opens onto the ocean via five straights: the Florida straight; the Windward Passage, sporting a depth of 1 540 m; the Mona straight, with a depth of 400 to 500 m, and those of Anegada and Jungfern, with depths of 1 910 m and 1 815 m. It is connected to the Gulf of Mexico by the Yucatan straight, which has a depth of 2 040 m. Within this semi-closed off sea, crossover with the Atlantic Ocean is regulated by openings in the West Indian island chain which prevents the deep waters of the Antarctic from entering. These waters are the densest of all the oceans and remain congregated at the bottom of the Nares and Hatteras abyssal plains. On the other hand, the deep waters of the North Atlantic enter via the Virgin Islands Basin and the Windward Passage.

The surface waters of the Caribbean Sea originate from the Guiana current, which divides into a northern branch – the North Equatorial Current – and a southern branch, the Caribbean Current. The latter traverses the Caribbean, cross the Yucatan and Florida straits and then re-joins its northern equatorial counterpart west of the Sargasso Sea, feeding into the Gulf Stream. The Guiana current is fed by influxes from the Amazon- and Orinoco rivers, as well as from the North Brazil current at its origin. In the course of the north-to-south oscillation of the zone of trade wind convergence, the Guiana current undergoes a retrofluctuation generating gyres which end up slamming into the Caribbean Sea and the Gulf of Mexico in the form of five giant rotating currents – the Panamanian, Haitian, Cuban, Campeche, Texan and Floridian gyres. Smaller gyres of varying lifespans are also found across the entire Caribbean (figure 7).

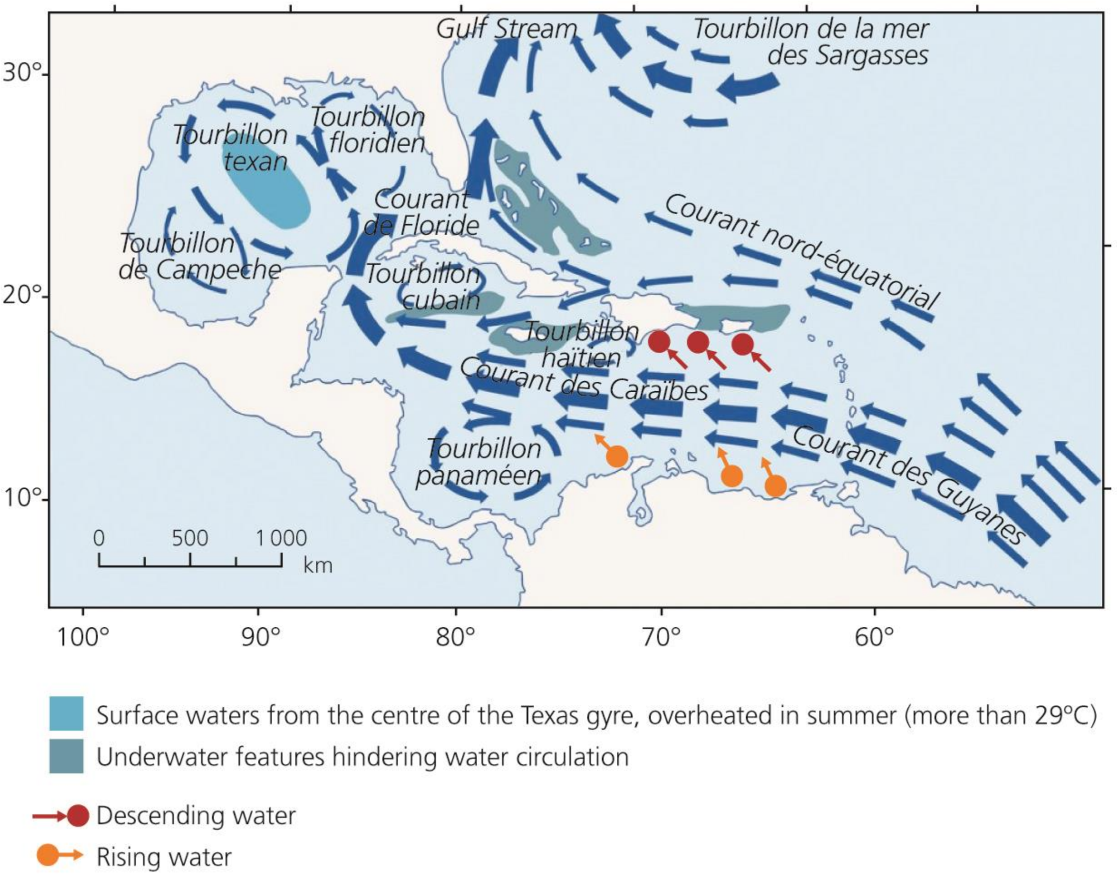


Figure 7
Water circulation in the Caribbean Sea and the Gulf of Mexico (Encyclopaedia Universalis, Pinot, 1969).

B/ Haitian hydrographic and oceanographic context

Figure 7 shows that, in terms of marine hydrology, the Republic of Haiti find itself in a rather privileged position. It is irrigated in the north by an offshoot of the equatorial counter current and in the south by the Caribbean current, the southern coast being close to the Haitian gyre and thus lending itself to primary production.

The seabed of the Haitian EEZ is located at a depth of between 0 and 4 440 m (average 2 726 m). As far as details are concerned, Haitian hydrography is rather badly informed, with the most recent data compiled as part of the international GEBCO (General Bathymetric Chart of the Oceans). Prior to 2019 spatial resolution operated earth mapping at a rate of 30 seconds per arc, corresponding to a single hydrographic value for a square of 1 x 1 km. The latest version operates at a spatial resolution of 15 seconds per arc, i.e. a hydrographic value of 450 x 450 m per square (figure 8).

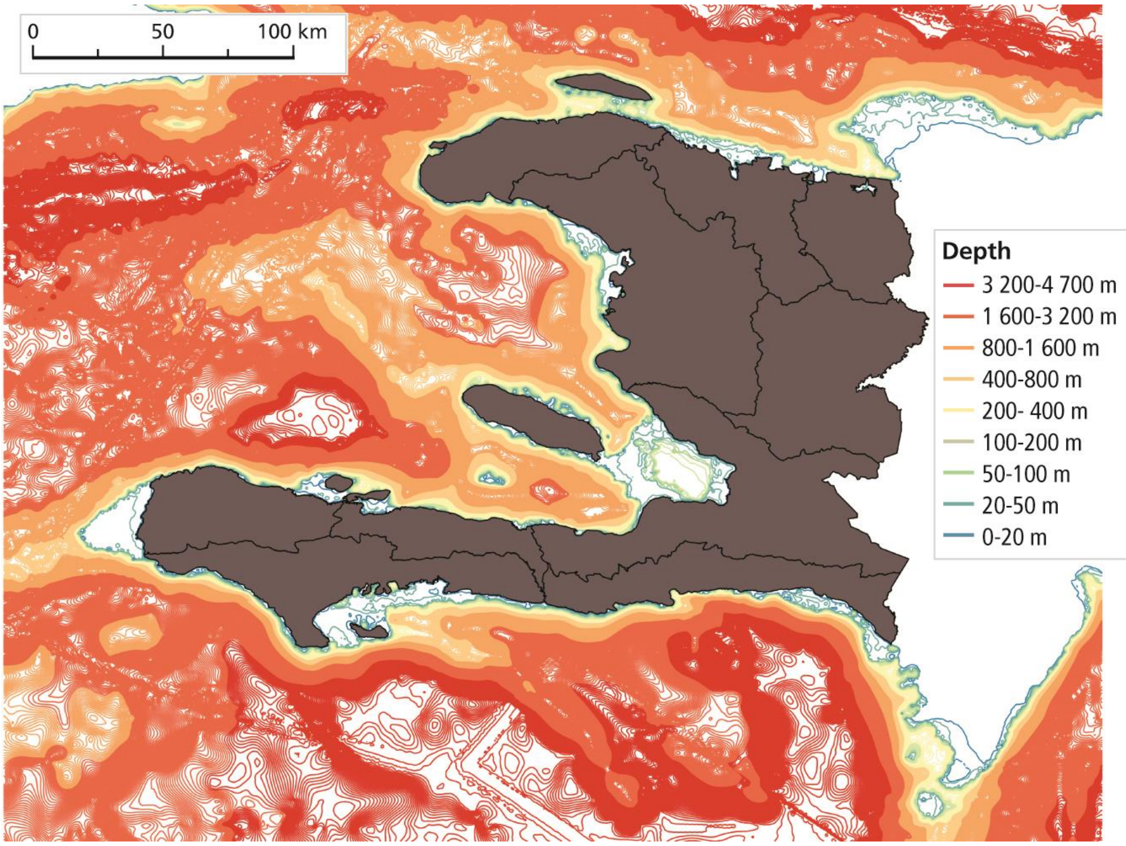


Figure 8
Topography and hydrography of the Republic of Haiti, with depth indication (© H. Valles, 2021 - data GEBCO).

Despite the rough nature of the hydro graphic data available, it is possible to derive interesting lessons from them as far as fishing is concerned.

The first of these relates to the limited surface area of depths – generally less than 100 m deep and often less than 50 m – within which Haitian small-scale fishing takes place. Figure 8 shows that the surface area of small shallows (less than 100 m) is very limited compared to that of the rest of the territorial waters extending 12 miles (22 km) from the coastline. A large part of these territorial waters feature no fisheries exploitation at all outside of established fish concentration schemes (FADs).

The second lesson bears on the significance of areas within the territorial waters sporting depths of 500 to 1000 m or even more. Many parts of the island are not far removed from these depths, which are well-suited to catching deepwater demersal fish. In the south, depths of more than 1000 m are found close to the towns of Jérémie, Port Salut and Jacmel, possessing hydro graphic configurations most favourable to the creation of FADs. The north-western part of the country boasts similar conditions, all the more suitable for fishery within fixed FADs given that it is irrigated by a branch of the equatorial counter current, meaning that this large straight between the southeast point of Cuba and the northeast of Haiti constitutes an obligatory passage for shoals of tuna fish.

The south of the country is affected by the Caribbean current, fed by the Guiana current (figure 7). Pushing towards the Grande-Anse River, the current creates a gyre favourable to primary production and also a very unusual connective configuration: while the Grande-Anse is fed by larval fish flow via the waters surrounding the south of the country, larvae emerging from fish species making their home in the Grande-Anse are confined to that area. This current-based context explains the potential value in putting in place protected oceanic zones to the north and south of the Grande-Anse, as well as near Gonâve Island, in order to optimise the area's connectivity and to feed the entirety of the gulf with larval flow (V.2).

3. Habitats

The seascape exploited by Haitian small-scale fishing contains numerous biotopes housing many species which, in turn, present significant potential for fishery and marine aquaculture (Célestin, 2004). Apart from the three major ecosystems which characterise the island spaces of the Caribbean Sea (mangroves, coral reefs and spermatophyte seagrass beds covering the coast and the shallows of the upper part of the island base, one also notes the existence of the neritic (coastal water) zone ecosystem, as well as the benthic and demersal ecosystems on the floor of the island base slope and its lower part, deepwater and offshore pelagic ecosystems, mesopelagic (intermediate depth) fish species, bathypelagic (deepwater) fish species and bathyal fish species (inhabiting the area between the island base and the abyssal zone (figure 9).

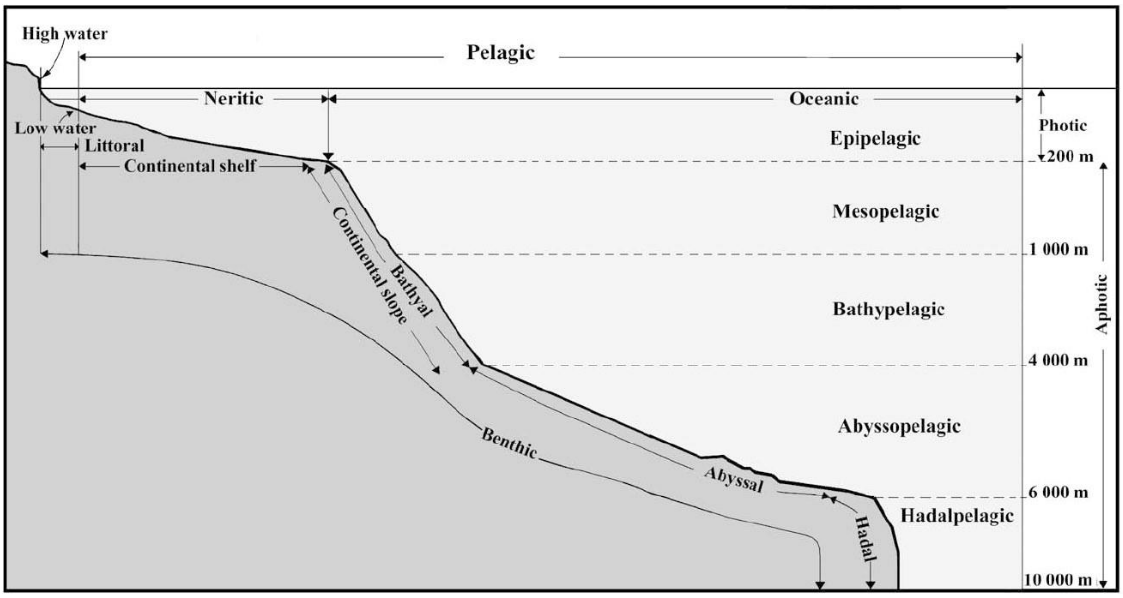


Figure 9
Main subdivisions of the marine habitat (Carpenter, 2000).

Generally speaking, the marine habitats of Haiti are not well known; this includes those closest to the coast, as is evidenced by the paucity of information about Haiti found in global atlases of mangroves and coral reefs (Spalding *et al.*, 1997; Spalding *et al.*, 2001). The marine ecosystems which are best inventorised are those situated around Navassa Island. Putting in place protected marine spaces in the south of the country and north of the Three Bays area did however serve to generate new information regarding ecosystems thus protected. In 2014, the Foundation for the Protection of Marine Biodiversity (FoProBiM in French) made a rough inventory of the mangroves, coral reefs and seagrass beds on a country-wide scale (Wiener, 2013). Similarly, the development of high- and very high resolution satellite imagery over the last ten years has enabled the first mapping of the coastal habitats of Haiti (figure 10).

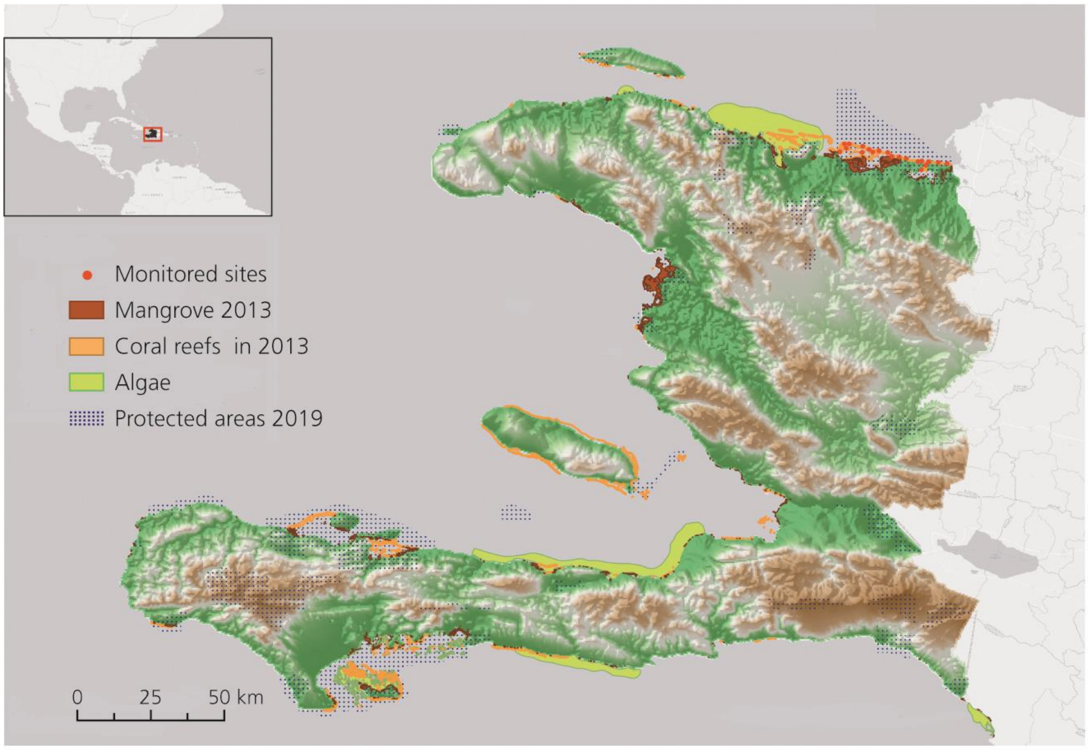


Figure 10
The coastal habitats of Haiti: mangroves, coral reefs and seagrass beds of marine spermatophytes (source: Olivia Baleya, 2021, based on CaribNode, GEBCO & map base: Esri Gray (light)).

A/ Coral reefs

On a planetary scale, coral reefs occupy an exceptional place within marine biodiversity because they serve as habitation for a third of sea- and ocean species (Moberg and Folke, 1999; Reveret and Dancette, 2010). Their contribution to the food security of the island populations inhabiting inter-tropical zones is essential (Hugues *et al.*, 2012). However, this ecosystem is under threat both from human activity and climate change (Salvat, 1987; Pendleton *et al.*, 2016), and coral reefs currently in good health are growing fewer and fewer. The Caribbean is the most degraded coral reef zone on the planet, as evidenced by global evaluations of reefs carried out during the decade 1998-2008 by the GCRMN (Gobal Coral Reef Monitoring Network), a technical body associated with the ICRI (International Coral Reef Initiative)[10] tasked with monitoring

[10] The ICRI was created in 1994 through the efforts of a number of government officials who were also diving enthusiasts and concerned with improving the means of managing the health of reef ecosystems, as well as raising awareness of them among the political class and prioritising the pooling of information

the health of coral reefs on a global scale (Wilkinson, 1998, 2000, 2002, 2004, 2008). Since the beginning of the 1990s a tendency towards the evolution of coral ecosystems towards ecosystems dominated by macroalgae (seaweed) was noted (Hughes, 1994) and confirmed ten years later (Bellwood *et al.*, 2004).

Nevertheless, field observations show that the coral seems to demonstrate a higher resiliency than originally imagined (Bruno *et al.*, 2009), and notably those corals under frequent local anthropic stress, and having managed to adapt to it, appear to be less vulnerable to climate change (Bruno and Valdivida, 2016). Within this context it is essential to have precise information about the state of coral reefs and to monitor their health. In this field Haiti occupies the place of "poor cousin" of the Caribbean, being the only country (out of 35) not having provided a national report for the GCRMN study undertaken on the evolution of the health of reefs in the region between 1970 and 2012 (Jackson *et al.*, 2014). The same is true regarding the impact of the incident of massive bleaching having affected the Caribbean coral ecosystems in 2005 (Wilkinson and Souter, 2008).

No inventory of coral species has yet been produced on a national scale, even though the information is available at a local level; thus 51 species of coral, 43 of octocorallia and 21 of echinoderms have been identified in Three Bays national park (Kramer *et al*., 2016; Bouchon, Bouchon-Navaro, Legendre, Louis, Jean-Baptiste, Célestin (2006). The only national inventory of Haitian reefs which has been undertaken only addresses inhabited surfaces, drawn from analysis of satellite images taken towards the end of the 1990s for the global reef atlas (Spalding *et al*., 2001); it shows that the coral reefs are situated all along the coastline (including Gonâve Island, Turtle Island, Cow Island and the Cayemites), covering around 450 km^2. Since then the spatial resolution of satellite earth imagery has improved. From 1985 to 2000 the smallest spatial unit detectable has decreased from 900 m^2 to 16 m^2. Today it can sometimes attain less than a m^2 measurement, which enables very precise mapping. Within the context of current expertise, a 15-class mapping of Gonâve Island has been carried out (figure 11).

This kind of mapping is very useful if completed via *in situ* measurements. In the absence of a local scientific team enabling the regular monitoring of the evolution of coral habitats to evaluate the effects of anthropic stress, and also of climate change, on reefs, only a preliminary monitoring of the reefs has been undertaken by the NGO Reef Check. Focusing on the recovery rate of coral habitats and the generation of indicators, the Reef Check protocol is simple enough to be utilised by non-professionals, i.e. volunteer divers trained by marine biologists; yet it is precise enough to detect changes in the coral ecosystem when monitoring is undertaken at regular time intervals, as well as for estimating damage done by the passing of a cyclone or by a bleaching incident such as occurred in 1987 and 2005. Reef Check can thus be used at a limited cost for a great number of sites provided enough people are available to do so.

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regarding their health. The founding nations were Australia, France, Japan, Jamaica, the Philippines, Sweden, the United Kingdom and the United States. In 2021, 44 states held membership in the ICRI, among which 5 Caribbean island nations (Barbados, Cuba, Grenada, Jamaica, the Dominican Republic), but not Haiti.

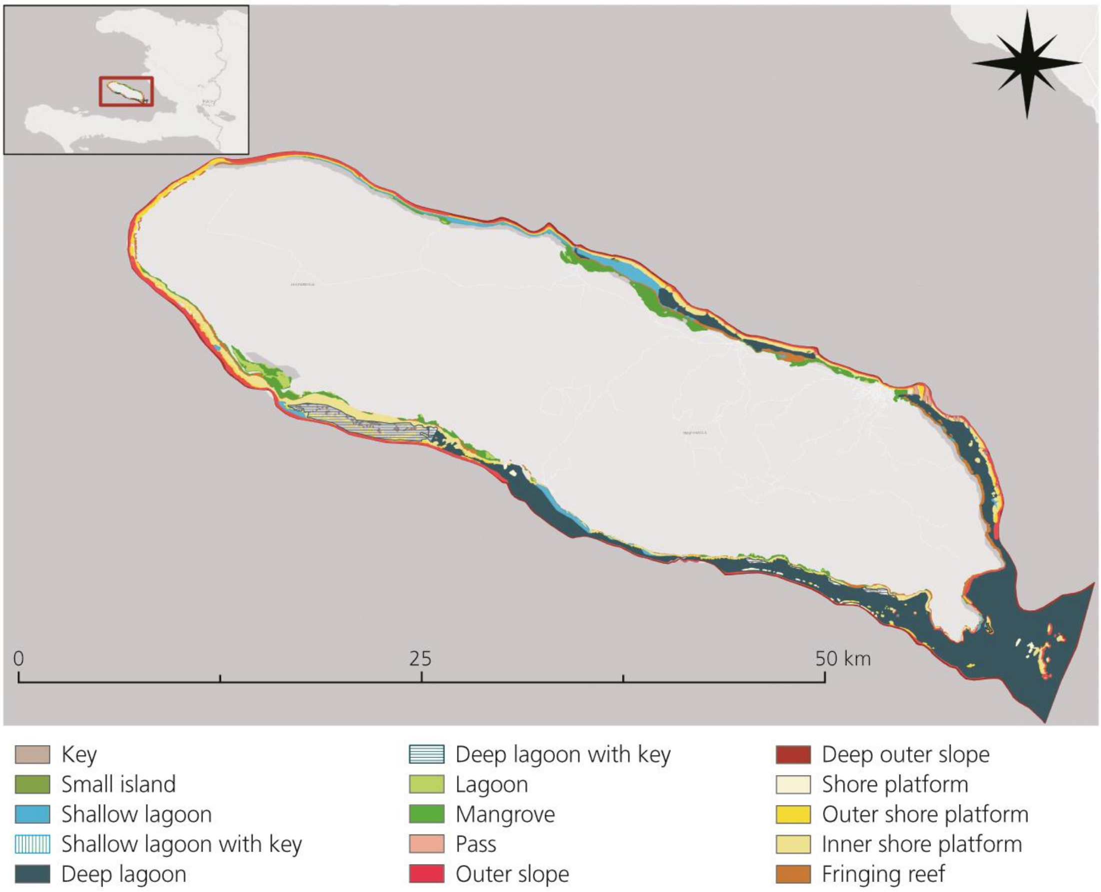

Figure 11
Example of reef mapping enabled by earth observation via satellite at very high spatial resolution. (Source: BALEYA (2021) – map base: Esri Gray (light)).

Monitoring undertaken over the last few years shows that close to 80% of Haitian coral reefs are currently badly degraded as a result of hurricanes, water warming, sedimentation from watersheds and agricultural- or urban pollution. Added to these factors is also overfishing, which leads to the disappearance of grazing fish. Little by little the coral becomes covered by algae and the coral reef disappears, making way for spongy algal coral reefs instead. Thus the monitoring carried out by Reef Check in 2011 showed that living coral colonies made up less than 10% of the hard substratum, whereas macroalgae and sponges covered some 50%. This evolution is particularly worrisome given that the entirety of the reef barrier, when in good condition, offers essential protection against coastal erosion by dissipating the energy of incoming waves and swells, thus enabling the development of marine spermatophyte seagrass beds in those depressed zones of the reef plate where sediment accumulates.

B/ Seagrass beds

Made up of 9 species of spermatophytes, the Haitian seagrass beds develop in sheltered areas, i.e. the lower parts of intertidal zones less than 15 metres deep (except for 2 species which reach up to 25 and 30 metres in depth). As a result of Haiti's hydrographic profile, seagrass bed zones are narrow and their surface area therefore reduced. They serve as spawning grounds and food sources for herbivorous fish (parrotfish, wrasses, damselfish, filefish…) and shellfish including queen conch *(Lobatus gigas)* and other conches. Among these species, turtle grass *(Thalassia testudinum)* plays an essential role as preferred habitat for marine macrofauna.

Detailed information about seagrass beds, their specific composition and their placement is rare, but three studies undertaken in this regard can be flagged. Carried out north of the bay of Port-au-Prince, the first gives an account of the healthy state of the region's seagrass beds, little impacted by sediment deposits and made up for the most part of *Thalassia testudinum* and *Syringodium filiforme* (Louis *et al*., 2006). The second, carried out in the Port Salut region, testifies to the state of *Halodule beaudettei* in addition to the previously-mentioned species (Reef Check, 2013). The third study was carried out within the framework of a proposal for the creation of ten marine protected areas (MPA) put forward by FoProBiM and Reef Fix (Wiener, 2013). Of the ten inventoried sites, only the Caracol (Three Bays) seagrass bed covers a vast expanse, namely 7 140 ha. Of the remaining nine sites, the encroachment of the seagrass beds and the hard coral upon one another has prevented an estimation of the former's surfaces. On the other hand, the health of the seagrass beds could be evaluated, and has been judged good for six of them (notably at Caracol), average for two others and very degraded for the remaining one, located at Gonaïves-Grande Saline.

Seagrass beds are vulnerable to incidents of massive sediment deposits whenever hard rains are accompanied by significant soil erosion from watersheds. During a cyclone storm waves passing over the reef wall can cause plants to be uprooted. Seagrass beds are also vulnerable to organic pollution or hydrocarburants, to tearing up caused by low-hanging bolt ropes weighed with beach seines, and to anchoring which, depending on the speed with which the current acts on a boat, can continue for 10 to 20 m before the anchor ultimately "sticks".

C/ Mangroves

Mangroves are the only example on earth of maritime forests. Faced with two constraints inhibiting growth in terrestrial plants, namely the oversalinisation of a particular landscape and soil asphyxia in the area in which they grow, they have developed two forms of adaptation: air roots allowing them to draw in atmospheric air at low tide, and an exceptional osmotic pressure imbuing them with a tolerance of salt levels sometimes far greater than those exhibited by sea water. They grow primarily in closed-off areas on loose substrata (alluvium, silt, sand) near the water's edge or between ocean and inland water sources (estuaries, river mouths). The more salinated an area is, the less prone mangroves are to attaining a significant height. In areas far from the sea's edge which are untouched by sea water except during high tides, the evaporation of sea water leads to high salinity. In these extreme conditions mangroves expend all of their energy combating oversalination and only reach brush-level growth. In more salinated areas, called "tans", the soil remains virgin, with no mangrove species capable of growing in such conditions.

The mangroves of Haiti are divided into four main species. Red mangroves (*Rhizophora mangle*) are the most tolerant of salinity. They can grow at the seafront in ocean water subject to tidal fluctuation and make up 80% of mangrove types found in Haiti. Black mangroves (*Avicennia germinans*) grow in closed-off areas which are flooded with every tide. They represent 15% of mangroves found in Haiti. White mangroves (*Laguncularia racemosa*) prefer the least salienated areas, and cover only 5% of the country's mangrove spaces, whereas the grey mangroves (*Conocarpus erectus*) are even rarer (1% of Haitian mangroves). They are found on the edges of mangroves, connecting to the forests from under the soil (Aubé, 1999; Wiener, 2014, MDE, 2016; Kramer *et al*., 2016). Two other species even rarer than grey mangroves have also been noted: one by the NMHN in Washington, *Avicennia marina*, on Turtle Island (GBIF, 2019); the other, *A. schueriana*, in the Fort-Liberté mangrove (Kramer *et al*., 2016).

The first estimation of surface area covered by mangroves on a national scale was undertaken in 2015 via Landsat satellite imagery. Also registered was the diachronic evolution of this natural resource, as Landsat images were available for the years 2005, 1995 and 1985 (Cyprien, 2016). Over the course of thirty years the covered surface area has gone from 14 200 ha to 13 600 ha, i.e. a decrease of 4% (600 ha). In total, 94% of the country's mangroves are located on twenty forested mountain masses. Over the period 1985-2005, seven of these have seen a significant growth increase (+ 25%), from 2 010 to 2 656 ha; eight masses have had their surfaces reduced by 39%, decreasing from 2 810 to 1 706 ha. The five other masses, the most significant in the country (8 520 ha), have undergone little change. Among these are the Caracol mangrove, of which close to 2 000 ha are bordered by a coral reef which protects them from swells and waves (figure 12). Mangroves located close to urban centres have degenerated the most over the 1985-2015 period (Cyprien, 2016).

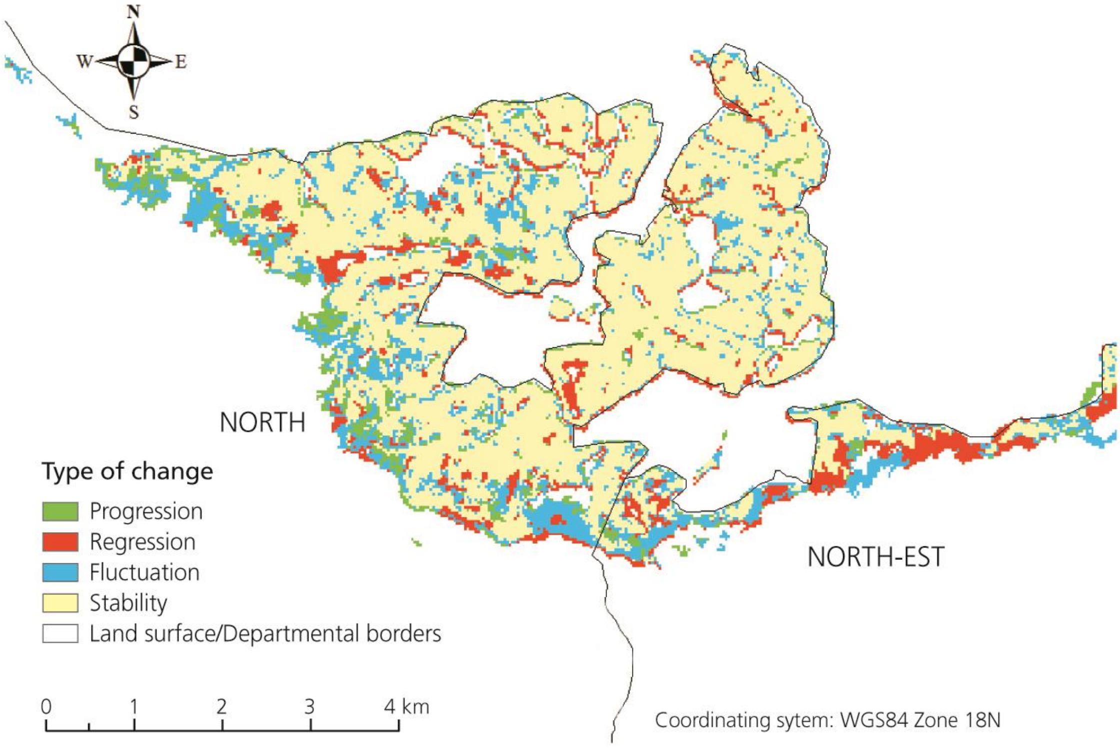

Figure 12
The Caracol mangrove in 2016 (image spot 7) and evolution 1985-2015 (Landsat images, source: Cyprien, 2016).

The Cap-Haïtien region is demonstrative of this evolution (figure 13). Already during the 1978-1989 decade tree felling for coal production resulted in a degradation of 43% of the mangrove surface area bordering the city (Aubé, 1999), foreshadowing their eventual occupation by the poorest inhabitants of the city as free living space. In total, over thirty years (1985-2015) 48% of the Cap-Haïtien region's mangroves have vanished (figure 13).

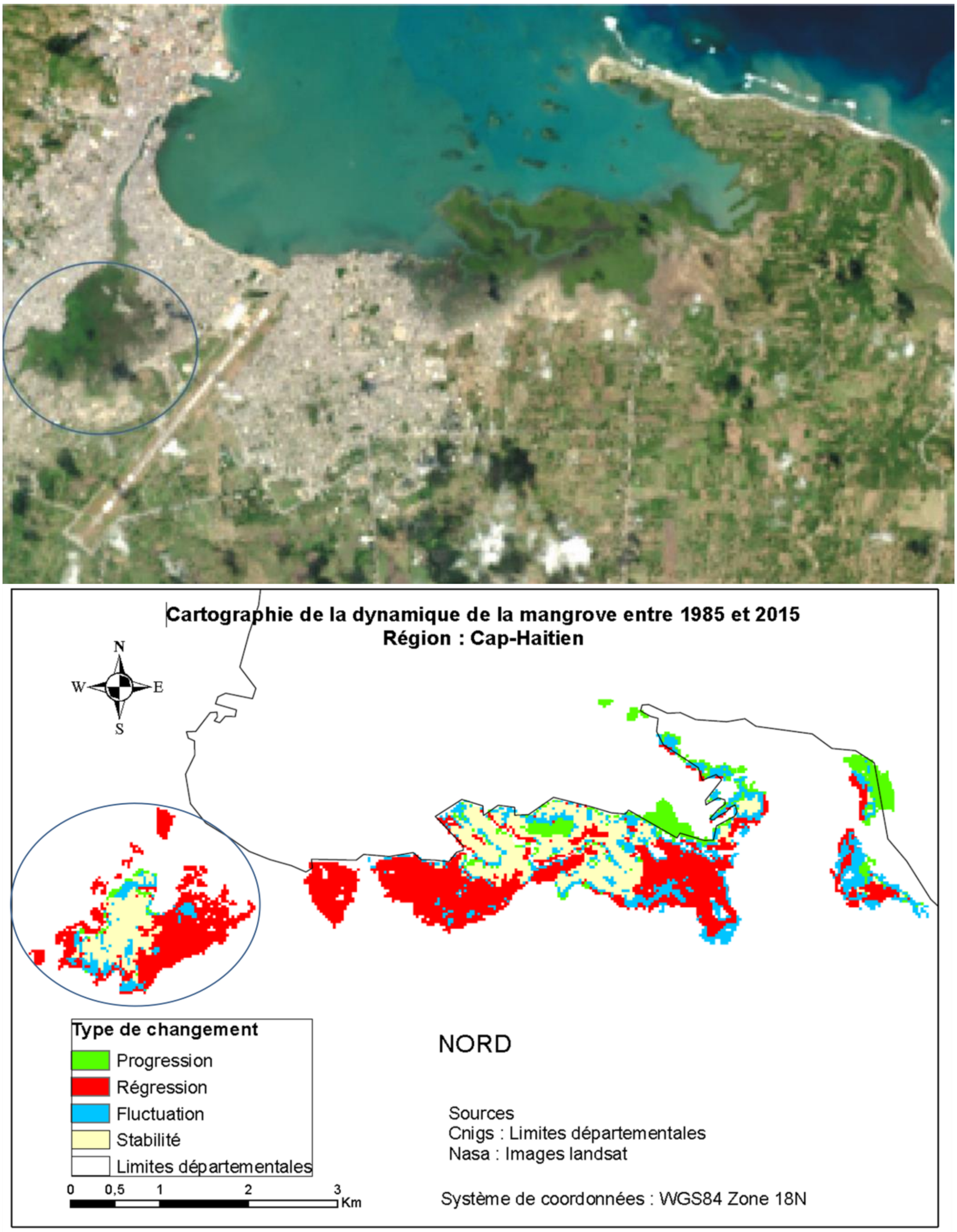

Figure 13
The region Cap-Haïtien mangrove in 2016 (image spot 7) and evolution 1985-2015 (Landsat images, source: Cyprien, 2016).

The decline in mangrove numbers is highly problematic. On the edges of urban areas they perform a purification function vis-à-vis water employed for domestic use. Next to coral reefs they carry out another ecosystemic regulatory function by trapping part of the sediment from watershed erosion and transported seaward by heavy rains.

Thus they prevent at least a part of the reef from being affected by bleaching, since sediment-heavy water prevents zooxanthellae microalgae – which live in symbiosis with the coral polyps – from achieving photosynthesis. Mangroves are also effective in carbon storage. Studies done in Guyana and Gabon have shown that tall mangroves can stock 1000 tonnes of carbon per hectare (Messame Me Mba *et al.*, 2022). They further play an essential role in the regeneration of marine populations by providing shelter from predators to the offspring of many species operating in these areas.

The mangroves of Haiti are the property of the state and are protected by law. A ministerial decree dated 10 July 2013 confirmed the prohibition against building inside mangroves, as well as hunting and fishing and the utilisation of their wood, and further envisions their "systematic restitution" during the five years following its promulgation (Martelly, 2013). Since then, eight mangrove rehabilitation operations have been carried out in the country.

4. Marine biodiversity

While fishery in Haiti has given rise to an extensive literature on the subject, the specific makeup of fishing hauls and, more generally, that of Haitian marine biodiversity remains poorly documented. Nevertheless, these data are essential for understanding and evaluating the impact of fishery on the monitoring of marine biodiversity, notably the cascade effect brought about on the trophic chain as a result of overfishing among species targeted by fishers, and that within the context of an ecosystemic approach to fishing which has largely proved its efficacy on the global scale.

Obtaining knowledge of biodiversity (specific diversity) in Haiti is a process which has unfolded at different speeds and more or less slowly depending on the major taxonomic categories involved. Among vertebrates the commencement of knowledge gathering actually dates back to 1850 and has been progressively added to this very day; as far as plants and macro algae are concerned, it began later, in 1900, and its advancement was rapid until 1940 before tapering off; for cnidarians it began in 1860 and then advanced slowly until 1960, then sped up until today, when it is continuing; with regard to porifera knowledge advancement started late and stagnated at a very low level until 2002, when it suddenly exploded. These differing dynamics show that within certain toxonomic categories acquired knowledge is almost complete, whereas within others it is still in the process of being gathered. Knowledge of specific diversity is a stage in biodiversity monitoring which more and more is being integrated into fishery diagnostics, particularly multispecific fishery such as that practiced within island coral ecosystems. The erosion or progression of this biodiversity needs to be surveyed at different spatio-temporal scales (figure 14).

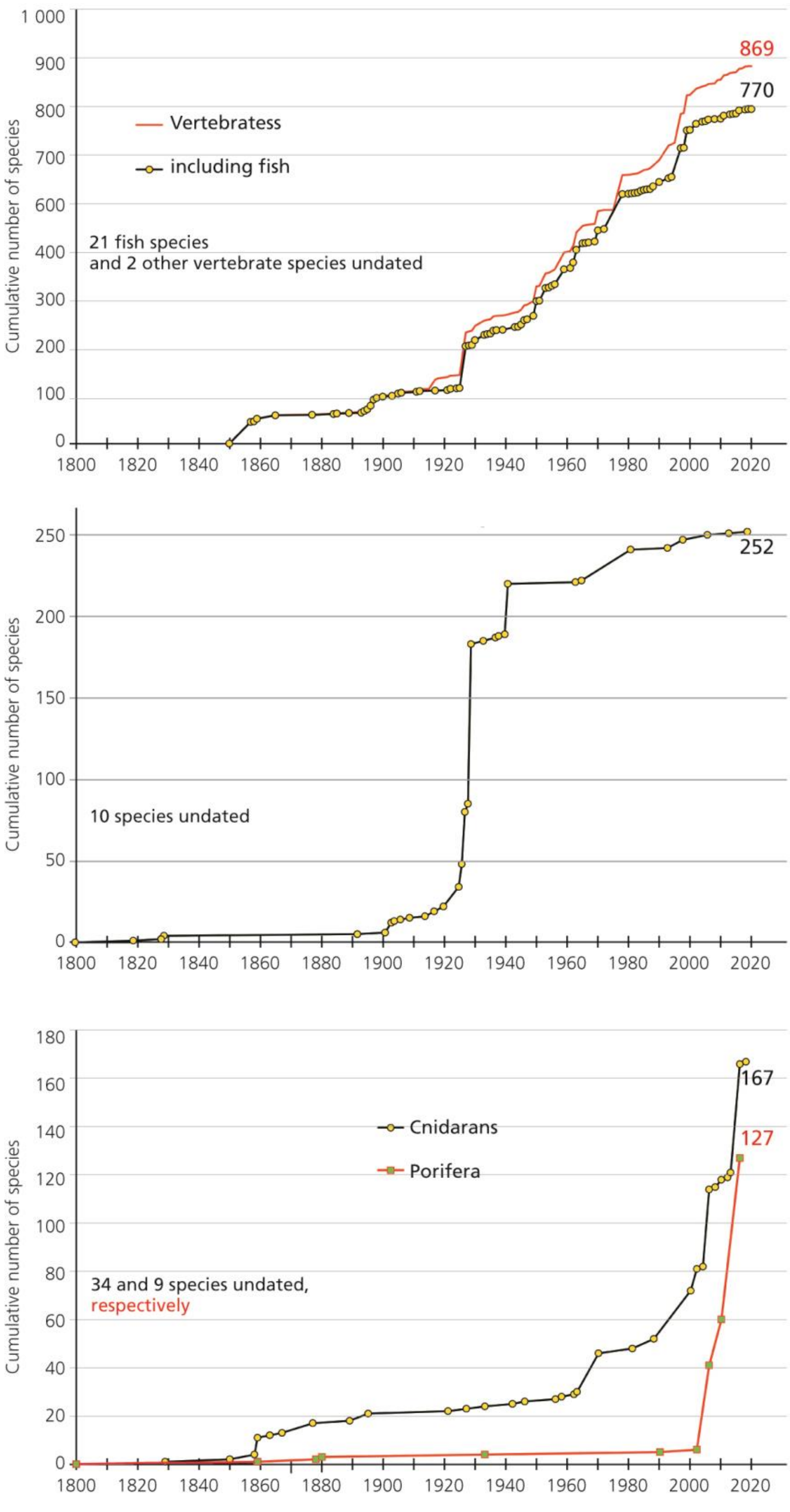

Figure 14
Development of biodiversity knowledge within the major taxonomic categories, from left to right: vertebrates including fish; plants and macroalgae; cnidarians and porifera. (P. Vendeville. Based on : Obis, GBIF, june-august 2020)

The project undertaken in 2015 in the Three Bays national park by the TNC (The Nature Conservancy), financed by the IDB (Kramer *et al*., 2016), shows that, at the level of a number of pilot sites (or indicators) the undertaking of sampling efforts at regular intervals (once a year or once every five years according to cost), at the same time of the year and according to a rigorous protocol and subject to being replicated, would enable the monitoring of biodiversity development. The project undertaken in 2006 between Pointe Saint-Marc, Port-au-Prince and Gonâve Island presents a second example which can serve as basis for a sampling protocol (Bouchon *et al*., 2006, Bouchon-Navaro *et al*., 2006, Louis *et al*., 2006). Ideally a 3rd pilot site would be defined in the southern or south-western part of Haiti in order to obtain a representative view of the development of biodiversity in the country.

At a country level, it would be ideal to archive geo-referenced data on species location (I.1) In this regard the two existing databases – OBIS (Ocean Biodiversity Information System)[11] and GBIF (Global Biodiversity Information Facility)[12] – were they to be regularly updated, could serve as a monitoring tool for biodiversity at a country-wide level, and even at a smaller spatial scale. However, such is not the case currently. Data gathered by the TNC (The Nature Conservancy) and the national agency for protected spaces (ANAP in French) in 2015 (Kramer *et al*., 2016) were published in a systematic, standardised database, The Darwin Core Archive[13], in order to carry out the reconstruction of map-based sampling via SIG of the benthic and terrestrial habitats; but these data have not been pooled into the GBIF database, even though the latter does allow for this type of archiving[14].

Past analysis of occurrence data on Haiti show that reports have been produced in fits and starts in relation to the major taxonomic categories: with regard to plants and macro algae, reports from the years 1929 to 1941 make up 74% of the total; with regard to crustaceans 65% of reporting was done in 1970; in terms of other vertebrates - essentially water-, river- and coastal marsh fowl - 90% of reporting was done between 2008 and 2018. As far as marine biodiversity is concerned, out of 56 444 797 occurrences listed in May 2019 in the OBIS database, only 6 592 related to Haitian EEZs, i.e. 0.012% of the total, of which 51% focused on bony fish (osteichtyes). Following a notable contribution made in 1957, occurrence reporting only resumed in the 1980s. They were again interrupted after 2005 and have been recommenced in 2018 on the initiative of the MARNDR (figure 15).

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[11] Ocean Biodiversity Information System http://www.obis.org/
[12] Global Biodiversity Information Facility, https://www.gbif.org/
[13] Fore more information : http://tools.gbif.org/dwca-assistant/?lang=fr
[14] see http://tools.gbif.org/dwca-assistant/gbif_dwc-a_asst_en_v1.1.pdf

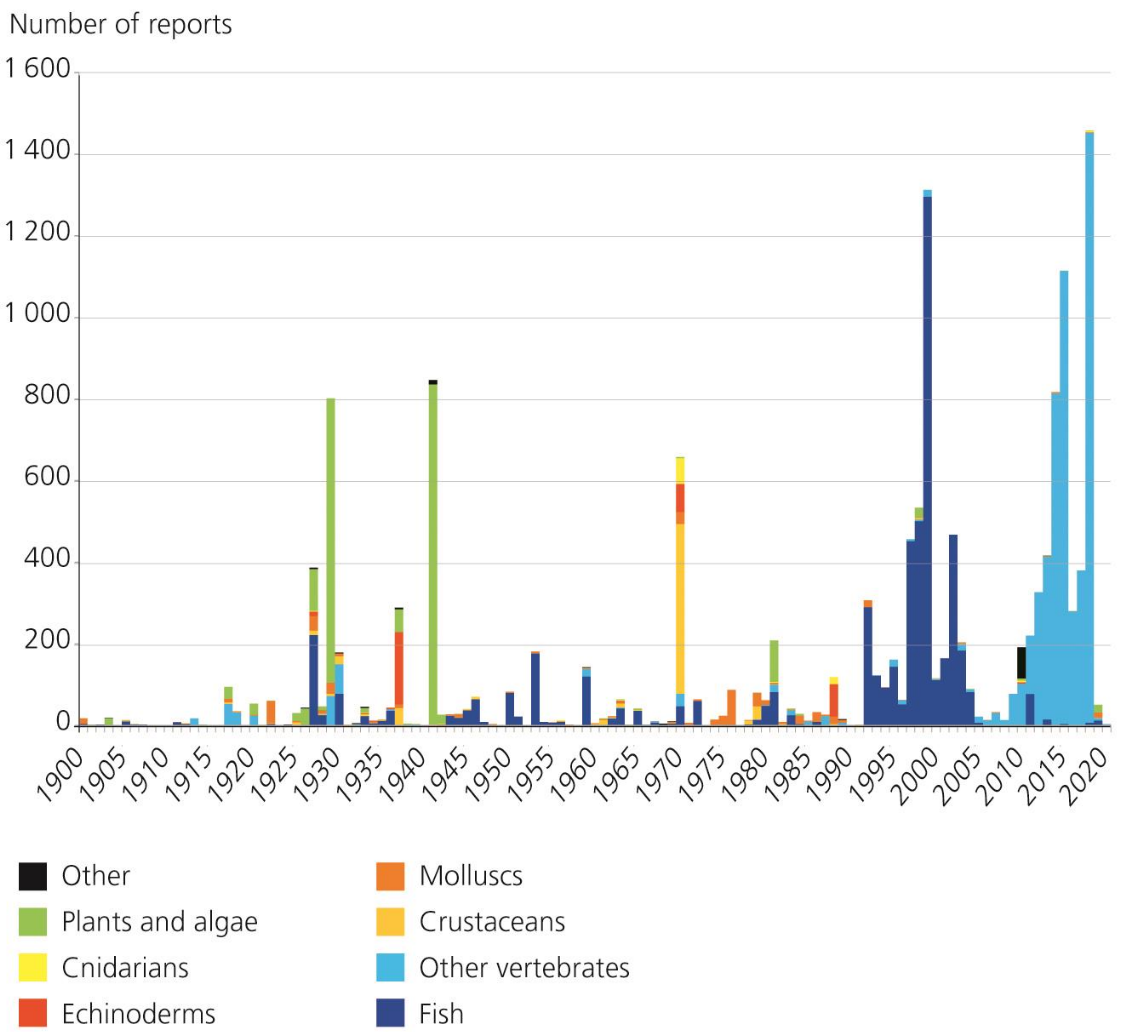

Figure 15
Number of occurrence reports on Haiti according to date in the OBIS and GBIF databases according to major taxonomic category between 1900 and 2020.

Carrying out the archiving of occurrence data in the OBIS and GBIF databases would, in time, create a useful tool for ecological monitoring at a national scale, accessible to the greatest number of people and all the more user-friendly given that consultation of these databases is done via the programming language R, free software used for the development of a number of statistical applications (script) applied to ecological study. With data concerning Haitian biodiversity thus made available to the greatest number of researchers and students alike, such an archive would likely lead to new initiatives aimed at greater knowledge of the marine ecosystem and its operation.

On the basis of scientific documents and articles consulted, FAO documents, the Fishbase and Sealifebase databases, the international OBIS and GBIF databases, the inventory of known (reported) marine biodiversity in Haiti presented within the framework of this assessment has been fixed at 2 584 species, to which are added 26 genera and 2 families of which the precise determination remained incomplete. The animal kingdom is represented in 2 305 species, 24 genera, 2 families and 12 species not listed in international taxonomic databases; the plant kingdom is accounted for in

279 species and 2 genera. This collection is far more extensive than the one inventoried via a study on the Island of Hispaniola distinguishing between Haitian species and those from the Dominican Republic (Herrera-Moreno, Betancourt-Fernández, 2005); the total number of species classified in that study – which took into account neither mammals, nor reptiles, nor birds nor the plant kingdom – came to 1 057.

5. Ecology of species targeted by fishery

A/ Methodology for inventory and areas of study

The inventory of fish species made within the framework of the present assessment is based on five sources: (1) scientific articles; (2) information provided by regional organisations in charge of fisheries management (ORGP in French) and other bodies; documents edited by the FAO for the central-west Atlantic; (3) international databases focusing in marine matters and fishery - *Fishbase*[15] for fish and *Sealifebase*[16] for other marine organisms; and finally (4) those international databases dealing with biodiversity - OBIS and GBIF[17], as well as *VertNet*, a collaborative database of vertebrates created at the initiative of the National Science Foundation (NSF)[18].

This inventory focuses on the EEZs of Haiti and the Navassa Island enclave which share the same marine species and which have been the subject of numerous scientific studies (Miller and Gerstner, 2002 ; Miller *et al.*, 2003 ; Karnauskas *et al.*, 2011). It follows the hydrographic distribution of habitats used by Carpenter (2002). Five major areas have been identified: the coastal area, directly affected by continental waters; the island base which extends from the external limit of the coastal zone to the external limit established by agreement at an isobath of 200 m; the island spur between the 200 m and 4000 m isobaths; the shallows corresponding to an ocean layer above the island base of the continental plateau; the seascape located beyond the shallows (figure 9). Bottom-dwelling species (benthic and demersal) inhabit the first three areas, the former permanently joined to the ocean floor, and the latter living close to it but also occasionally venturing out into open sea. The substratum (alluvium, sand, sponges, shell particulates, rocks, coral) and the organisms overgrowing them (seagrass beds, sponge banks, sea urchins, anemones) play an essential role in their spatial distribution. Deep-sea species live in the open water; they inhabit the two latter areas. A distinction can be made between bathypelagic species which inhabit the deepest sea layer situated at between 1 000 and 4 000 m, mesopelagic species located at between 200 and 1 000 m under the surface, and epipelagic species found within 200 m under the surface. These are particularly fond of immobile floating objects or those made up of algae such as banks of sargassum within which a high concentration of fish can often be found.

In its study on the dissemination of species on a regional scale, the FAO (2002a, 2002b, 2002c) estimates that 23% of the 1 172 species inventoried are endemic to limited territories. As a result, there is no generalised connectivity over the entirety of the Caribbean-Gulf of Mexico region, and it is clear that water current circulation plays

[15] www.fishbase.org
[16] www.sealifebase.org
[17] Global Biodiversity Information Facility, https://www.gbif.org/
[18] National Science Foundation : http://vertnet.org/

an essential role in the dispersal and spread of eggs and larvae (figure 7). The gyres and swirls reduce the dispersal area. In the case of Haiti, the northern part is most affected by Florida-based populations, whereas the southern part is most affected by the Colombian and Venezuelan basins (Schill *et al.*, 2015).

Efforts toward compiling a detailed inventory will allow for a better idea of species distribution, as well as their means and period of reproduction. These data can be directly applied to the management of fisheries via the institution of fishing prohibitions during spawning for the purpose of a necessary “biological respite” for fish species. Investigations undertaken within the framework of this assessment at Chardonnières and Bainet in 2018 (box 4), those by Vallès *et al.* (2018), Favrelière (2008), Celestin (2004), Miller (2015), and reports on the national fish census (USAI-MARNDR, 2019) enabled the identification of 47 species. Fishers also serve as an importance source of information on the seascape, sadly too rarely consulted. Nonetheless, it should be emphasised that the way in which they name and classify fish often differ significantly from the scientific nomenclature (family, genus, species). A single species may have many local names or two species may bear the same name. Hence an important effort at equating local and scientific names remains to be undertaken.

B/ Selected species

Among the major families which are known and pursued by fishers, some species will be highlighted here, and of which a number of carnivorous predators will be presented. It should however be noted that the herbivorous parrotfish probably represents one of the reef-based families the most fished and consumed along the length of the Haitian coast (Vallès, 2016)[19]. For every species the main morphological and ecological characteristics are presented, and their level of vulnerabilities are also described. This latter parameter, intrinsic to each species and generally utilised, gives an idea of its position with regard to the danger of extinction. It is notably employed in the international databases FishBase and SealifeBase. The higher the vulnerability, the more the species is at risk of disappearance. Between 34% and 45% is considered as a moderate risk[20].

[19] For a more complete view of the inventoried species, the reader is referred to P. Vendeville, W. Célestin, H. Vallès & S. Jean-Marie (2021) – co-edited by IRD and the FAO.
[20] As illustration, the vulnerability score for the whale shark is 89% and that of anchovies and sardines is 24%.

Dolphinfish (pelagic species)

Family: *Coryphaenidae*
Creole name: dorad
Habitat : 0 to 85 m below the surface

Photo 1 – *Coryphaena hippurus*
© Jeff Weiss

Two species are found in the region:
– the **common dolphinfish** (*Coryphaena hippurus*) can reach 2.10 m with a weight of 40 kg. It feeds on cephalopods and various bony fish. Its predators are seabirds, tuna, marlin, swordfish, other dolphinfish (cannibalism), dolphins and sharks. Its vulnerability is moderate, 40 % ;
– the **pompano dolphinfish** (*C. equiselis*) is more common and smaller (maximum 127 cm with a weight of 15 kg). It is found further out to sea, in waters up to 400 m above the ocean floor. It feeds on squid and small fish. Its vulnerability is weak to moderate, 35 %.

As species of which the meat is greatly valued, these fish are the target of recreational fishing and extracted by professionals by surface lines dragged or floating, or by tuna longlines and occasionally by purse seines. Dolphinfish fishing is seasonal.

Blue marlin (pelagic species)

Family : Istiophoridae
Scientific name: *Makaira nigricans*
Creole name: vwalye
Habitat: high seas

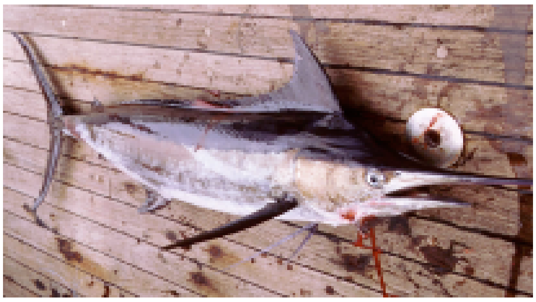

Photo 2 – Makaira nigricans
© IRD – A. Bertrand.

This species, the largest of the marlins, populates the blue waters of the high seas with a surface temperature of 22-31 °C. Its total length can reach 5.0 m with a weight of 636 kg. Its primary prey is bony fish (sardines, trevally, dolphinfish, groupers…), but also crabs and cephalopods. The marlin’s vulnerability of moderate to high, from 41% to 65 %. The Atlantic blue and white marlins are listed on the IUCN red list as at risk species.

Nassau grouper (demersal species)

Family : Serranidae
Scientific name: *Epinephelus striatus*
Creoles names: nég, nagul, tienne
Habitat: mangrove edges

Photo 3 – *Epinephelus striatus*
© g.phia.

This species is hermaphroditic, with females able to transform into males of quite large size (between 30 and 80 cm). While solitary, some grouper species gather together during spawning season, making up groups of up to 50 000 and 100 000 individuals. These gatherings take place at set times between December and March, between 1 hour before and 20 minutes after sunset around deep sea reefs. This behaviour renders the species particularly vulnerable to targeted fishing during their reproductive period. The IUCN considers the species to be in a critical situation.

Common grunt (demersal species)

Family: Haemulidae
Scientific name: *Haemulon plumierii*
Creole name: krokro
Habitat: sea grass beds close to reefs and mangrove edges.

Photo 4 – *Haemulon plumierii.*
Vendeville P. © Ifremer-IRD.

In the waters of Cuba its spawning takes place year-round. The eggs are pelagic and its young grow within the *Thalassia testudinum* seagrass beds. Haemulidae vulnerability is weak to moderate, running from 27% to 45 %, with the exception of the white grunt or croco, for which it is 62 %. Of the 13 species found here, 7 carry a risk of ciguatera.

Snapper (demersal species)

Family: Lutjanidae
Scientific name: *Lutjanus synagris*
Creole names: sad, vivano
Habitat: hard seabed (sand, rocks, coral) including seagrass beds.

Photo 5 – *Lutjanus synagris*, dit « vivaneau gazou »
©IRD/B.de Mérona.

Often found in large numbers, notably during periods of reproduction, their maximum size varies from 16 to 71 cm with a maximum weight of 3.5 kg. They are found at depths of up to 400 m. Snappers are mostly nocturnal. A dozen species have been identified as having a close relation with corralled environments. Their diet is made up of polychaete worms, tunicates, invertebrates, benthic crustaceans (crabs, shrimp), bivalve molluscs, gastropods and fish. Their primary predators are moray eels, barracudas, trevally, groupers and king mackerel. The vulnerability of their population varies from 32% to 68 %. Three of these 10 species are listed on the IUCN red list; 9 of the 10 species pose a risk of ciguatera.

Redband parrotfish (demersal species)

Family: Scaridae
Scientific name: *Sparisoma aurofrenatum*
Creole names: pawokè, vant sal
Habitat: coral reefs

Photo 6 – *Sparisoma aurofrenatum.*
© A. Cox.

A species mostly dispersed over the entire Caribbean zone, the redband parrotfish, like other parrotfish, exhibits very different aspects and colours depending on its growth phases (juvenile, larval or, here, adult phase). Its average size is 20 cm, with maximum length of 28 cm. This species is labelled as "slightly concerning" on the UICN red list. It poses a risk of ciguatera.

Longspine squirrelfish

Family: Holocentridae
Scientific name: *Holocentrus rufus*
Creole names: kadino, kadina gwo je nwa
Habitat: coral reefs

Photo 7 – *Holocentrus rufus*,
©IRD/B.de Mérona.

Belonging to the family of squirrelfish and cardinalfish, the longspine squirrelfish is a representative feature of coral environments. Seven species operate near the seabed between 0 and 210 m. These fish species are nocturnal, given to grouping together and by day conceal themselves in the crevices of coral reefs. Their diet is made up of zoobenthos, sea urchins, zoanthids, molluscs, benthic crustaceans (crabs, shrimp) and fish young. Their primary predators are trumpetfish, west Atlantic trumpetfish, snapper, groupers, seabirds and dolphinfish. Squirrelfish species have a weak to moderate vulnerability. For 3 of them the risk of ciguatera is moderate.

Bigeye mojarra (demersal species)

Family: Gerreidae
Scientific name: *Eucinostomus havana*
Creole name: wodo
Habitat: estuaries and shallow seabeds

Photo 8 – *Eucinostomus havana*
©IRD/B.de Mérona.

White fish of the Gerreidae family are represented by 11 species in Haiti. They are found in shallow coastal waters of depths up to 70 m, but mostly of 35 m, in estuaries, mangrove edges, in lagoons and near seagrass beds. They feed on worms, molluscs and crustaceans. Their primary predators are barracudas, groupers and tarpon. Their vulnerability varies between 15% and 34 %. They are caught by fishing net, trammel, traps, and beach seine. Commonly sold, in contrast to the preceding species they are cheap and widely consumed.

6. Fishers and their profession

The term "profession" is generally understood as denoting the sum of practices, techniques and values characterising a profession. In the case of fishing, an additional definition can be applied, with the profession understood as a coherent, functional entity with regard to type and size of boat, fishing equipment, species (or groups of species) targeted, as well as spatial- and temporal habits (Cardiec, 2021). In Haiti, small-scale fishing is primarily made up of a collection of various small-scale crafts[21].

The notion of a "fishing ground" is part of the idea of fishing as profession, corresponding to the area – populated by fish – in which the profession is practiced. Each fishing ground can be represented as a spatial unit of relative homogeneity with regards to ecology and the exploitation of fishery resources taking place within it (for example: narrow continental shelf, sandy floor, fishing by net and line predominant) (Damais *et al.*, 2007). On this basis thirteen major fishing grounds can be identified in Haiti (figure 16).

[21] The term "traditional" is not used here. It touches on multiple realities and is often incorrectly thought to stand in opposition to modernity. Traditional small-scale fishing is dynamic, fluid, making use of specific fishing equipment such as fishing lines, fishing spears or netting (particularly mosquito netting).

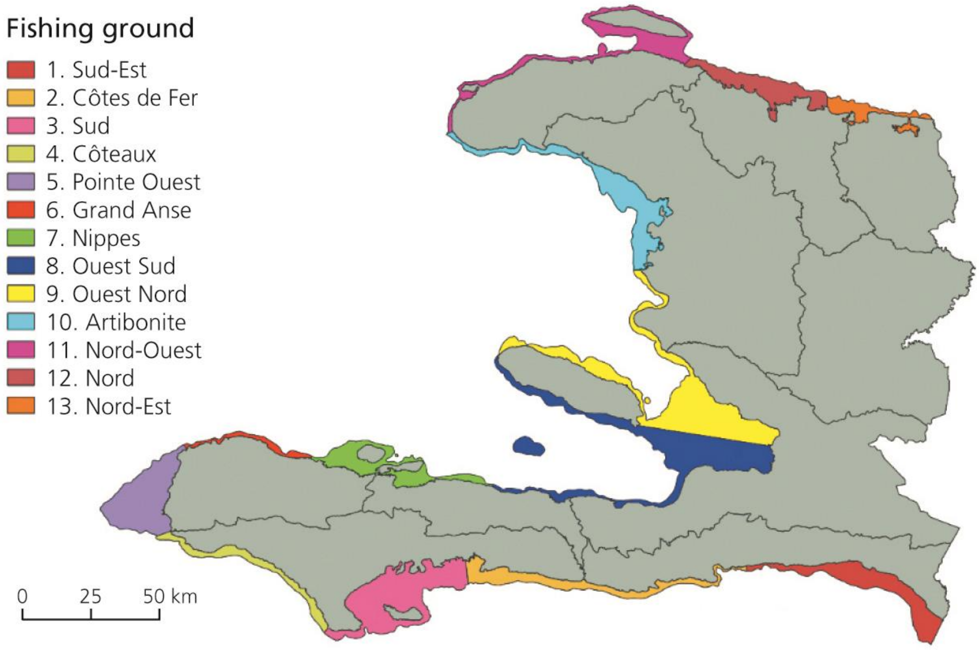

Figure 16
Demarcation on the island base (< 200 m deep) of the 13 fishing grounds (Vallès, Browne, 2020)

A/ The means of production

BOATS

According to the MARNDR, the Haitian small-scale boating fleet comprises 28 056 units (USAI-MARNDR 2019)[22], docked in 592 docking points of which the geographic distribution is relatively homogenous across the entirety of the country. More than 95% of these are the product of small-scale handcraft. They include small dugout canoes (carved out of the trunk of a single tree) about 3.5 metres in length and propelled via paddles or sails, and wooden, keeled canoes (*kanot*) about 5 metres long. Locally referred to as *bwa fouye*, the 14 326 dugout canoes represent 51.06 % of fishing boats. They are particularly used by fishers heading out to sea on their own, and only enable fishing to be done close to the island and in calm seas (figure 17).

[22] The figures that follow refer to data obtained from the Phase 2 census carried out by USAI-MARNDR in 2019.

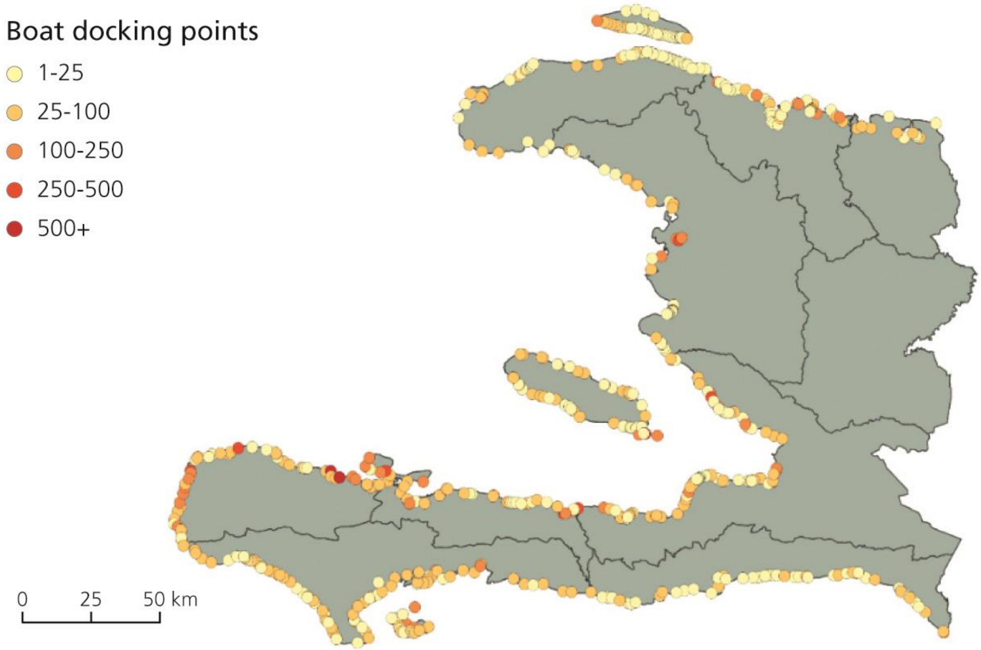

Figure 17
Distribution of 592 fishing boat docking points identified as part of the Phase II national fisheries census with estimate of the number of boats. (Vallès, Browne, 2020)

Numbering 10 312 units (36.6% of fishing vessels), keeled canoes, when propelled by sails or motor (however rare) enable the exploration of more distant fishing areas. On the other hand, their operational reach is not much greater than that of dugout canoes when propelled by oars or sculls. Both dugout- and keeled canoes are manufactured locally. The former is usually owned by the fisher himself, while the latter could also be owned by private ship owners.

Motorboats make up less than 5% of fishing vessels. Numbering some 1 200 (Badio, 2018), they are essentially of two types. Coral boats (*koralen*) are boats with flat bottoms, about 5.5 metres in length and which are enabled by their motors to go as far as the raised coastline ("accores" in French)[23] and thus to navigate the totality of the island base. Locally constructed they are generally owned by private boat owners.

Fibreglass boats are known as "yachts". Their length varies between 5.5 m and 7 m. Made from layers of fibreglass and resin, they are equipped with outboard motors of 15 to 40 horse power. This enables them to operate at a distance from the island base and to explore the slope where the seabed lies at more than 200 m deep, or the waters around FADs which are sometimes located at several dozen km from the coast. Yachts are almost always imported from abroad by government- or non-governmental agencies

[23] "Accores" are steep coastlines rising almost vertically from the underwater landscape. The "accore" of the island base and the "accore" of shallower areas often constitute zones of particular interest to fishers since they are areas of vertical water swirling, where deep water rich in nutritional salt is brought to the surface by convection currents.

and which are later donated to associations or groups of fishers for collective use[24] (photo 1).

Photo 9 (a,b,c,d)
The four types of Haitian fishing boat (clockwise: dugout canoe, keeled canoe, coral boat, yacht).
(Photo 9a © D. Dorestan, 2020 ; photo 9b © H. Vallès, 2015 ; photo 9c © P. Favrelière, 2008 ; photo 9d © D. Dorestan, 2020.)

Investigations carried out within the context of the present assessment at Chardonnières, Belle-Anse and Anse d'Hainaut in the south of the country demonstrate that, when the seabed rises to an "accore", boats are able to explore significant depths - this includes dugout canoes, which are able to move beyond the shallows when the weather allows. These findings are important since they indicate that, in these three villages, dugout canoes, coral boats and keeled canoes all operate at all fishable depths. Adult fish belonging to demersal species which inhabit depths of less than 100 m therefore have almost no hydrographic depth within which to hide and to ensure safe reproduction (table 2).

[24] One should also note the recent appearance of new boats created by fishers of modest means: inflatable inner tubes equipped wih wide-meshed netting on which the fisher sits while fishing. Their employment remains very limited for the moment, used only within a few very specific areas of Bainet.

Type of boat	Township	2-8m	9-16m	17-24m	25-32m	33-64m	65-96m	97-160m	>160m	No. of fishers consulted
Dugout Canoe	AD	2 %	2 %	18 %	39 %	70 %	7 %	0 %	16 %	44
Dugout Canoe	CH	9 %	36 %	25 %	32 %	48 %	41 %	34 %	2 %	44
Keeled Canoe	AD	0%	0 %	2 %	11 %	71 %	20 %	4 %	36 %	45
Coral Boat	BA	13 %	27 %	63 %	97 %	90 %	60 %	0 %	0 %	30
Yacht	AD	0 %	2 %	2 %	7 %	59 %	18 %	2 %	64 %	44
Yacht	BA	0 %	0 %	0 %	0 %	0 %	0 %	0 %	100 %	20
Yacht	CH	0 %	0 %	0 %	0 %	0 %	0 %	0 %	100 %	50

Table 2 – Estimation of fishing depths according to fishers depending on type of boat and township: Anse d'Hainault (AD), Belle-Anse (BA), Chardonnières (CH).

The same study indicates that fishing effort, reflected in number of excursions per month, are sustained (table 3). More than 80% of dugout canoes go out an average of ten times per month for the entire year, and about a third go out more than twenty times, which corresponds to an annual average of about 200 excursions for Anse d'Hainault and Chardonnières. Taking into account the weather conditions and the state of the sea, neither of which is always favourable year-round, these results lead to believe that fishers go out at every good weather opportunity, but that even in unfavourable ocean condition excursions take place as well. In this context, given the number of excursions, fishing can very much be classified as "livelihood" in its primary sense: the fisher engages in the activity in order to live, either through direct consumption of his catch or through revenue acquired in order to ensure economic viability or even family survival.

Fishing activity of coral boats and dugout canoes is measurably less, taking place an average of 155/160 days per year. On the other hand, it makes sense that fibreglass boats (all motorised) should present a notably higher frequency of excursions (almost one a day at Anse d'Hainault and at an even more sustained pace at Chardonnières). During periods of abundance of pelagic fish surrounding FADs boats may even undertake more than one excursion per day, albeit with different teams. The cooperative structure of yacht ownership explains the low level of activity exhibited by some fishers. On average a yacht's team carries out 50 to 65 excursions per year, but as a result of the limited number of boats almost one fisher in five – belonging to a cooperative at Anse d'Hainault or Chardonnières – never goes out during the entire year (table 3).

Type of boat	Township	Inactive	1-10 excursions	11-20 excursions	21-30 excursions	>30 excursions	Total no. of excursions per year per boat	No. of fishers consulted
Dugout Canoe	AD	1 %	18 %	50 %	26 %	5 %	**203**	44
Dugout Canoe	CH	10 %	9 %	46 %	34 %	0 %	**196**	44
Keeled Canoe	AD	0 %	45 %	31 %	24 %	0 %	**160**	45
Coral Boat	BA	1 %	39 %	43 %	17 %	0 %	**156**	30
Yacht	AD	18 %	52 %	26 %	4 %	0 %	**310**	44
Yacht	BA	0 %	90 %	10 %	0 %	0 %	**203**	20
Yacht	CH	22 %	55 %	14 %	10 %	0 %	**414**	50

Table 3 – Number of excursions by teams per month depending on type of boat and township: Anse d'Hainault (AD), Belle-Anse (BA), Chardonnières (CH).

FISHING EQUIPMENT AND TECHNIQUES

A dozen boat-fishing techniques have been identified within the framework of this assessment in the townships of Anse d'Hainault, Bainet, Belle-Anse and Chardonnières. This list is not exhaustive. Fishers in every locale are versatile (Favrelière, 2008). They combine a number of fishing techniques, which usually include equipment which is not very selective such as nets, trammel and traps, with selective techniques, generally using fishing lines and hooks, such as ball fishing, fishing with multiple lines, longline fishing, light fishing, fishing with trolling lines. Regarding the latter technique, the line is baited with small sauries, with fresh "lak-crapo" (small water-based frogs or lizards), with small fish split along the length and deboned, or with a lure made of corn silk (photoboard 1) (photoboard 2). In the course of conducting this assessment it was also discovered that fishing with an air compressor can be found in numerous villages in the country – confirming the observations made by Miller in 2015.

Photoboard 1 – The most-used fishing equipment

Net ("Pèch filè"): Net constructed from one or more rectangular layers with meshing generally small, used vertically in the water and held in place with floats on the upper part and ballasts on the lower. These nets may be placed on the water surface or on the seabed depending on the species targeted. Generally they are raised daily.


Photo 10 – Samuel (2020).

Trap ("Pèch nas"): These fish- and crustacean traps are made from a wooden or iron frame to which split bamboo or reeds are attached. Traps are generally in a Z form, with two opposing openings; their dimensions vary greatly, with a maximum length of 3.5 m. They are usually fixed to the seabed, but may also be placed on the surface (floating traps) according to the species targeted. They are baited with different types of bait and usually raised every three days.

Photo 11 – Samuel (2020).

Trammel ("Pèch tremay" or "twanap"): Trammels are meshed nets that operate through entanglement and are made from three layers: two external with large meshing (e.g. with lines 3mm in diametre and 20-25cm unstretched meshing) and one internal with small meshing (e.g. with lines of 1.5mm and 5-8cm unstretched meshing) attached with plenty of give. They are generally raised daily. Trammels are deployed vertically in the water and held in place with floats on the upper part and ballasts on the lower.

Photo 12 – Adesca (2020).

Longline fishing ("Pèch pa-lan"): A longline is made up of a principle line (mainline or master line) generally made from nylon monofilament of several hundred metres long, to which is attached a secondary line (1.5 to 1.8 m long) at 30 to 50 cm intervals, fitted with baited hooks and varying in shape and size depending on the species targeted. A longline may be fiited with hundreds to several thousand hooks. A float is attached to each end as well as to the middle in order to keep the hooks above the seabed. It is dropped once or twice a day/night depending on the size of the hauls. Longlines are carried in circular baskets with the hooks stuck around the edges before deployment.

Photo 13 – Samuel (2020).

Photo 14 – Samuel (2020).

Photoboard 2 – Selected fishing techniques

Photo 15 – Dorestan (2020). Photo 16 – Adesca (2020).

Ball fishing, trawling, deepline fishing ("Pèch boul", "linn tren" and "linn granfon"): These types of fishing is characterised by the use of weighted lines fitted with baited hooks (bait being living or dead) or with artificial lures. Trawling lines and ball fishing lines are generally used singly, fitted with a single hook. Deep line fishing lines are usually used in multiples, fitted with 10 to 35 hooks. Oftentimes a float is attached to the other end of the line. The size and form of the hooks vary depending on the species targeted.

Battery fishing ("Pèch batri"): This type of fishing involves the use of an submerged 25-30 watt bulb (connected to an electric battery of 100 ampere hours) for attracting shrimp and small fish which are caught and then used as bait for line fishing on the shores of the island spur. It is usually practiced at twilight of moonless nights; fishers begin their fishing at depths of 20 to 30 m and then move towards deeper water as the night advances.

Photo 17 – Adesca (2020).

FAD fishing ("Pèch FAD"): FADs are artificial structures made up of a floating mechanism connected by a long line to a dead weight placed on the seabed at great depths (often deeper than 1000 metres). FADs attract pelagic ocean species. This type of fishing involves the use of single-line FADs fitted with metal line hose of 15 cm resistant to biting from targeted species and with a large hook baited with some natural foodstuff (still alive for some targeted species), or else artificial. Oftentimes a float is attached to the other end of the line.

Photo 18 – Vallès (2015).

The versatility of fishing equipment and techniques is particularly developed among fishers making use of dugout- and keeled canoes. Most of these usually operate in shallows measuring less than 50 m in depth in pursuit of demersal species. The results of the national fishing census indicate that less selective equipment, and that characterised by small meshing, is overrepresented among the totality of fishing equipment used in the whole territory (USAI-MARNDR 2019). This development testifies to the fishers prioritising productivity over quality or the sound management of resources (Favrelière 2008), which is often the case in overexploited systems. Fishers's wives often take on roles of operating tasks related to pre- and post-fishing, i.e. the preparation of bait for long lines, weighing, processing, packaging and sale (Frangoudes et Gerrard, 2019). Generally these women consider such tasks to be part of their regular household duties rather than as "employment" requiring remuneration.

Apart from boat fishing, fishing without boats is equally widespread in the country via the use of casting nets, sheets or tulle bags for catching assorted tiny fish ("pisket") in river mouths during the rainy season. A particularity that should be noted is the use of mosquito nets having been diverted from their primary use in order to be used as seines for catching small pelagic fish (sardines, herring, "pisket"…) and a large number of fry – this made possible by their extremely small meshing[25].Fishing with beach seines require teams of 5 to 30 men and is mostly practiced during 6 months from July/August. This is one of the oldest Haitian fishing techniques. Targeting small pelagic fish as well as young fish living in seagrass beds, this kind of fishing risks damaging the latter habitat when practiced too often in the same area. Itinerant fishing, commonly called "hand fishing" is practiced by many (male and female) fishers, notably those of modest means. They usually operate alone, equipped with a curved piece of iron, a handheld fishing line and a rope for carrying their hauls. They wander around reefs looking for shellfish, octopus, lobster or reef fish such as mullet and small trevally. Whatever the equipment employed, the success of the fishing technique used depends above all on know-how, being a combination of such knowledge as having been transmitted to them by other, older fishers and their own experience.

B/ Fisher knowledge and know-how

Fisher knowledge primarily has bearing on species fished and on the environment in which they live. Indeed, a specific vocabulary distinguishes between the experienced fisher and the beginner: the "*amatè*" passes his knowledge to the young apprentice fisher, known as the "*soutnè*" who in turn over time becomes an "*amatè*". Before becoming a fisher proper, the aspiring practitioner must first and foremost be a good observer of his environment. His ability to act on and within the seascape does not usually depend on his educational level or on any particular kind of job training, but rather on his experience, on shared stories and myths around which know-how is collected, as well as know-how itself and such values as are deeply ingrained over the

[25] Following a devastating earthquake having struck the country in January 2010, an abundance of mosquito nets made their appearance. Designed to prevent mosquitos and other undesirable animals from entering homes or storage areas, their layers are made of thin metal, plastic or fibreglass meshing, or from small-meshed material such as gauze or tulle. Widely distributed by NGOs for keeping mosquitos a bay, these mosquito nets could be found in large quantities in Haitian marketplaces, and a large number have been converted from their original purpose in order to serve as fishing nets.

course of generations. Table 4 indicates some of the knowledge useful for fishing, e.g. regarding plants that can be used for constructing canoes, for bait, for making fishing equipment, etc.

. Type of Use	Nb of Plants Used	Plant Species Used	Origin
Construction of canoes, oars…	7	*Melia azedarach* (**lilac**), *Bambusa vulgaris* (**bamboo**), *Mangifera indica* (**mango**), *Rhizophora mangle* (**red mangrove**), Lysiloma latisiliqua (**false tamarind**), *Catalpa longisima* (**oak**), *Haematoxylum campechianum* (**logwood**)	wooded plots, agroforestry, plots, Creole, gardens, mangrove forests
Fish bait	5	*Mangifera indica* (**mango**)**, *Citrus sinensis* (**sweet orange**)**, *Artocarpus incisa* (**breadfruit**)**, *Moringa oleifera* (**drumstick tree**), *Cucurbita maxima* (**squash**)	wooded plots, agroforestry, plots, Creole, "*Jaden Lakou*".
Dye (net, trammels, line…)	1	*Curcuma longa* (**tumeric**)***	Garden
Fish tie	5	*Impomea pescaprae* (**goat's foot**), *Dalechampia scandens* (**spurgecreeper**), *Macfadyena unguis-cati (funnel creeper), Merremia umbellata (hogvine), Entada gigas (monkey ladder)*	seashore, dry forest, "*rak*" (wooded area).
Food for captured lobsters	2	*Carica papaya* (**papaya**)*, *Manihot cassava* (**cassava**)*	garden, agroforestry plots
Poison for fish	1	*Gaïac Guajacum sanctum* (**tree of life**)	wooded plots
Material for fish aggregators	2	*Cocos nucifera* (**coconut**)*, *Oreodoxa regia* **(royal palm)***	beaches, wooded plots,
Material for fishing equipment (lines, traps, buoys for nets and Trammels)	6	*Gynerium sagittatum* (**uva grass**) *Exostoma caribeum* (**chinchona**), *Agave rigida var. elongata* (**Caribbean agave**) *, *Coccothrinax sabal* (**sabal palmetto**) *, *Languncularia racemosa* (**white mangrove**), *Dalechampia scandens* (**spurgecreeper**), *Entada gigas (monkey ladder)*	Mangrove forests, woodded plots, agroforestery plots, "*Jaden Lakou*" (Creole garden) "*rak*" (wooded area)
Inflammable material for night fishing	3	*Exostoma caribeum* (**chinchona**), *Agave rigida var. elongata* (**Caribbean agave**), *Amyris balsamifera (balsam torchwood)*	wooded plots, agroforestery plots, "*Jaden Lakou*" (Creole gardens)

N.B.: plants without specific indication are used for their stems, whereas those marked with a (*) are used for their flowers (**), their fruit (***).

Table 4
Plants used for fishing by fishers in Chardonnières and Bainet according to utilisation and origin.

First contact with the seascape for a fisher generally takes place at an early age. His first excursions are made accompanied by a close family member (father, uncle, cousin or friend) and/or an acquaintance. This process of initiation has no set duration, but operates depending on the young neophyte's ability to control any tendency to seasickness, as well as on his ability to adapt to his observation and interpretation of the elements making up his immediate environment. Finding fishing sites, for example those where fishing equipment had been left, is done via identification, from the water, of specific landmarks – known as "*remak*" in Creole – i.e. noteworthy elements of the landscape, the vegetation or the infrastructure present. In addition to a good knowledge of tidal currents and the different effects of lunar phases on fishing, a number of ecological indicators also enable the detection of where shoals of fish ("*li pwason*"[26]) may be present – the colour of the water and its movement, the presence of birds associated with a particular targeted species – what Michel Serres (1980) referred to as "reading the signs".

From having to clean their fish, fishers come to know their dietary habits through observation of the stomach contents, and can adapt their bait to the specific species they are targeting. They also know the influence of seasons and day- or night-time on the fish's availability. They have a very good knowledge of the earth's natural elements, which can serve them well in the practice of their fishing. As much as they worry about the increasing scarcity of fishing resources, they are also concerned about the increasingly difficulty in finding plants having been subject to uncontrolled exploitation and/or the effects of climatic variation over the last few years. (In this regard hurricane Matthew, which struck the Grand Sud area in 2016 is still mentioned to this day.) Fishers regularly make use of various plant materials for the building of boats and fishing equipment, to bait their hooks or as poisons for fishing, and for feeding lobsters between the time of capture and sale. In the course of investigations carried out at Bainet and Chardonnières, 23 plants related to 9 different types of utilisation were identified (table 4). This knowledge often goes beyond just dietary uses and also operates in the field of healthcare.

While Sargassum can be damaging to the health of inhabitants when piling up on beaches and beginning to decay, the proliferation of these algae since 2013 simultaneously presents fishers with an opportunity in cases where it doesn't beach but instead remains at sea, since then it tends to create a concentration of pelagic fish. From paddle-driven hollowed-out canoes fishers fish here using handheld lines, catching Carangidae, Scombridae and Sphyraenidae.

C/ Modern professions

By "modern" professions is meant large pelagic fishing, notably around designated FADs, as well as fishing for deep-dwelling demersal species, at a depth of more than 200 m. These professions are a recent introduction. Until the 2000s, sailing vessels of 4 to 5 m in length enabled the dragging of one or two lines beyond the island base, up to 20 nautical miles away (just over 37 km). This range of activity was considerably extended with the development of motorboat-based fishing, the result of

[26] Expression used by the fishers of Chardonnières for a shoal of fish.

aid provided by NGOs such as Food for the Poor[27], or within the framework of international projects such as the cooperative venture between Spain and the MARNDR aimed at strengthening ocean fishing in southeast Haiti (Vallès, 2016). Currently fibreglass boats are most frequently used as part of modern fishing professions, and the organisation of excursions is no longer done within the context of the family but rather within that of a cooperative or a fishers's association. Thus fishing is no longer experienced simply as a means of feeding oneself, but has become a lucrative activity aimed at providing fresh fish to the produce market – the exploitation of fishing resources has therefore become driven by the desire to fish for the purposes of selling. Fishers target high-value species in response to a growing demand both on the local market (the Port-au-Prince cluster) and on the international one. These targeted species are mostly large pelagic ocean fish (tuna, common dolphinfish, blue marlin, king mackerel, sailfish) as well as deep sea demersal species (snapper and groupers). Trawling lines and vertical longlines (handlines) are the two pieces of equipment used, both selective.

As illustrated in figures 1 and 8, the Haitian seabed is sometimes steeply sloped. Sea beds of 200 to 500 m, well-suited to deep demersal fishing – and even sea beds of 1 000 m corresponding to a hydrography that is most productive in terms of FADs – are sometimes accessible to fisher a few km off the coast. Such is the case for the northeast coast from Cap à Foux to Pointe Jean-Rabel, of the southern coast from Grand Gosier to Bainet, of the southwest coast from Port Salut to Tiburon and from the southern coast from Grande Anse d'Abricots to Petit-Goâve. In these areas keeled canoes and coral boats, and even dugout canoes, can exploit the resources of these "new" fishing zones when the weather and sea are sufficiently calm. Because of their larger size and their motorization, fiberglass boats are able to operate in these fishing zones when ocean conditions are less good, and can go much further when the weather is favourable. Needless to say, all areas situated beyond the 13 fishing grounds dedicated to small-scale subsistence fishing (figure 16) running to depths of 200 to 2 000m or even more are exploitable by the "yachts".

Because of the distance to travel and the high price of gasoline, these excursions have to be sufficiently productive in order to be profitable, something which is not always the case. Available material and its utilisation does not readily make for optimal conditions for obtaining high yield and preserving the value of hauls. On the one hand, the boats are not fitted with any sort of canopy under which fishers can shelter from the sun on the way to fishing areas nor, more significantly, which can provide shelter for their catch on the way back. Thus exposed to the surrounding heat as well as to direct sunlight, the fish that were caught rapidly lose some of their physical qualities, as well as their financial value. On the other hand, the handlines are solely hand-operated, which demands a significant effort when having to raise onto the deck a fish caught at 400 m. Finally, given the fact that deeplines and handlines are not used in equal measure, deep sea excursions often focus exclusively on the pursuit of a single fish species – targeted using a particular type of line – as a result of which boats often return

[27] Food for the Poor is an American NGO created in1982. Christian in origin, it seeks to reduce malnutrition and poverty on Latin America and the Caribbean basin. Within the fishing sector, Food for the Poor promotes the modernisation of exploitation by distributing fibreglass boats.

from a relatively unproductive outing near a FAD without attempting any fishing in deepwater habitats where demersal species are likely to be found.

These constraints, or dysfunctionalities, would be easy enough to resolve. It is not expensive to affix a canopy to a boat, but in order better to take on the deep sea, a small cabin would provide much more comfort to the fisher (photo 2) while also providing better storage for his catch. It should be noted that among the islands of the Pacific storage of small- and medium-sized hauls is done in seawater cooled to 4° inside a cooler. The fish is not gutted but killed immediately upon their being pulled from the ocean via medulla extraction with a small iron spike driven into the head according to a Japanese method called "Iki Jime" (Harada, 1988). Outfitting boats with draglines that can easily be converted into handlines would enable the undertaking of excursions featuring drag fishing and handline fishing in equal measure, resulting in an increase in the size of hauls and ultimately in the revenue claimed by fishing crews. In order to achieve this dual-purpose fishing, a number of Pacific fishing services for the past thirty years have been promoting the use of Samoan-style wooden reels (photo 2). Small boats (of about 5 m in length) are fitted with two reels. Boats of an average size of 7 to 9 m can carry four deep fishing reels, with only two of them used for drag fishing. Skipjack tuna (*Katsuwonus pelamis*) is one of the best baits to use for deep sea fish, which are sensitive to the scent emanating from its flesh. Following a fishing excursion near designated FADs, as soon as the preservation in a refrigerated cooler of the skipjack tuna and other small tuna fish caught has been ensured, it is usual for fishers to spend 2 to 4 hours or even more in deepwater fishing for demersal species by baiting their reel with pieces of tuna. Achieving comparable results thus becomes the rule for excursions rather than the exception, providing a major advantage: fuel costs barely increase but the number and value of hauls are notably more, which increases all the more the profitability of the excursion.

Access to far-removed areas via fibreglass motorboats has resulted in some fishers regarding with less respect traditional rituals and beliefs related to fishing, something that is particularly mourned by their older counterparts. Thus these days one may well hear seaborne fishers express themselves in insulting terms vis-à-vis the ocean or the *mèt dlo* (voodoo deities) or to whistle, which some believe can lead to the summoning of a violent wind capable of destroying a fishing boat. The arrival on the scene of a *"young generation of FAD fishers"* is viewed in a particularly negative light by the older guard. Nevertheless, in case of some misfortune many are quick to return to the voodoo priests for preparation of lotions used to anoint their boats or their equipment, or to obtain a blessing on the fisher's hands. It is even likely that the very increased modernisation of the profession leads fishers to seek out means of reducing the uncertainties linked to the use of new fishing gear and the exploitation of new fishing zones by integrating such modernity into the familiar framework of their relations with the otherworldly.

Photo 19
Small fishing boat fitted with a cabin in Guadeloupe, and a Samoan type wooden fishing reel[28]

D/ Fishing effort

Due to the large diversity of fishing methods in relation to targeted species, it is in vain that one might attempt to define a standard measure of fishing effort in relation to results obtained by the various types of equipment in use. The approach used here is to

[28] source: https://biodiversitemarineguadeloupe.wordpress.com/2015/05/18/la-peche-en-guadeloupe

view the boat as at the centre of the undertaking, and then to multiply the number of excursions by their average duration in order to discover a measurement of excursion-metres – a method proposed by Dunn *et al.* (2010) for this region. In order to gauge the impact of such effort on fish resources, with resources equated with individual fishing grounds (figure 16), the total of excursion-metres corresponding to the totality of fishing stations within a particular area is divided by the total surface of the island base of the area in question in order to arrive at an estimation of the fishing effort per surface unit (excursion-metres per km^2), which in turn allows for an estimation of the fishing effort for the whole of the territory (figure 18). For the entire country, the fishing effort is 19.7 excursion-metres per km^2. There are significant regional fluctuations in this number, with the Grand'Anse and Nippes areas notably showing an effort of more than twice that (figure 19).

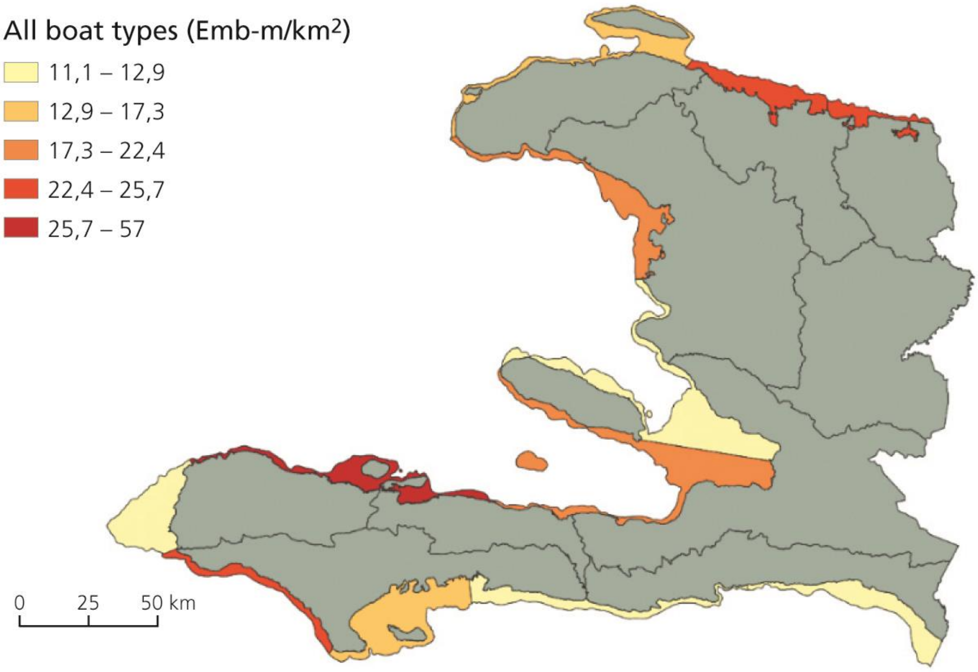

Figure 18
Distribution of fishing effort (all boat types included) across the 13 Haitian fishing grounds

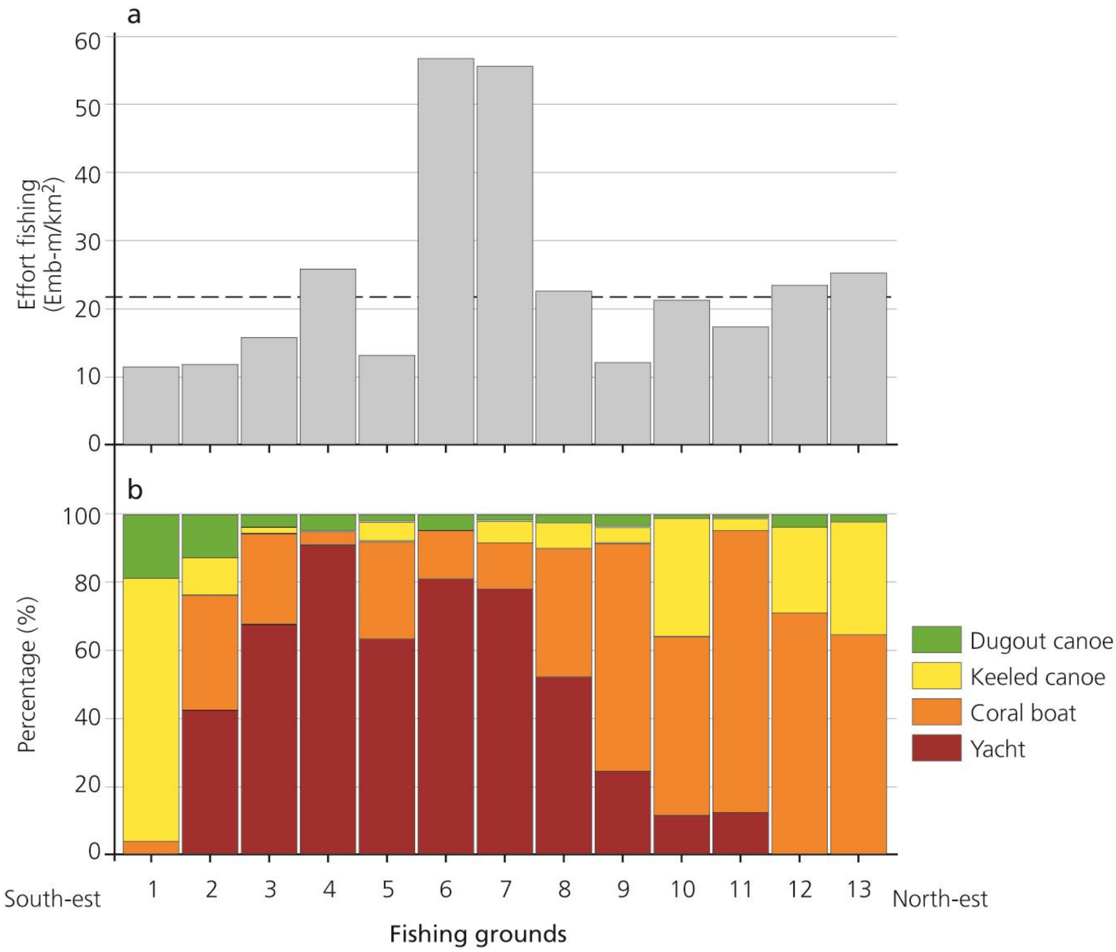

Figure 19
Fishing effort in each fishing grounds (a) and relative contribution of the different types of small-scale fishing boat to fishing effort (b). The fishing grounds are arranged from left to right according to placement from southwest to northeast along the Haitian coast (see figure 16 above for which number corresponds to which area). The dotted line in the middle of (a) represents the fishing effort total for the entirety of the national territory.

Despite their small average size (3.5 m), dugout canoes represent 44.7% of fishing effort. They are followed by keeled canoes, of larger average size (4.7 m), with a 38.6% share of fishing effort. In third place are found coral boats, slightly larger (5 m) with 13.2%. Yachts, with an average length of 5.7% only contribute 3.5% to the total fishing effort.

Lacking regular statistical data collection for fishing effort and catches, fishers remain the most obvious source of information for engaging with the essential issue of overexploitation. This is characterised by an imbalance in demographic structure of the resources to be exploited: fish not yet having attained sexual maturity are overrepresented, while adults – particularly older adults – are underrepresented. The entire question of overexploitation is determined by the fact that fishers do not regulate their efforts in reference to the state of the resource they exploit, but rather in reference to their expectations of volume obtained, which they view in terms of revenue to be gained, this being the case whether they are motivated by the desire to sell their product or, in the case of subsistence fishing, the desire to extract a sufficient quantity to ensure adequate food for their families' subsistence. The dynamic related to fisheries exploitation, and by extension overexploitation, are thus based on the relation between "resource expectation" and production[29].

Well aware of the difficulties they are likely to encounter, fishers consulted in Chardonnières and Bainet (see box no. 4 and specifically contribution XX) consider the coastal zone today as playing less and less its former role as sure-fire food supply; they indicated having been obliged to adapt their practices, both by increasing fishing volume by using less selective equipment and by developing new techniques aimed more at the deeper sea, these often not very favourably considered by the older fishers. They estimate that overexploited species are mostly found around the island base, especially species from the Lutjanidae and Mullidae families, much appreciated by consumers and thus having a significant market value. Hence they estimate that 80% of fished species are in decline, and that 5% are overexploited, particularly those found around the FADs. In this regard they specifically point to marlin (Istiophoridae), dolphinfish (Coryphaenidae) and tuna (Scombridae). Nine out of ten fishers attribute the reduction in fish numbers to the total absence of regulation, to bad fishing practices and to fishing techniques which are damaging to the resources. Other causes, identified less unanimously, include: "human malice", demographic increase and "contempt" for local ecological knowledge. Practices which do not respect the biological cycles and habitats are also mentioned: not respecting a species' spawning period, placement of fishing equipment directly on reefs, failure to align fishing sessions with the lunar cycle and, finally, water pollution.

Information available on sampling and fishery globally is fragmented and incomplete, even on occasion contradictory. Such data as are available concerning the state of fish stock, population dynamics or biodiversity in general, as well as analysis of means of protection, conservation and value extraction from the knowledge and experience of fishers, derive from grey literature and a few fishery studies. The lack of an organised system of collecting fishery information enabling monitoring of fishing effort and its effects on fish populations via the size and weight of hauls constitutes a major obstacle to any kind of management of coastal fishing aiming at the reduction of overexploitation (Mateo et Haughton, 2003). The putting in place of an observation network of fishery activity therefore constitutes a priority (see role of the SIH, part III).

E/ Fishing to eat or to sell?

Small-scale fishing as commercial venture distinguishes itself clearly from subsistence fishing by the fisher's desire to sell his catch (box no. 1). For the fisher therefore, fishing is not approached solely as a means of feeding his family, but serves as financial activity meant to ensure an income by providing the market with fresh fish products. Thus fishing becomes an economic activity transcending the local level of the fishing village and engaging with such challenges as arise at national level. In the first

[29] A socio-economic interpretation of fisheries exploitation as complement to the much more common biological one (Laurec et Le Guen, 1981).

place, at this level they have to participate in the reduction of the deficit operating within the commercial equation by increasing the value of exports while also reducing the volume of fishery imports. In the second place, fishers have to respond to the increase in demand for quality products in the Port-au-Prince cluster, where the highest income is concentrated (among expatriate and national populations alike). In the third place the country's food security situation has to be improved, *per capita* consumption of fish still being very low (5 kg per year, i.e. a quarter of the global average). All these national objectives operate in conjunction with the local desire of fishers to increase their revenue, together leading to a significant increase in fishery production, as opposed to the situation as it would operate in an entirely subsistence economy.

Box no. 1 : Commercial and non-commercial fishery

"Self-consumption fishing" refers to all fishing of which the entire haul is consumed by the fisher and his family. By extension, the meaning of subsistence fishing can be extended to include the villages to which the fishers belong whenever non-fishers receive fishery products within the framework of a non-commercial exchange, usually in the form of a gift.

"Subsistence fishing" refers to all fishing aimed at providing fish for non-commercial ends. Self-consumption and self-subsistence fishing count as subsistence fishing. At the same time the description is not really accurate, given that a part of subsistence fishing may be commercialised when self-consumption results in a surplus (whether at an extended scale or not). In no instance can such a surplus represent more than 30% of the total production. The portion meant for self-consumption therefore constitutes at least 70% of production.

In contrast to subsistence fishing stands "commercial fishing", defined as all fishing of which the practice is motivated by the desire to sell. At a minimum, 70% of production should constitute the object of a commercial transaction. The remaining 30% may be passed on to the fishers and their families as gratuity.

"Mixed fishing" is fishing of which 51% to 69% of the production is used for commercial purposes, while 49% to 31% is consumed by the fishers or else passed on to others for free. Thus this is a form of commercial fishing of which only a part of the practice is motivated by the desire to sell. The other part is motivated by the desire to fish for self-consumption, for exchange or to give away for free. This is not a case of a surplus resulting from fishing for self-consumption, since the extra effort expended in order to create the surplus derives from full knowledge of the fact that the additional production is meant for purposes other than commercialisation.

In order to attain these objectives, for some twenty years now the focus of international aid has been on modernising the means of production, notably the motorisation of boats and the use of more productive fishing equipment, thus to enable fishers to target species of high market value (lobster, queen conch and "rose-coloured" fish) for the international market or the national one (i.e. the Port-au-Prince cluster). Faced with a situation in which most small-scale fishing is done using fishing boats of small dimension – of which the length rarely exceeds 6 m – the "usual" reaction of fisheries development experts is to propose the modernisation of boats in order to replace dugout canoes and sailing vessels with motorboats. Allowing for a larger sphere of activity and longer excursions, this strategy aims at creating an impressive increase in fishing effort and the exploitation of new fishing zones inhabited by stock thus far still underexploited. The sustained focus placed on the development of fishery around FADs forms part of this strategy and illustrates the desire of the MARNDR to displace fishing effort from shallower zones, of which the demersal stock is often overexploited, to deep sea zones, of which the pelagic stock is in a much better state.

Could the hoped-for development of small-scale fishing over the next few years limit itself to this policy of modernising the means of production? In other words, is this strategy sustainable?

If fishery is considered solely from a biological perspective, the response may well be positive, provided that the redeployment of fishing efforts towards deeper-lying demersal resources – still relatively unexploited – and pelagic resources around established FADs is accompanied by the rigorous management of fishing stock. For if this stock comes to be overexploited, it is highly probable that the modernised fleet would return to the exploitation of the shallower areas and there be in competition with tens of thousands of fishers still engaged in small-scale fishing operations either by choice or by necessity, being excluded from the policy of fishering effort modernisation. Such a competition would be both a biological disaster, leading to the collapse of exploited shallow-water demersal fish stock, and socially catastrophic, leading to the abandonment of fishing by many fishers in the face of their economic "failure" and to a general shortage of fresh fishing products across the totality of the country's coasts.

On the other hand, if fishery is considered from a wider perspective, integrating the social and economic aspects, the response is resolutely negative. Reducing the development of small-scale fishing to the modernisation of the means of production is a strategy that is neither economically nor socially viable. Outfitting all the fishers with "modern" equipment would mean a spectacular increase in the cost of fishing excursions, which would inevitably lead to an increase in the selling price of fish. However, it is very probable that the demand would not be equal to this newly-priced fish supply, given that the purchasing power of most Haitians would be insufficient. Within this context, only those outlets targeting a more affluent market (big city restaurants, hypermarkets and exportation) would remain as consumers, and as a result a significant number of fishers would be obliged to reduce their area of fishing activity, increasing fishery effort in relation to shallower water resources, these already greatly overexploited and the only source of fishing for small-scale fishers not having benefitted from the modernisation strategy. Finally, there is a great risk that over time the general modernisation of the means of production would result in both an economic and ecological disaster, with serious repercussions for food security and thus for the well-being of the Haitian people.

Any modernisation of the means of production should therefore be done while keeping in mind the capacity of fishery resources to subsist in the face of such a change, as well as the capacity of consumers to increase their demand for good quality fishery products but at a higher price. Usually this type of modernisation would inevitably lead to the drastic limiting of the number of beneficiaries of the policy, leaving the majority of 45 728 of the country's fishers (as per census data) out in the cold, something which would be socially unacceptable.

Within the Haitian context, any modernisation of the means of production should therefore be accompanied by complementary measures aimed at those fishers unable to benefit from the modernisation effort. In the framework of this assessment, the experts have decided to focus on ecological intensification, the development of aquaculture and strict management (part II), as well as on improvement of the fishery products supply chain (part III). This improvement aims at crafting a better response to a challenge ignored by the modernisation of the means of production: how to reduce significantly the volume of imports, of which a large part is made up of cheap fish, in order better to align with the weak purchasing power of the immense majority of Haitian households? Indeed, the high cost of fish compared to the average household income is one of the factors which explains the low level of *per capita* consumption of fishery products in Haiti. On the coast, responding to this challenge would not result in the sidelining of subsistence fishing, but rather the opposite. Any fish caught by subsistence fishers can be seen as a substitute for an imported fish, and thus a contribution made to reducing the country's commercial deficit.

Fishing to eat or to sell? The answer is now quite clear: fishery should first and foremost serve as food source, which requires two types of fishing: subsistence fishing for self-consumption and commercial fishing to sell, thus to feed those Haitians who do not fish themselves.

PART II: AQUACULTURE, ECOLOGICAL INTENSIFICATION, MANAGEMENT

Ecological intensification is a concept derived from the world of agronomy, having as objective better utilisation of the natural mechanisms, or ecological processes, of ecosystems in order to obtain more efficient production from available resources based on novel scientific knowledge (Chevassus Au Louis and Griffon, 2008 ; Dugue *et al.*, 2011). This concept can be perfectly applied to the production of ocean products. The sustainable intensification promoted by the FAO (2011 et 2008), i.e. producing more or as much with less input can be perfectly applied to aquaculture by using a multi-trophic integrated aquaculture (Amti) such as has been developed in Canada (Chopin, 2013 ; Chopin *et al.*, 2008). Based on the principle that within the food chain one species' waste can serve as food for another, Amti aims at breeding fish in cages close to shellfish and algae, the latter's growth thus boosted by their consumption of such food as is left unconsumed by the fish, as well as their faeces and urine. As for fishery, it is necessary to go beyond the management of predator-prey relations (i.e. fisher-fish) and to place the focus on the rehabilitation of marine habitats, notably coral reefs and seagrass beds. Without "healthy" biotopes ocean populations exploited by fishers cannot reach the desired abundance allowing for their maximal exploitation. In sedimentary areas where algae and coral larvae are unable to take root, the setting up of artificial reefs enables the creation of small islands of hard substratum on which new coral- and algae ecosystems can develop, thus increasing in a significant way the volume of exploitable fish. It should be noted that artificial reefs, being vulnerable to sedimentation and overfishing, require an integrated approach in order to ensure sustainable intensification of the marine ecosystem over the long term.

Before looking more closely at these two approaches, which could spell a bright future for small-scale fishing, one should also recognise the considerable possible potential for Haiti in an integrated, multi-trophic aquaculture contributing to the country's food security. Applied expertise has resulted in an aquaculture programme, with aquaculture not to be considered as fishing, and it is achieving undeniable global success as a means of providing an immediate supply of protein to local populations.

1. Aquaculture in Haiti and the potential of "Amti" (Multi-trophic integrated aquaculture)

For some decades now the contribution of aquaculture to the planet's food security has been on the increase. In 2018 it generated 82.1 million tonnes of fish, molluscs and crustaceans for human consumption, while fishery accounted for 94 million tonnes (FAO, 2020), i.e. the same amount as in 1996. That said, aquaculture production for the same year was only 26.4 million tonnes[30] for the entire planet. Its evolution is therefore obvious: all development related to the production of aquatic protein should now rely on aquaculture.

[30] http://www.fao.org/3/w9900f/w9900f02.htm

Aquaculture has been practiced in Haiti since the 1950s. Developed by statal or parastatal organisms (NGOs, FAO, government departments), until recently it focused on freshwater species and was limited to hilltop lakes and today to 16 floating cages in the brackish waters of Lake Azuéi. There is also a small-scale aquaculture operated in basins (concrete or earth) at the family- or village level. So why not reboot the practice of aquaculture? This is a question posed by older Haitians who remember more expansive periods of development. Aquaculture, if implemented while ensuring that the production of input is local, could provide a good response to the protein requirements of the Haitian population, which reaches an average of 18.25 kg per year – i.e. a daily average ration of 50 g per person (Kayser, 1970). Per every 100 g of food the protein content of small pelagic fish is 18.8 g, for tuna fish 10 g and 8.5 g for other fish, including reef-based species and those raised via aquaculture (Jardin and Crosnier, 1975). Annual consumption of 4.5 kg of fish thus only provides about 450 g of protein, i.e. 2.5% of the population's requirements[31]. Room for improvement is therefore ample, and aquaculture has an undeniable role to play in this regard.

A/ Past experience

Since the 1950s the FAO has hoped to stimulate fish farming and has distributed tilapia fry *(Oreochromis mossambicus)* in the country. The project ended four years after commencement, but training and popularisation continued, and until the end of the 1960s there were 5 000 families practicing fish farming.

Between 1985 and 1991, two new projects were launched by the MARNDR with financing by the United Nations Development Programme (PNUD in French) and with the help of the FAO (Célestin, 2006). The first national aquaculture hatchery was established in 16 ponds along with training, production and fry feeding centres, as well as the introduction of new lineages. The aim was to benefit from hilltop lakes by establishing aquaculture installations on them. For the whole of the 1990s the persistence of the country's socio-political crisis created a powerful obstacle to the development of aquaculture production and avenues toward commercialisation. Today, more than thirty years later, of 126 hilltop lakes selected only a few operational projects remain. But these operations have enabled the annual production of 414 tonnes of fish and 82 719 tonnes of vegetable matter, having significant positive agro-socio-ecological impact (Celestin 2017).

At the beginning of the 1990s, the private sector also took an interest in the aquaculture sector. A giant freshwater prawn farm (*Macrobrachium rosenbergii*) was founded targeting the export market to Florida. A first test delivery of close to one tonne was made, but the economic blockade imposed by the United States from 1991 to 1994 led to the cessation of food imports and as a result the production of *Macrobrachium* had to be ended as well.

It should also be noted that in 1988, as a result of 6 million US dollars in financing, an experiment with breeding shrimp was started on 400 ha in the Grande Saline/L'Estère region, conducted by the multinational Shrimp Inc. based in Florida. For socio-political reasons this initiative did not advance.

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[31] These values are only valid for when fish is served alone. Serving it with starchy foods or adding it as condiment adds a protein supplement to the starch, of which the nutritional value is thereby considerably optimised, the proteins they contain being thus better digestible by the human body (figure 2).

It was not until 2010 that a significant project emerged. An NGO led by an Ivorian entrepreneur, Caribbean Harvest[32], took the initiative to develop aquaculture on Lake Peligre, with a hatchery of red *Oreochromis niloticus* of which the stock had been imported from Egypt and Israel. Another private entrepreneur, Taïno Aqua Ferme, participated in the construction of another hatchery dedicated to the same species, also built in the suburb of Port-au-Prince. It is aimed at supplying the 16 floating cage growing area on Lake Azuéi, of which the surface is 170 km^2 of brackish water (13 g/l). This farm is the only fish farming enterprise in Haiti having achieved commercial viability: it provides a production capacity of 10 tonnes per week and employs 86 people. A frozen packaging unit as well as administrative spaces have been established in containers on the lakeshore. Production flow does not appear to pose a major problem; however, food is imported from the United States, which renders exploitation vulnerable to fluctuations in the value of Haitian currency (photo 20).

Photo 20
Floating cage used by Taïno Aqua Ferme on Lake Azuéi (photo: Marie Arago).

Finally, despite the socio-political and economic constraints faced, aquacultural production has advanced since the beginning of the 2000s, increasing from 200 to almost 400 tonnes per year. However, the limited nature of convertible surfaces means that the developmental potential of aquaculture production in fresh water is also limited. It is therefore necessary to go further and imagine an ocean-based aquacultural production instead. (figure 20).

[32] www.caribbeanharvestfoundation.org

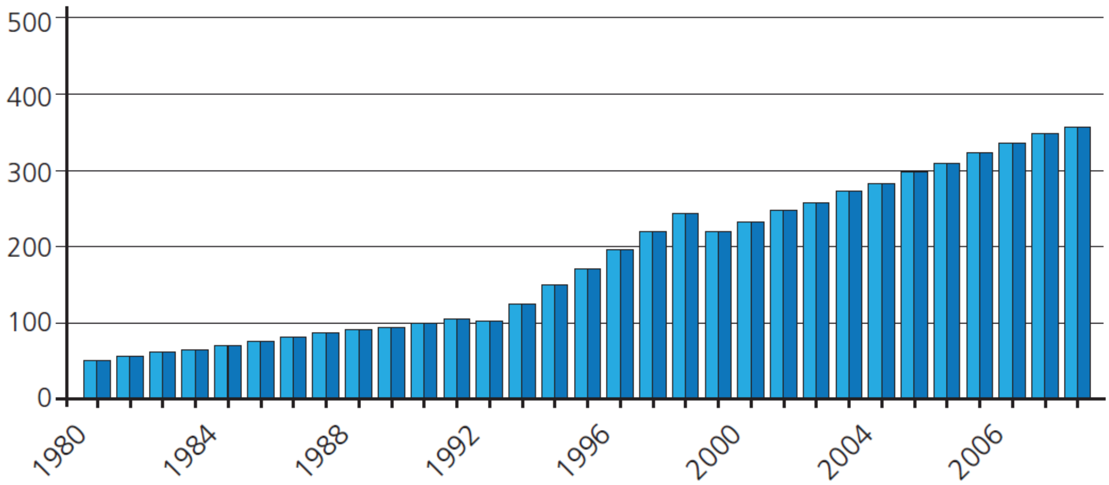


Figure 20
Aquacultural production in Haiti between 1980 and 2011.

B/ Ocean-based aquaculture development?

To develop aquaculture in the sea, two solutions can be envisioned: breeding in floating cages or in basins.

In floating cages, a solution in widespread use internationally, the viability[33] of breeding is threatened by illnesses, climatic intemperance (cyclones and storms), the high costs of feed and pollution of the landscape brought about by unconsumed foodstuffs and fish faeces. At the same time, in open areas the effluent created by breeding is dispersed into the landscape, making it difficult to derive benefit from it. Multi-trophic integrated aquaculture (Amti), also called "circular aquaculture" is an noteworthy attempt at reducing these two risks, and one which is arousing a great deal of interest among Haitian officials. It could become the subject of significant development over the next few years. A feasibility study was recently conducted in the protected marine area (MPA) of the Trois Baies national park, in the north-northeast part of the country (Kramer *et al*., 2016). In total, fourteen species were identified as possible to integrate into such a circular aquaculture project, among them three marine algae species of the genera *Gracilaria, Amphiroa* and *Acanthophora*, as well as an equal number of sea urchin and prawn species, two sea cucumber species, two bivalve species (i.e. oysters) and one marine gastropod species, the queen conch. But the expansion, in the region, of the presence of the red lionfish (*Pterois Volitans*), originally from the Indo-Pacific region (Albins and Hixon, 2011), shows that the danger of a species bred as part of an aquaculture venture becoming invasive should not be ignored, particularly in the case of predators. It is for this reason that our assessment does not recommend ocean aquaculture using cages, but rather basins.

[33] Viability corresponds to a combination of a steady state, "the combination of necessary and sufficient conditions to exist and perpetuate", and a dynamic state adaptable to conditions "that can combine to ensure development…" Doumenge F. (1983).

Amti is possible in a form other than in the open, i.e. in a more controlled setting or in basins. The aim here is to focus on the conservation and recycling of such nutrients as are produced by effluent from the breeding process, without being lost to the surrounding landscape, and that through a combination of organisms from different trophic levels (bacteria, microalgae, zooplankton, fish). Thus the one can benefit from the organic waste (faeces, urine) produced by the other for nourishment, either directly or indirectly in the form of microalgae, with the only input into the ecosystem consisting of agricultural by-products in the form of granules (no fish should be fed with other fish products in the form of meal, nor by foodstuffs directly consumed by humans). The primary advantage of this type of aquaculture is avoidance of dependence on expensive feed, particularly those which have to be imported. Thus it constitutes a sustainable aquaculture, producing high quality, inexpensive protein while free from vulnerability to external economic and political fluctuations.

The ideal species for basin-based Amti is the blackchin tilapia *(Sarotherodon melanotheron)*. Originating in the lagoons of West Africa, this species has the advantage of being able to adapt to a very wide temperature range (it is eurythermal) and to an even wider range of salinity; it can live and grow equally well in sea- and fresh water[34]. In its native habitat it is a detritivore and, at the adult stage, consumes organic material mixed into the sediment (Pauly, 1976). Amti breeding protocols for this tilapia were recently elucidated in Senegal by the IRD. Each aquaculture complex is made up of two sites, the hatchery and the growth basins (a single hatchery can feed into several growth sites) (photo 4).

Photo 21
S. melanotheron heudelotii, 800 g grown in green water. © IRD/J.-F. Agnèse.

Located at ground level, each hatchery comprises aboveground structures devoted to the fry- and pregrowth stages (from 40 mg to 40 g in 4 months) of the tilapias, connected to the lagoon-like basins in which is carried out the processing of the breeding effluence in which the progenitors will be held, as well as to other basins devoted to the regulation of phytoplankton biomass via zooplankton in accordance with

[34] The Taïno Aqua Ferme farm could well se in this Amti proposal an opportunity to reduce its expenditure and to diversify its production, all while maintaining its speciality operation, i.e. the breeding of tilapia.

the aquaculture integral recycling system (SARI in French) perfected by the IRD (Gilles *et al.*, 2008, 2013, 2014). “Race-way” type tubs are required for inducing reproduction in the progenitors. The totality of the structures is kept in greenhouses in order to maintain a year-round constant temperature, adequate for continuous reproduction and good growth of the fry and young fish. Boreholes located on the ocean front, on the upper part of the beaches, enables the procurement of seawater free from pathogens and competitors. Other boreholes provide the installations with fresh water, notably to compensate for evaporation of water used for breeding (photo 5).

Photo 22
Prototype of SARI established for six years by the IRD in Mbour, Sénégal
© IRD Panfili, Jacques.

Growth basins can be installed on the very salty, sand-clay stretches of soil covering the back of mangrove zones, called “tans”. Here are kept male-only batches in order to avoid unscheduled reproduction (males expend far less energy than females in order to produce gametes) for a growth period of six months, during which the tilapias grow from 40 g to 400 g. In addition, this system prevents reproduction outside of tans, and thus the possibility that the tilapias might become an invasive species. In total, ten months are required for a complete breeding cycle. The tans are not usually covered by tides except during flooding. As a result of their extreme salinity, these areas house only the sparsest of biomass. As a result, installing aquaculture basins in them has little impact on the surrounding ecosystem, all the more given that these environments are unsuited to any form of agriculture. On the other hand, the mangroves protect the basins from intemperate weather (notably cyclones) by their leafy mass and further provide good quality water. Indeed, the replenishment of the water in the growth basins is done naturally by the currents whenever conditions allow, or otherwise by pumping water along tidal channels using renewable energy. (photo 23).

Photo 23
Example of growth basins for prawn built on tans, New Caledonia (Futura-Sciences) (© JM Lebigre).

2. Ecological intensification

A/ Creating artificial habitats in coastal areas

PAST EXPERIENCE

Artificial habitats are still a rarity in Haiti. The first immersion site for an “artificial reef” (AR) dates back to the 1990s. It is in the Nord department, in sight of the beaches of Cap-Haïtien that the wrecks of old cars (without engine) were submerged in order to create a recreation zone for diving (snorkelling) and fishing accessible from the coast. Little ecological information could be gathered about this first site, except that it enabled the creation of areas extensively “colonised” and frequented by local divers and fishers (commentary by Robert Stryhanyn). Following this first submersion and the fact that it had an noteworthy result, a second site was developed in 2007. In that case it involved the submerging of concrete pyramids of 1 m^3 in a 5 m seabed, also rapidly colonised (photo 24).

Photo 24
Artificial reefs of concrete in the form of pyramids with holes in them (source Robert Stryhanyn - ECCOMAR).

Following these two initial projects, created as private initiatives, an experimental project called “ampil poisson” (Creole for “lots of fish”) was put in place in 2014 on the western part of Cow Island, funded and piloted by the American University of North Carolina within the framework of its laboratory for applied ecology named “ABACO Scientist” and based in the Bahamas. This experiment aimed at installing ARs, made up of honeycomb blocks, on a sedimentary substratum in order to create, *ex nihilo*, a miniature reef ecosystem by providing shelter, i.e. a residential space, to fish and crustaceans independent of the nearby marine spermatophyte seagrass beds. The governing hypothesis of the experiment was that the excreta of the fish species coming to inhabit the AR would provide the seagrass with nutrients and enable the development of their biomass. On a level of fishery the experiment is an interesting one, since it enables the justification for the introduction of lobster and other main species targeted for coastal fishing (Lutjanidae, Serranidae, Haemulidae). On the other hand, it was surprising to note that it was able to increase the biomass of a seagrass bed which, once covered by a AR, systematically disappeared. A tentative cost/benefit assessment of the functionality of the seagrass bed remains to be made following monitoring for 7 to 10 years (photo 25).

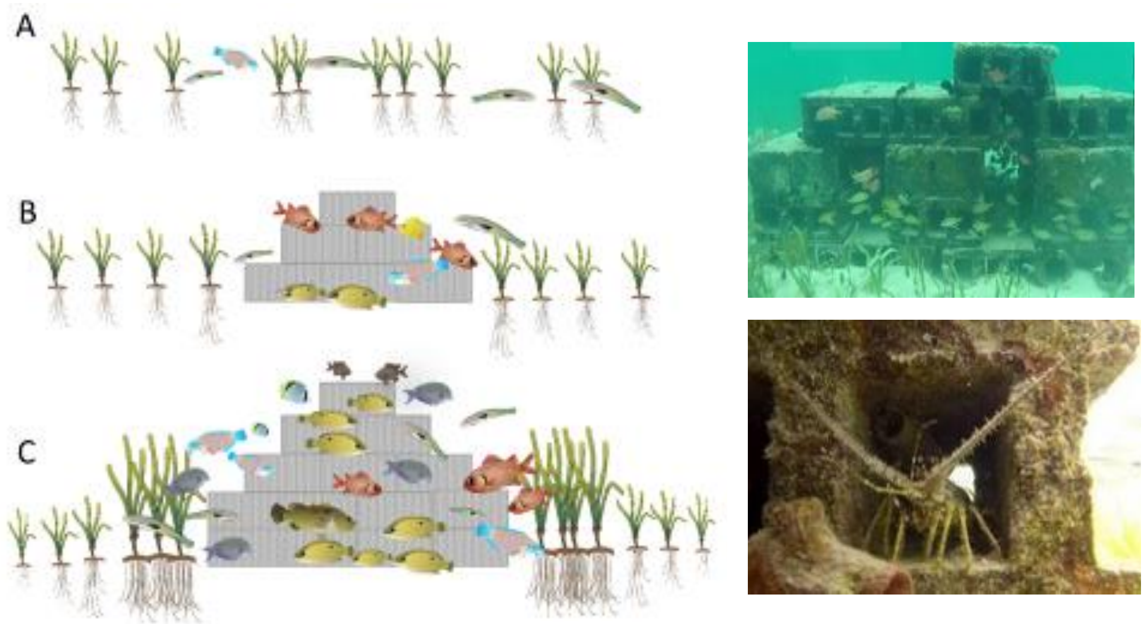


Photo 25
The “ampil poisson” project, the artificial habitat attracts marine fauna which, through its waste, fertilises the nearby seagrass beds (source Abaco Scientist, NC University and J. Allgeier).

The three projects noted above, while being narrow in scope and two of them not being subject to scientific monitoring, would appear to validate the use of ARs for populating an area with local species, notably species targeted for fishery and the development of permanently-placed fauna (coral, sponges…). It is for this reason that this assessment seeks the development of artificial habitats along the edges of MPAs in the south, so as to optimise their overflow by offering new implantation sites for coral larvae, shelter for juvenile fish and cover for targeted adults in order to colonise the fishery seascape well beyond the MPA (see Recommendations). Within the framework of this assessment a pilot initiative of fishery ARs, called “Lakay pwason” (Creole for “fish house”) was created in order to improve fishery for some 200 coastal fishers of Aquin Bay.

ADAPTED ARTIFICIAL FISH HABITATS IN HAITI: *LAKAY PWASON*

The principle of artificial habitats (AH) is simple, concerned above all with the restoration or creation of habitats adapted to marine species dwelling on hard seabed, notably coral, all while protecting the soft surfaces from damage, such as from nets destroying seagrass beds. The artificial habitat operates in three stages: a) by attracting marine species targeted for fishery by providing them with adapted habitats (snapper, groupers, lobster); b) colonisation of the habitat by the targeted species; c) production of the desired resource, the HA in this regard fulfilling three essential functions: protection (sheltering juveniles or adults according to design), nursery and reproduction, as much for the algae, coral and molluscs implanted on its surface as for the crustaceans and adult fish sheltering within them. As a general rule, the success of the installation of a

HA as a means of strengthening the productivity of a given area depends on three parameters simultaneously. On the one hand it depends of the quality of biophysical and cartographic data (hydro graphic, currents, meteorology, spawning areas, nursery areas, fishing areas, regulated areas and maritime activity); on the other hand it requires management (organisation of fishers, self-supervision, regulation, monitoring); finally it must be imitative of nature in terms of its design (with regard to animal behaviour of targeted species, the form of natural habitats and specific functions to duplicate – placement, orientation, depth). These three aspects are fundamental, with biophysical and cartographical data enabling the identification of suitable installation sites (species depth, trophic inputs, presence of coastal shelter, etc.); management techniques, when effectively used, enable the management of fishing intensity with regard to reefs in order to ensure optimal efficiency and sustainability of stock. Finally, data related to the design and placement of AHs on the seabed ensure habitation objectives and ecological functions with regard to targeting species (ethology) are realised (box no. 2).

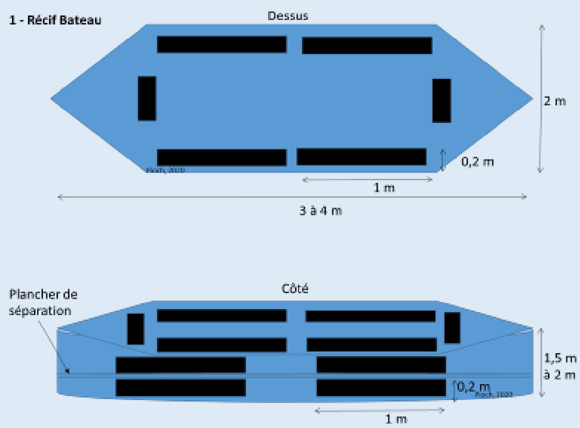
Box no. 2 – Different types of artificial habitats recommended for fishery in Haiti

Based on a dozen designs made with the help of fishers (notably professional underwater fishers) and field data gathered, four original designs were created within the framework of this assessment with regard to species targeted but also locally available material and know-how: the Boat reef, the Lobster reef, the Random cluster, and the Joint reef (IV.3).

Boat reef, proposal for an adapted habitat *for adult lobsters, yellowtail snapper, snapper (red and silver), sardines and kwokwo. Depth from 10 to 40 m.*

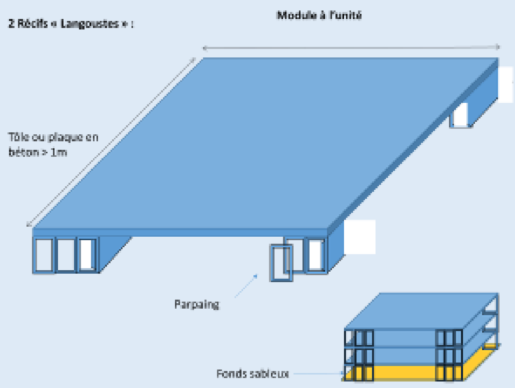
Boat type artificial reef; top: view from below, bottom: view from the side with separation planks indicated.

The advantage of this AH is that it makes for easy ocean placement due to its boat-like form, i.e. a floating structure which can be towed and, at the right location, submerged along the waterway.



Lobster reef*, depth 11 to 25 m.*

These modules are made of simple sheet plates, concrete slabs or tied and weighted bamboo, placed on 4 bricks or cinder blocks, based on the principle of "Casitas" used for more than thirty years by Cuban and Caribbean fishers



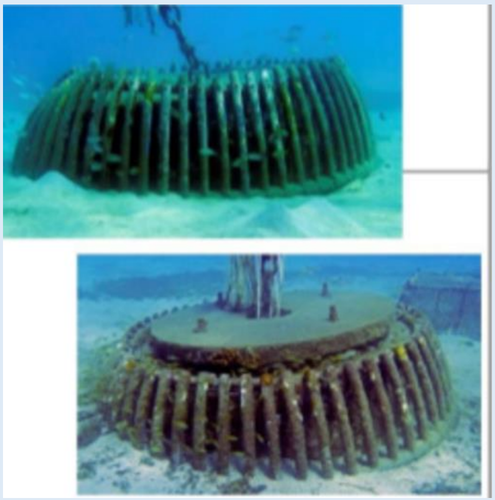
***Random cluster**, for juveniles on hard coral surfaces, from 7 m to 12 m deep.*

Blocks of debris from construction sites, collected and washed before submergence (concrete, rock, steel, sheet metal). Volume of the heap: 10 to 20 m3, i.e. 12 to 24 t. The height is between 1 and 2 m, and the length between 7 to 9 m (two surface buoys ensure the site is marked out). The reduced size of the blocks enables their transportation to the site by the fishers, day after day.

© M. Foulquié.

Joint reef

Targets lobster and juveniles of particular species at a depth of 7 m to 20 m. This AH constitutes a synthesis between the Lobster reef and the Random cluster, modules thus aimed at two objectives. It is designed to be resistant to cyclone-induced swells (> 17 m based on testing conducted in Guadeloupe) as well as for durability in excess of 50 years.



"Joint" reefs lobster and juveniles (photos: C. Bouchon, 2018).

In order to confirm these data, four field investigations comprising 147 interviews with local fishers regarding boats, diving into exploited natural habitats and behavioural knowledge about targeted species were conducted in 2018 and 2019 in the Sud and Sud-Est departments (IV.3). The principle of artificial reefs (AR) having been well-received by the local fishers, the HA design was implemented (box no. 2) and three priority sites selected, one in the Aquin bay, another in the Jacmel bay (the town having the advantage of being linked to the Port-au-Prince market by a regularly-traversed bus route), and a third between the small island of Kaialo and the coast, demonstrating a significant potential for lobster harvesting (figure 21).

Figure 21
Map of the 3 priority sites for the submergence of pilot artificial habitats, identified through multicriteria analysis and field investigations among the local fishers.
Pioch, Hardy, 2020

One site is particularly interesting for the placement of an artificial habitat, namely Aquin bay in the perimeter located between Lozandier and Grosse Cayes, in the perimeter of the future “Aquin bay” marine protected zone (figure 22).

Exemple of natural habitat attractive to targeted species, made up of a typical coral cluster (a coral “potato”, hollowed out) viewed from the side and on top H = 2 to 3 m, diam. = 2 m.

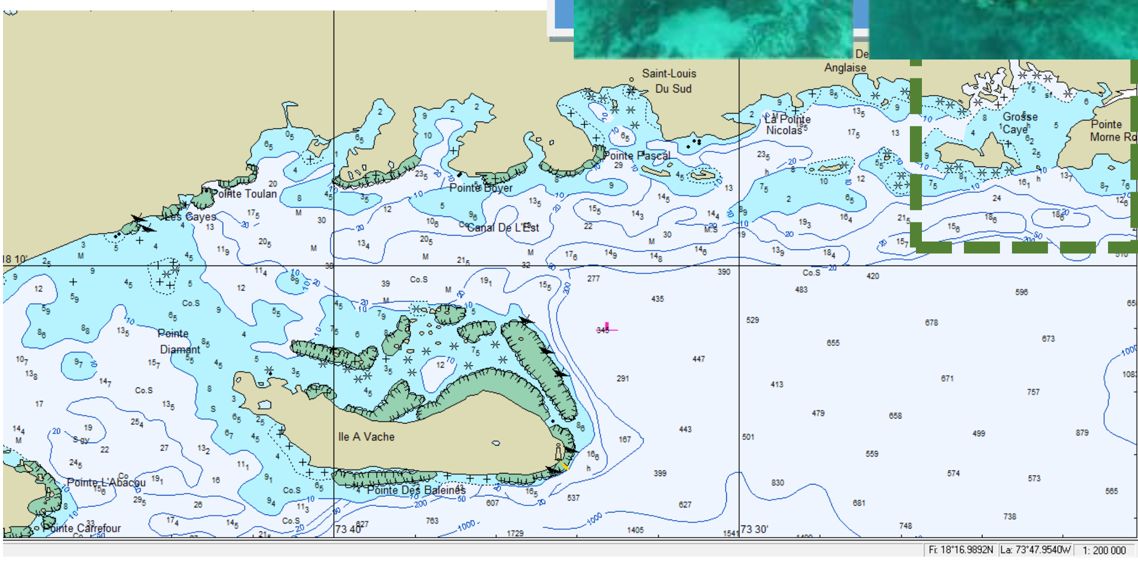


Figure 22
Priority submergence site recommended for the fisheries artificial habitat project in the MPA “Aquin bay” – due to access and set-up facility, as well as socio-ecology contexts
Source: Pioch, Hardy, 2020

Coral reefs are rare here, and mainly made up of large blocks (of the Montastrea or Orbicella type). Some of the natural habitats form out of coral spikes (commonly known as coral “potatoes” of 2 to 3 metres, of which the most extensively colonised are located on sandy sea beds and exposed to strong currents resulting in uniquely hollowed-out features (both in terms of height and depth). Artificial habitats of the “boat” and “joint” types mimic the natural habitats used by targeted species (snapper, groupers, grunts, jacks or king mackerel), whereas the lobster reefs are more aimed at lobster and the random cluster are aimed at the same species, only at a young stage. This site serves as a testing ground for fishers and their associations via participative cartographic tools (IV.3). It should be noted that the area closest to the village in terms of access through paddling corresponds to the identified site, which mirrors the disposition of coastal zones targeted by the fishers, making it easier for them to operate here given the means at their disposal (small open boats, paddles, sail, small motors, unsafe conditions).

Fishers are unanimous in favouring submergence of artificial habitats, albeit with some concerns: what is the depth of submergence sufficient for avoiding risks to navigation (i.e. running aground)? Can artificial habitats be used as attractors with a lamparo (acetylene lamp)? Can the installation be reversed? What is the volume caught and the distance to travel compared to the natural reefs in relation to the coast? Based on their responses to these very valid questions, the fishers contributed to the creation of an organisational plan for the submergence site, with each type of artificial habitat distributed across the selected area (figure 23).

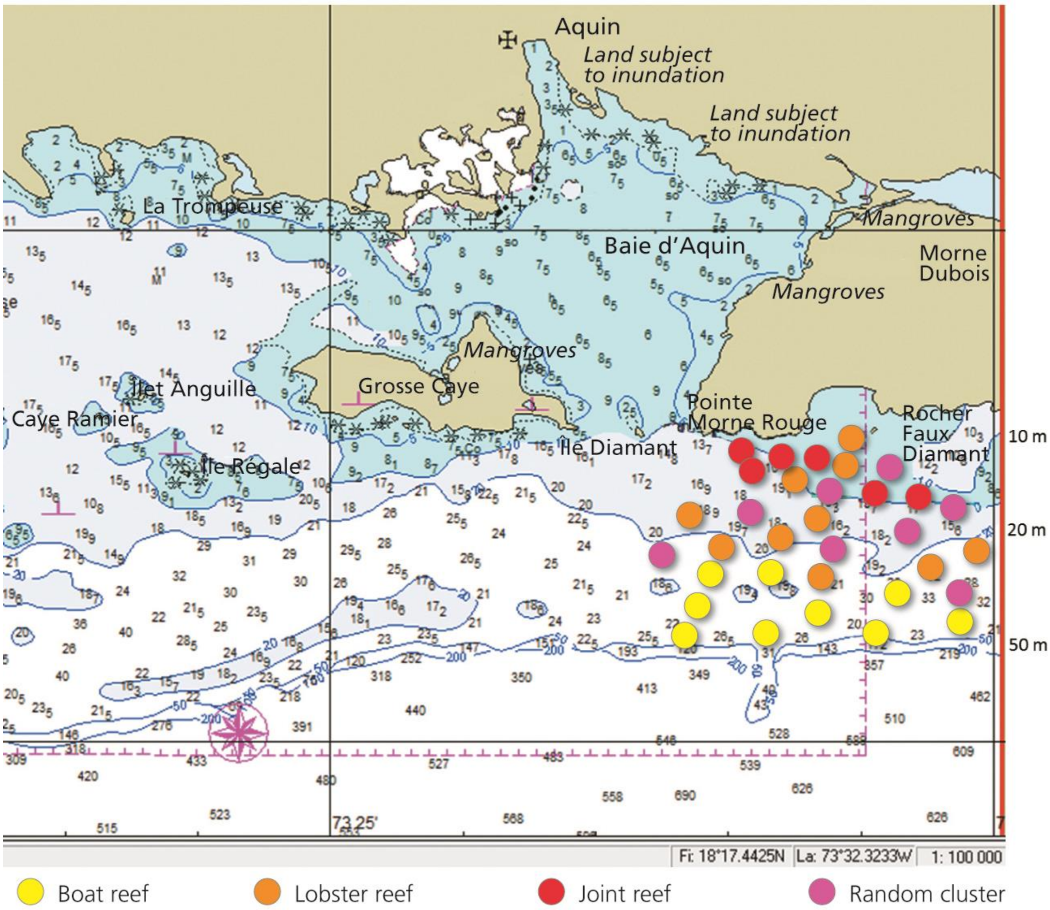


Figure 23
Location plan for the artificial habitats according to type (each module represented by an icon; the ovals represent the Random clusters) at the Aquin bay pilot site.
Source: Pioch, Hardy, 2020

Provided there is adequate management and a reorganisation of the commercial system involved (part III) for the 200 fishers concerned, 10 000 m^3 of submerged artificial reef could result in a fishery production of 200 to 250 tonnes per year. If one considers that a healthy reef produces around 35 tonnes of fishery biomass[35] per km^2, these 10 000 m^3 of submerged artificial reef could demonstrate a fishery production total equivalent to a coral reef surface area of 5.5 to 7 km^2. With the durability of the concrete used estimated at 50 years, a project such as this one could enable the production of 10 000 to 12 500 tonnes of fish, exploited via local fishing vessels (paddle, sail or small motorboats) and techniques both well-known and accessible (hooks, traps).

This pilot operation promises that, within the context of a participative government, the fishers would themselves participate effectively in the creation of a network of artificial habitats and that they will also take care of it – particularly if the network proves successful – both from a resources point of view as from an ecosystemic one. The network could be even more effective in the long term if it is linked to one or more MPA. Provided that the pilot experiment yields positive results, all that will be necessary is to add more sites within the framework of a national programme. The experiment is currently set to run over three years in partnership with the IDB and local organisations (MPA, fishers, reef manufacturing companies). It will enable an understanding of the conditions required for replication and the development of a national programme for the construction and utilisation of the most efficient (i.e. most cost-effective) artificial habitats having as objective, at first, one site per fishing ground (figure 16), followed by one in each large fishing community in each area.

B/ Ecological restoration and the creation of territories, Marine Protected Areas (MPAs)

Similarly to artificial reefs, MPAs have as primary objective the restoration of degraded habitats and the marine populations inhabiting them. Defined by the International Union for Conservation of Nature (IUCN) as *"a geographic area which is clearly defined, recognised, specialised and managed by legal- or other effective means, aimed at ensuring the long term conservation of nature, the ecosystemic functions and the cultural values associated with it"*, MPAs are legal territories enclosing a particular area in zones governed by rules which limit access to them as well as their utilisation, even prohibiting these in cases of sanctuary spaces. These zones are operated according to a management plan adapted to the MPA's own operation. The purpose of these areas is not to create a new ecosystem *ex nihilo*, but rather to put an end to, or to reduce, the anthropic pressures placed on the marine ecosystem in order to allow it to return to its former productivity once the full restoration of the habitat has been achieved. Ecological intensification is thus a product of the ecological restoration.

For more than twenty years the FAO has been promoting responsible/sustainable fishing so as to maximise the economic and social utility of such advantages as are afforded us by nature, all the while reducing as much as possible the impact fishing has

[35] This value is far from being exaggerated. Thus on Mayotte the fishery biomass is estimated at 90 t/km^2 (Wickel *et al*., 2006). On the unspoilt coral reefs of the eastern Indian Ocean it could increase to 120 t/km^2 (Trégarot *et al*., 2020).

on ecosystems. In this regard the management of fishery by prohibition of regulation applied to legally-classified areas reserved for fishing or MPAs has become an ever more common practice. As a result, some ancestral practices have been rediscovered. Indeed, restricting access to fishing zones is one of the oldest forms of management known to man. It is still used in the Indo-Pacific region and over the past twenty/thirty years has seen a renewed interest in the form of locally-managed seascapes (Locally Managed Marine Areas or LMMA[36]). First created in the Pacific, the LMMA network has now also reached the Indian Ocean and is beginning to spread across the Caribbean as well, preferred by numerous NGOs seeking to engage in the protection of biodiversity and the local management of natural resources. The Territorial Use Rights in Fisheries (or TURF) stems from a related philosophical outlook. Fishing is no longer conceived of as an activity regulated by the rule of free access, but instead as a territorial activity. The national plan for the development of fishery established by the MARNDR in 2010 proposes communal directives as an instrument for enabling the decentralisation of decision-making related to fishery. In this regard it contains the notion of territorial control over access to the resource via the drawing up of decrees allowing for the regulation of access to communal waters by a community's legal authority. The implementation of this approach remains a challenge however. An analysis of the causes of obstacles to implementation, combined with a comparative study of other countries in similar contexts, would be instructive.

In Haiti, MPAs are recent creations. It was only in 2013, following the creation of the National Protected Areas Agency (ANAP) by the authority of the Ministry of Environment (MDE in French) that the first MPAs were put in place. Currently numbering nine in total, seven of these are situated in the south of the country, and the remaining two on the coast of Grande Anse. At the end of 2013 a large protected area comprising the Caracol bay, the Fort Liberté bay and the Limonade bay was created in the country's north, and named the Trois Baies national park *(Parc national des Trois Baies)* (figure 24).

[36] See the site https://lmmanetwork.org/

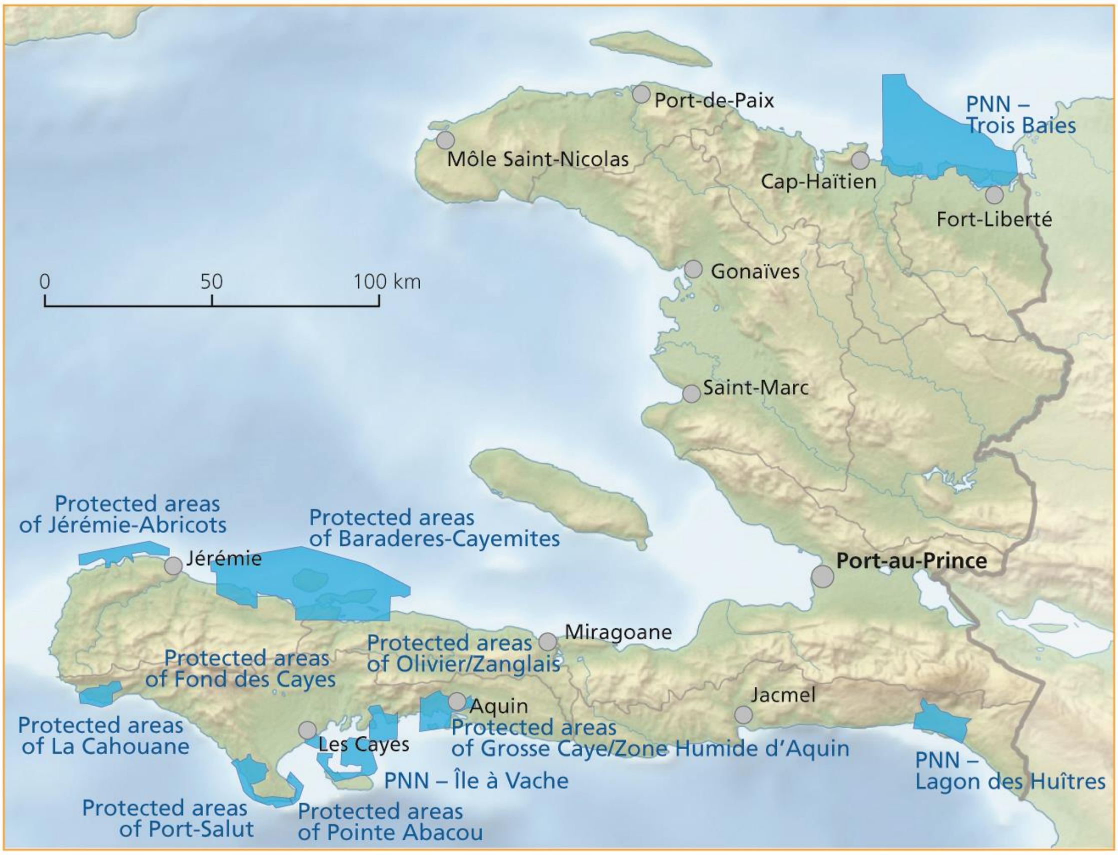


Figure 24
Location of the protected marine- and coastal areas in 2018 (in blue).
Source: UNDP – according to Anap, 2018.

While at an international level the MPAs are now considered as an instrument of fisheries management (Gascuel, 2019), those created specifically for regulating fishing are rare. However, by prohibiting any kind of destructive fishing within their borders, the MPAs have had an immediate effect on overfishing. As soon as fishing effort is reduced, a noticeable revivification of fish populations takes place, as does an increase in the number of adults, i.e. the number of reproductive entities. In the midterm, trophic chains are repaired, leading to the first consequences of an adult overpopulation: there not being enough food available within the MPA, predators start emigrating, a phenomenon known as *the spillover effect*. As the number of reproductive entities increases, so too does the number of larvae and juveniles carried outside the MPA by the ocean currents, and that quite significantly. These biological effects, effectively creating a reserve of fish stock outside the MPA, are all the more important given the limited nature of fishing effort on the inside. The same effects manifest in maximal form inside sanctuary zones (figure 25).

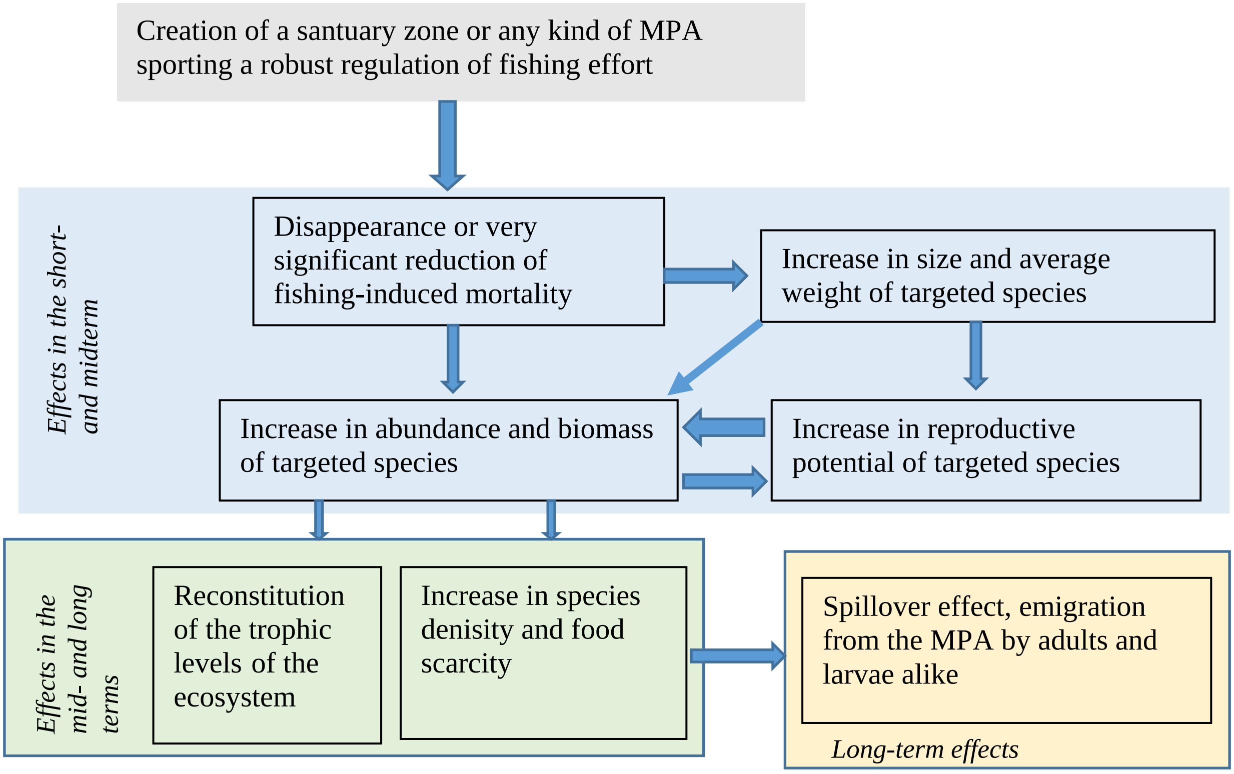


Figure 25
The effects of reserve creation from a biological and ecological perspective.

While the primary objective of all MPAs is conservation, this is dependent on two other parameters of sustainability: social acceptance and funding (figure 26). The creation of an MPA implies the implementation of specific means: informing and training the coastal population and academics, the activation of surveillance boats, regular diving expeditions to monitor the revivification of the ecosystem and the state of its health, co-management of these zones by the local populations serving as partners in – and even co-owners of – the endeavour. Monitoring of this type is all the more effective and cheaper since it is carried out by the fishers themselves (box no. 3).

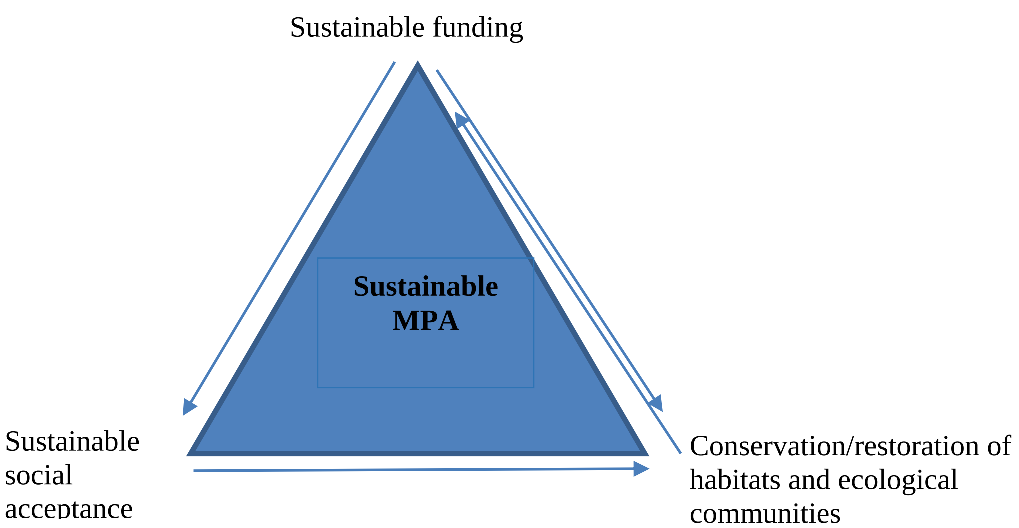


Figure 26
The three conditions necessary for the sustainability of an MPA.

Maintaining an adequate level of acceptance of an MPA by the fishers is a difficult task. In the short term they will be losing a part of their former fishing territory and thus a part of their earning potential, without the decrease in fishing productivity being offset by an increase in the price of fish. The more their fishing territory shrinks, the less will be their willingness to accept the MPA.

An MPA destined to function solely as a sanctuary will only have positive effects for fishing after, at best, ten years or more, i.e. a length of time likely to induce only a low level of social acceptance. In order to transform into a useful instrument of fisheries management more rapidly, the MPA has to combine a sanctuary zone with fishing zones of sufficient size to ensure the economic viability of the coastal populations who would be granted conditional access to them and would also be involved in the co-management of their resources. This type of conditional access constitutes one of the biggest advantages posed by an MPA insofar as it opposes the usual free access to territorial waters granted to all Haitian nationals, this being a reason for overfishing and the impoverishment of local fishing populations. Exclusive access to fishery exploitation would lead the latter to consider fishing stock as natural capital and a heritage to be transmitted to their children.

Ecological engineering should serve in support of the creation of MPAs by providing artificial habitats which would optimise the spatial diffusion of the spillover effect for neighbouring stretches of water and thus improve the chances of social acceptance of the MPAs by the fishers. From the moment of their being put in place, the HAs would in effect enable several species targeted for fishing to shelter within them, and the more a HA becomes covered with coral and larvae, the more it can act as a facilitating factor in concentrating fish in one location; thus it would enable fishers to increase their production, particularly where they have exclusive rights to the use and management of the marine populations thus concentrated. Placing a HA near an MPA should therefore be presented to the fishers as a means of, on the one hand, enabling them to partly make up for the reduction in their fishing effort imposed on them as a result of the creation of the MPA and, on the other hand, as an opportunity to enjoy full use and management of a new fishing territory holding much productive potential likely to increase over time.

C/ Clustering of fishing resources off the coast: designated FADs

The use of Fish Aggregating Devices (FAD) appeared across the whole of the Caribbean at the end of the 1980s (Reynal *et al.*, 2000). At the international symposium held in 1999 at Trois-Îlets in Martinique it was presented as a support to sustainable development in the Caribbean (Le Gall et al. 2000) and was the subject of a FAO/COPACO working group, of projects (Dauphin, Magdelesa[37], Carifico[38]) within the framework of which regional workshops were organised[39], and of a workshop

[37] https://www.magdelesa.eu
[38] http://www.crfm.int/index.php?q=carifico+project&option=com_finder&view=search&Itemid=186
[39] CRFM, 2013. Report of the CRFM - JICA CARIFICO / WECAFC - IFREMER MAGDELESA Workshop on FAD Fishery Management, 09 - 11 December 2013, St. Vincent and the Grenadines. CRFM Technical & Advisory Document, No. 2013 / 9. 42p.

dedicated to the production of manuals of best practice held in 2015 in Saint-Vincent-et-les-Grenadines (CFRM, 2015).

In Haiti, the attraction exercised by floating clusters of matter on fishery resources has led fishers to construct, through their own handcraft, FADs from plant matter and discarded materials held underwater via nets, ropes, boxes. Floating moorings made from coconut leaves, covering about 10 m^2 is the oldest instrument aimed at clustering fish used by fishers (in use for some forty years). However, these days they tend to use a method of attracting fish consisting of floats made from bottles, from traps floating between two currents and from immobile traps anchored to the seabed by a rock or a piece of metal such as a car engine. This method enables catching small pelagic fish used as bait. The use of homemade FADs has lead to a progressive redeployment of fishing effort aimed at large pelagic species in the open sea, at depths of more than 100 m all the way to 1000 m or even 2000 m in zones furthest removed from the shore. At these depths the homemade FADs are replaced by modern FADs made according to designs widely disseminated internationally by the FAO (Ben Yami *et al.*, 1990) or regional organisations such as the southern Pacific Community (Gates *et al.*, 1996). Anchored FADs enable the capture of large pelagic fish, and notably migratory species such as tuna, king mackerel, dolphinfish…

Since 2003, at the instigation of the government as well as international agencies such as the IDB or FAO, and especially those representing Spanish-Haitian cooperation, the installation of FADs has been done in the open sea off the coast of the Sud-Est department. At the beginning of 2008, the placement of 24 FADs – three per community – was planned, but without the fishers having been prepared to manage the equipment and to exploit the resources in a collective manner. As a result, the time necessary to prepare the fishers's associations to develop FAD-based fishing and to join together towards operationalisation led to the installation of the FAD only taking place in 2011. Thus it was only from that year that this mode of fishing started developing in a significant way, and that following an initiative to gather together all information required for the conception, fabrication and ocean placement of FADs (Gervain *et al.*, 2015).

Following training provided by the government and a number of NGOs, the "metal drum technique" became commonly implemented. This technique consists of the use of metal drums attached to a drifting vertical line of 80 to 200 m employed to catch large fish at depth (yellow tuna and marlin in particular). The hook, generally used singly, is baited with small, live tuna fish called "bonites" (*Katsuwonus pelamis, Thunnus alalunga*). Up to a dozen metal drums can be fixed around a FAD at the same time, and monitored by one or two teams of fishers (figure 27).

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http://www.crfm.int/images/Report%20of%20FAD%20Mgmt%20Workshop%20(final%20version)%203%20Feb%202014.pdf

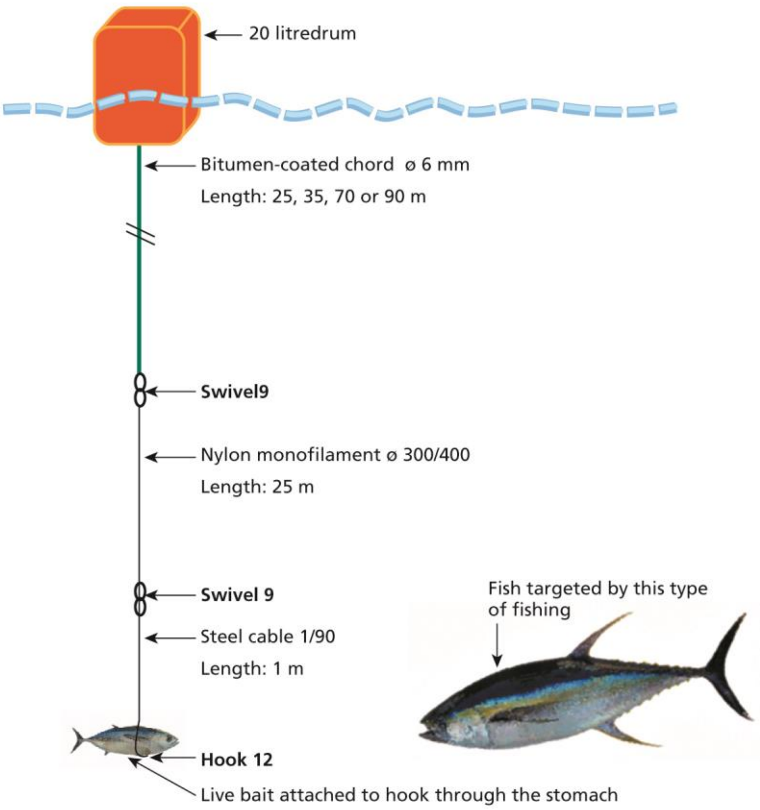


Figure 27
Metal drum fishing around anchored FADs.
Source: based on AECID, Haïti.

Chardonnières is the Haitian township best equipped with regard to FADs. The percentage of excursions using FADs has reached around 60%. Two associations are responsible for this: the Chardonnières fishers's association (APEC in French), created in 2002 and boasting 173 members of which 60 professional fishers, 13 non-professionals and 100 female traders; the Group of organised fishers of Chardonnières (RPOC in French) created in 2009 and comprising 48 members, all professional fishers. At Bainet the fishers are united into a federation named the Communal union of fisher's associations of Bainet (UCAPEB in French). They have been provided with fibreglass boats with outboard motors and sea rescue equipment by the MARNDR, Food for the Poor, the FAO… The FAD fishers of Chardonnières catch an average of 10 550 pounds of fish per year (about 5 tonnes) at a commercial value of about 357 046 gourds (between 4 800 and 5 000 euros). As a comparison, one may consider that the town's other fishers catch an average of 4 594 pounds of fish (2.25 tonnes) corresponding to an income of 247 037 gourdes (3 000 to 3 500 euros). However, even though FAD fishing can provide increased revenue, it remains limited by the rather arbitrary nature of its productivity (though less so than drag fishing) and by the far-flung location of fishing areas; any unproductive excursion has a negative effect on the operating budget of the fishers involved. The introduction of FADs along with motorisation (according to the ports, 92% to 100% of FAD-related excursions are made using motorised boats) has therefore only barely reduced pressure on coastal zones, but instead has merely enabled the exploitation of resources formerly little taken advantage of, or not at all (such as yellowfin tuna and blue marlin) by making them more accessible to the small, deckless boats making up the bulk of the region's small-scale fishing fleet – provided distances to cover are not too great.

The fishers train themselves and little by little modify their practices in order to streamline them. They band together and try to face up to the challenges posed by modernisation, adopting co-management strategies for fishing areas and taking responsibility for their territories. However, such aid as are provided to them is usually not sufficiently broad, or often significant obstacles end up "breaking the chain", such as due to the absence of naval shipyards for constructing suitable boats, the absence of regulations to ensure the fishers's safety, the absence of clearly-established maritime routes – which increases the risk of FADs being destroyed by passing commercial vessels. Fishing boats used are still too fragile; the majority do not conform to international maritime safety standards; they are devoid of decking, nor do they provide shelter for the fishers, and all are too small for travelling outside of territorial waters; weak engines mean the time required to reach FADs is increased, thus leaving less time for fishing once there… All of these obstacles should be taken into account, and locally-identified means of finding solutions in order to manage access should make up a key part of any learned lessons shared. It is essential to ensure that knowledge acquired by different groups of fishers be disseminated and capitalised upon so that both knowledge and know-how regarding FADs in Haiti can be further developed, and that small-scale fishing of large pelagic species can become one of the primary pillars of fisheries development in Haiti.

3. Fisheries management

At the national level the government is the only institution which can pass legislation, ensure compliance with it on national territory and decide whether to implement, or not, such constraints as it may impose at an international level. At the local level it is expected of fishers to exploit the country's territorial waters so as to contribute to its food security and its international trade, all while operating within the boundaries of national legislation. In this regard a weak institutional and legal context is often cited as one of the major problems faced by maritime fishing in Haiti (MARNDR, 2010). Despite this argument being made for many years now, the problem remains largely unaddressed. The socio-political context has barely evolved in any kind of positive way, and the decree of 27 October 1978 regulating the exercise of fishing rights in Haiti has been rendered largely obsolete (Samb, 1999; Damais *et al*., 2007). Of course it is not within the scope of this assessment to rewrite fisheries legislation, and in fact the shortcomings of the October 1978 decree is only part of the problem given that the implementation of all national legislation suffers from a three-fold constraint: firstly, the lack of human resources and required funding; secondly, the country's socio-economic and political difficulties which can have a paralyzing effect on the State's functioning; thirdly, social acceptance of regulations, something which is subject to significant influence by the first two conditions.

In order for fishing activity to be sustainable, ensuring the respect of governing regulations is a necessary, albeit not sufficient, condition for management – defined as the totality of *"decision-making processes, regulation of practices in terms of actions and interventions in a territory, and the implementation of public policy"* (Barrière, 2005). It is also necessary to monitor the exploitation of fishery resources, i.e. regularly to gather data related to fishing effort exercised on fishing stock and the production resulting from it. Taking into account the wide dispersal of docking sites – 592 having been identified as part of a recent national fisheries survey (figure 17) – such monitoring would only be possible where the institutional organisation of the public service is such as to allow for it. We will therefore be focusing on this latter requirement before discussing the putting in place of a fisheries information system at a national level.

A/ Institutions in charge of fisheries management

Fishing falls under the authority of the MARNDR and its Directorate of Fishing and Aquaculture (DPAQ), which oversees the fishery sector. It fulfils a dual function. On the one hand, it plans the development of fishery – it is within this context that a national fisheries survey was conducted in 2018, 2019 and 2020 in order to perfect and contextualise geographically knowledge about small-scale fishing practiced mostly within the informal sector – and on the other hand it functions as primary contact point for NGOs, service providers, fundraisers and international organisations seeking to engage with the fishing sector. Their approach is often very big picture-orientated, but it does have local effect. Thus, for a dozen years now the MARNDR has successfully supported the creation of fishers's associations in the south of the country by providing them with the means of engaging in deep-sea fishing. As a result it has earned real trust from the fishers belonging to these associations, as well as creating positive publicity for itself from unaffiliated fishers.

The Haitian maritime and navigation service (SEMANAH in French) is an autonomous public organ operating under the auspices of the transportation ministry and tasked with monitoring ocean faring traffic. Its activities do not include monitoring of traditional fishing boats, these being too small.

This assessment has demonstrated the value of MPAs as instrument for fisheries management, as a result of which we call on the National Protected Areas Agency (ANAP) – renamed the Directorate-General of the Ministry of Environment in May 2017, to take its place as major role-player in Haitian fisheries policy, notably in order to optimise the connectivity between protected coral reefs and future artificial habitats. The ANAP has extended recognition of the three sites identified for the placement of artificial reefs (photo 8 and figure 21) – i.e. that of the Aquin-Saint-Louis bay and that of the coast between Jacmel and Belle-Anse – as priority zones and could provide essential and complementary data to those already in the possession of the MARNDR (regarding hatchery zones, nursery zones, etc.). An MPA comprising a site for the placement of artificial habitats is planned between Aquin and Saint-Louis by the ANAP, which is hoping to integrate into its operational plan a collective management arrangement closely involving the participation of local fishers. They would have free access to the MPA on condition they accept the terms and conditions of a "good behaviour" charter drawn up around four commitments: (1) no poaching; (2) no nets covering artificial habitats; (3) no fishing for juvenile fish, and (4) respect for the biological "rest period" of fish species.

The government is also the guarantor of the respect of international regulations (see part III). The MARNDR monitors the exportation of all ocean products requiring authorisation (Damais *et al*., 2007). It is also responsible for the implementation of its agreements. Thus there are texts to which the MARNDR and the Ministry of Environment (MDE) are signatories and engaged parties, among them the Convention on Biological Diversity (CBD) signed in 1992 by Haiti and ratified four years later. With this signature the Haitian state committed itself to follow the 2011-2020 CBD strategic plan, known as the Aïchi objectives. Four of these objectives relate directly to small-scale fishing in Haiti. Objective B6 deals with the sustainable management of aquatic stock; objective B10 is aimed at ensuring the reduction of anthropic pressure on ecosystems rendered fragile as a result of global warming and the increase in ocean acidity, notably around coral reefs; objective C11 aims at converting 10% of the EEZ's surface into MPAs by the end of 2020 (it is likely that the next CBD strategic plan will set this target at 20%, even 30% by 2030); objective E19 has as ambition the gathering together of knowledge on biodiversity from scientific databases. Within this context the MDE publishes periodic reports on the state of biodiversity, on results obtained from measures instituted to preserve, improve and restore it, and which present new actions undertaken to this end (MDE, 2016; MDE, 2019). It should be emphasised that even in cases where it is not a formal signatory, in a number of instances it remains obligated to respect certain international agreements, such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) within the framework of its regular relations with other countries in the region. Thus it is no longer allowed to engage in trade with protected and at-risk species listed on the IUCN's red list with states which are signatories to the CITES.

The agricultural departmental directorates (DDA) represent the extension of the MARNDR's central services across the territory. They operate under the direct authority of the director-general of the MARNDR, whose primary responsibility is the coordination of administrative activities. Two services within the MARNDR share responsibility for the fishery sector: that of Natural Resources and that of Animal Production. The role of these services is to coordinate activities undertaken in the field closest to the role-players involved. As a general rule, these services are staffed by personnel better acquainted with agriculture than fishery, and it is often remarked that there is a lack of coordination between ministries and technical services. Thus these agencies appear very centralised and as not having enough contact with the realities on the ground. Sometimes fishers are not even aware of their existence, and sometimes they encounter conflicts between them. Better coordination or even integration of maritime- and coastal policy is sought: internal coordination between services, but also external coordination with the ministries responsible for actions on the ground which could impact fishery,

B/ Local management structures and intermediary institutions

While small-scale fishing benefits from operating within a solid national legal framework, it can only be properly managed (e.g. with regard to regulation of activity) through the putting in place of management structures or management oversight at a local level. The aim should be to create closer relations between the public services and the fishers so as to enable the latter better to understand such regulations as are promulgated within their areas in order to manage fishing effort. Ideally a true co-management model involving the partners would be the best way of deciding on regulations together and, as a result, would promote social acceptance of such regulations. MPAs and exclusive fishing areas (TURF), which could be linked to the installation of artificial habitats would provide a suitable legal framework for testing such co-management agreements (box no. 3).

Box no 3: Co-management of fishery

Mostly developed since the 1980s, the co-management of fishery consists of a negotiated and accepted sharing of responsibilities with regard to the management of fishery resources (Jentoft, 1989 ; Berkes *et al*, 2001 ; Berkes, 2009 ; Weigel and de Montbrison, 2013). Thus it is power sharing between public services and a group of fishers (Feeny *et al.*, 1990) which can even go as far as the State or a government agency delegating part of its prerogatives regarding the management of fishery stock to the fishers, who then become both de facto users and managers of the resource.

Co-management involves a number of different role-players: the fishers and other professionals involved in fishery activities, administrative bodies (national, regional, local), researchers and civil society (associations, local decision-makers…). These are subject to evolution over time and are often the result of a societal learning process taking place over a number of successive iterations. And as for the development path followed, the motivations, concrete modalities and stakes involved in co-management are also unique to each situation, context, etc. In order to avoid missteps, it is therefore essential that any co-management agreement spells out clearly the decision-making powers of each of the participating parties, as well as the responsibilities they will be undertaking. It is also necessary to ensure that the scope of fishery activities to be co-managed is not too extensive, that the negotiation process between the parties not be limited to too short a timeframe and that the fishers are adequately supervised in their implementation of the co-management agreement (Weigel et de Montbrison, 2013).

In actuality co-management can take various forms between the two extremes of centralised governmental management on the one hand and community management on the other. Between these two forms lies a continuum made up of seven co-management levels: informative (the community is only kept informed of initiatives undertaken), consultative (the community is consulted), cooperative (the community has some limited input into the management process), communicative (based on mutual exchange, the concerns of the community are taken into account), advice-based (the community advises the government), partnership (decisions are made jointly), and under community control (the community exercises power delegated to it and keeps the government informed of its decisions) (Sen and Nielsen, 1996; Berkes et al, 2001).

Of these seven levels the most effective are those involving the fishers in an active way. Indeed, co-management is based on the hypothesis that the users of a particular resource would be as inclined to practice sustainable and responsible fishing and thus should be involved in the drawing up of management regulations rather than only having to implement directives handed down by a central administration not taking into account the stakes and the concerns they are meant to address. For the State, successful co-management of fishery creates more efficient management at a much lower cost than the use of a management model imposed "from on high". Among the value-additions to be had, the literature describes a number of advantages, notably conflict resolution, transparency of the decision-making process, greater acceptability of management activities, making fishing communities more responsible (Borrini-Feyerabend *et al*, 2004).

Currently, local management of fishery remains in a formative state and centred on fish production, even though the many professional fishers's- and fishmonger's associations could constitute a landscape favourable to the initiation of a policy aimed at creating local management structures. Supervision of fisheries development is mostly carried out by intermediary institutions (local or international NGOs and private service providers[40]). These institutions provide technical support to fishers, notably with regard to the construction and installation of FADs, and enable projects to implemented using public funds, and sometimes their own (e.g. the installation of FADs by the CPA-SA at the end of the 1990s) (Damais *et al*., 2007).

Increasing the number of fisher's associations at the community level was already one of the central ambitions of the national plan for the development of maritime fishing of 2010-2014 (MARNDR, 2015b) and this objective remains relevant. Initiated in 2000, the National association of Haitian fishers (ANPH in French) operates in 96 of the country's fishing communities; it collaborates closely with the National association of sea products merchants (ANAMPROM in French) of which the president is also a member of the steering committee of the ANPH. As a general rule, fishers's associations are diverse. Some aim at improving the socio-economic situation of their members – fishers and traders alike – while others seek improvement in fishery. Some of these associations, whether operating at community- or national level, unite fishers and merchants, whereas others include only fishers or merchants. They dispose of only modest means, their resources made up from membership dues, rental costs of fishing material (for those associations that own boats and fishing equipment) or income from a supply store. Some associations have been able to acquire motorboats within the context of fishery development programmes.

The community-based management of fishing excursions enables fishers to improve the conditions under which they practice their craft compared to their former situation operating as poor, small-scale fishers, all while reducing individual fishing effort, since some crews only go out a few days every month (table 3). This type of cooperative structure also provides participating fishers with timely assistance whenever a health-related problem should arise. Generally speaking, the field of activities engaged in by these fishers's associations is quite extensive. Some associations specialise in the creation and management of anchored FADs, or engine repairs, the upkeep of buildings and materials used for the conservation and storage of products. Others try to ensure the organisation of all fishing activity in a particular village, from the collection of levies to the sale of fish caught. In this regard they engage in the training of role-players in the field, in planning fishing excursions, in determining the number of people to participate in a given excursion, in drawing up a fishing registry (containing information on the

[40] NGOs such as the "Pêche Anse d'Hainault Irois" (PADI); Oxfam Quebec; Food for the Poor. Private foundations such as Aquasol Services, "Compagnie de pêche antillaise" (CPA-SA).

size of the catch resulting from excursions, income gained and expenses), in direct collecting of taxes on fish caught to be used for maintenance of FADs installed in the open sea.

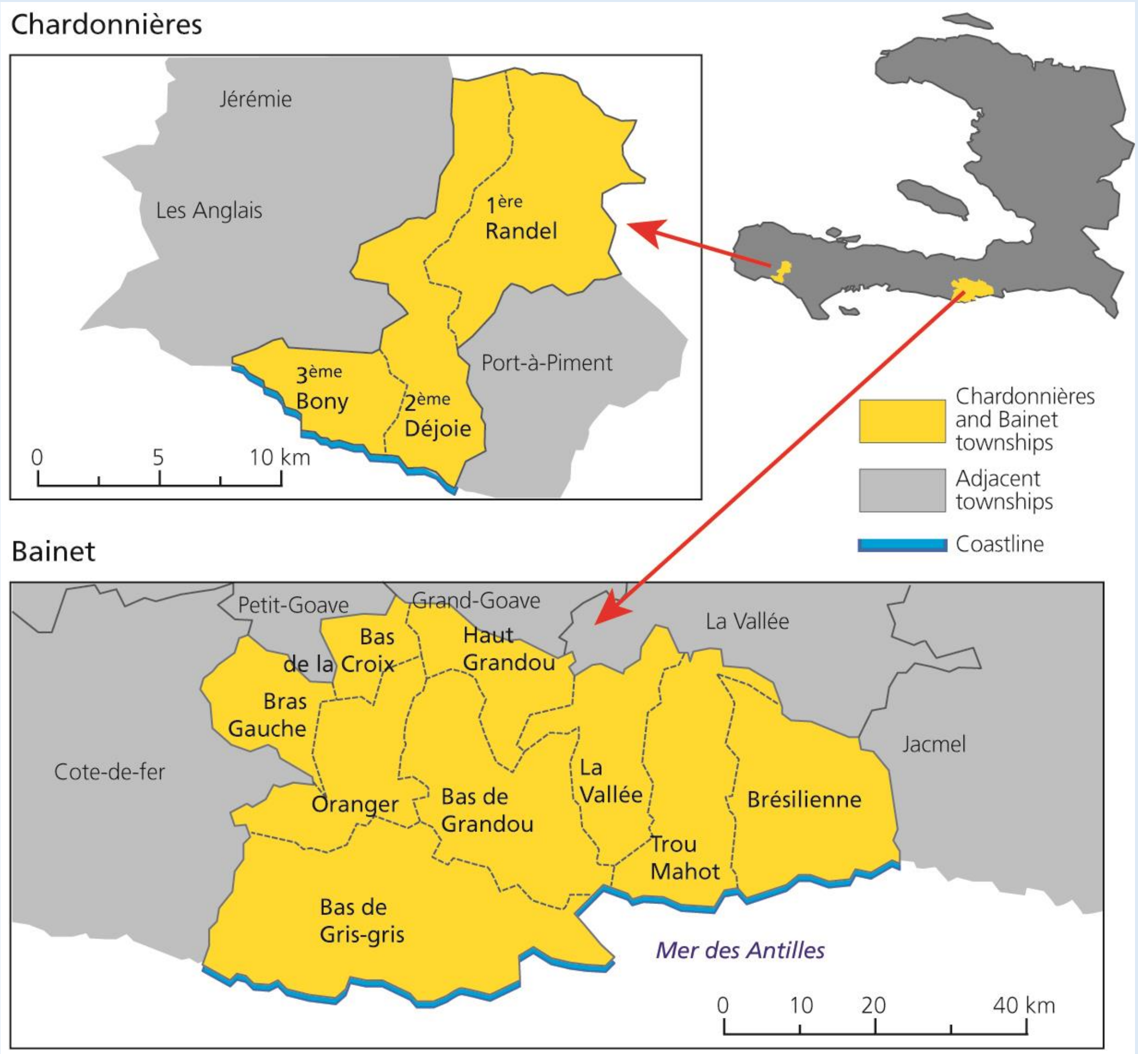
One should take note of such challenges to viability as are faced by these associations. The majority of them are created within the framework of international public support projects, of which the operation tends to unfold over too short a time period to meet the requirements for creating and stabilising such an organisation. The organisational construction of such associations from the ground up requires enough time to ensure their long-term existence and efficacy.

The existence of an associative structure (formal or informal) grouping together operators within the fishing sector has increased to include 44% of fishing boat docking points. In total, 262 associations were recorded as part of phase I of the national fisheries survey (Anon., 2018). Operating as part of an association is generally favoured by fishers, though it does not always prevent intra- and inter-association conflict in cases where fees for the use of FADs are not paid, where captains favour some groups of fishers belonging to an association over others, or in cases where the government supplies new equipment and sharing is difficult. Nonetheless, in all cases the members make an effort at resolving such tensions and conflicts, notably by facilitating loans of new equipment to fishers who do not have access to it. The creation of fishing cooperatives was regularly brought up during interviews conducted at Chardonnières and Bainet as a preferred option over fishers's associations: joining a commercial venture such as a cooperative is seen as a possible step towards rising out of a situation of needing assistance and moving towards a more entrepreneurial mode of operation. Still, the question as to the viability of these cooperative structures continues to be posed, notably following the termination of the fishery development projects having enabled their creation in the first place. Box no. 4 describes succinctly a case study on transformation in the fishing sector carried out in two townships, illustrating such adjustments as these communities have made in order to safeguard their fishing- and commercial activities, whether or not supported by outside agencies, as well as the hardships they currently face.

Box no. 4: Case study of the Chardonnières and Bainet areas (2018)

A targeted ethnographic profile was created for the south of the country, specifically at Chardonnières and Bainet, in order to describe fishers's preferred practices, to give an account of such values, knowledge and know-how as are locally employed to carry out their activities and to organise the management of the territories involved.

The township of Chardonnières is located in the Sud department of Haiti. It covers a surface area of 115.04 km^2 and includes a coastline of 12 km. Bainet, in the southeast of the territory, covers 3.25 times the surface area of Chardonnières, i.e. 300.88 km^2, and with 86 755 inhabitants has a population density of 288.6 inhabitants per km^2 (IHSI, 2015), being 1.3 times more than Chardonnières, which boasted a population of 25 240 in 2015.



Source : S. Jean Marie, based on data from CNIGS, projection Transverse Mercator ; reference system WGS 1984 UTM Zone 18N.

These townships are built on a part of the island base that is not greatly extended and sports steep underwater rises. Their geographic location imposes certain physical constraints, as well as major natural risk factors. Both are situated in the path of cyclones and being far removed from the capital with connecting roads being all but impassable, both qualify as isolated communities.

In these two townships twelve months of fieldwork, from 2018 to 2019, were required in order adequately to be able to describe its fishery activity and organisation, and more specifically to analyse the evolution of natural knowledge possessed by the fishers and the local and institutional management practices related to fishery. An initial collective exploratory inquiry was undertaken in September 2018. Between 12 December 2018 and 29 April 2019 a detailed ethnographic profile of the fishery milieu was created. In addition to observations made on land and ocean alike, and the conducting of many short interviews, 260 semi-guided interviews (130 in each village) each lasting between one and four hours were carried out in order to allow the fishers to express themselves as freely as possible on the subject of their reality and their view of the future of fishery in Haiti. The interviews were conducted with role-players in the world of Haitian fishery (decision-makers, scientists, public servants, NGO workers, representatives of communal fisher's unions, locally-based MARNDR contacts), as well as with role-players in the sector in their places of work (fishers, intermediaries, retailers, agents, labourers, wholesalers/exporters, etc.).

After having circumscribed the social and environmental context of the two townships in which observations and semi-guided interviews (with 63 men and 197 women) were carried out, the study made an account of the ecological knowledge of the fishers and of their accounts of such changes as fishery resources have undergone. Then local fishing practices were identified, as well as such recent modifications as fishers have been employing in order to adapt to a changing social, environmental and economic context. Finally, based on the differing values accorded to various species by the Haitians, as well as on their views regarding the protection of these resources, a study was made of how recent transformations affecting fishery activity in the region could feed into discussions related to the promulgation and implementation of public policy in fishery, which would integrate – among other things – the practiced skill sets of the Haitian fishers as daily participants in the island's fishing sector.

Other support services for fishery do exist, including the supply trade, shipyards, engine- or refrigeration reparation, training structures, credit providers, etc. Refrigeration, gasoline, fishing equipment and equipment for maintenance of same is in short supply. Generally speaking, access to refrigeration is limited and also expensive. A rare few freezers can be found in Port-au-Prince (belonging to private exporters, supermarkets…). A few freezers also exist in the provinces, belonging to exporters. Four or five trading houses based in Port-au-Prince import fishing material and equipment or outboard motors. These houses redistribute furnishings to hardware stores located in provincial capitals. Only small pieces of equipment such as nylon lines and hooks are sold on a small scale by traders at rural markets. Live bait can be bought locally from other fishers or else caught directly by the fishers themselves (Damais *et al*., 2007).

C/ Fisheries management and monitoring of exploitation

All rigorous fisheries management requires the monitoring of fishing activity and its impact on exploited populations. However, currently in Haiti information regarding fishing activity is obtained in irregular fashion and often relates to only part of the territory. This situation is all the more unfortunate given that pressure on resources is considerable, requiring management. Without fishing statistics or an evaluation of exploited or exploitable resources fishers at a local level experience the consequences of overfishing in the form of a perceived decrease in return for their efforts (in terms of kg caught per excursion), without this perception being confirmed as actually real at the level of the region or the country as a whole. They know that the likely overexploitation of coastal zones is done by Haitians themselves, and they would be willing to submit to the imposition of regulations on their activities if they could be persuaded of the effectiveness of the measures taken and by their good-faith application by other fishers in their area and in neighbouring zones. And the pressure from the necessity of economic survival experienced on a day-to-day basis by households should not be too great (Mérat, 2018). A system of fishery information (SIH in French), regularly updated with data on the state of exploited stock and fishing pressure imposed on it would enable fishers to obtain the necessary information in order better to recognise overfishing, all while allowing the MARNDR and its local partners to attempt putting in place a system of sustainable management of fishery resources.

Another reason for Haiti to put in place monitoring of its fisheries derives from the necessity of being in compliance, as member state of the FAO, with the requirements of the Code of Conduct for Responsible Fisheries (CCPR in French) (FAO-1995[41]). In and of itself this code only puts forth a number of principles, but it is based on the more stringent legal framework represented by the the United Nations Convention on the Law of the Sea (UNCLOS, 1982), to which Haiti became a signatory in 1996. This convention confers upon coastal states certain rights regarding the exploitation of their Exclusive Economic Zone (EEZ), while at the same time imposing certain obligations on them, notably regarding the management and monitoring of resources, including the commitment to provide statistical information to appropriate international organisations. These obligations are however difficult for developing countries to meet, given that some of them do not possess the capacity to put in place mechanisms for gathering such statistics by themselves. That is why the FAO has expanded upon its role as receiver and centralising agency of global fisheries data also to add a function as advisor and methodological support agency aiming at strengthening countries' capacity to gather statistical data, to provide them to international organisations in a standardised form and ultimately to analyse them within the framework of regularly-convened regional working groups for the evaluation of resources – in the case of the Caribbean organised under the auspices of the Western Central Atlantic Fisheries Commission (WECAFC/COPACO).

[41]"States are to ensure that current statistics on fishing effort and catches, being complete and reliable, are gathered and maintained in adherence to applicable international norms and practices, and ensure that they are sufficently detailed to enable viable statistical analysis. These data are to be updated regularly and verified according to a suitable system. States are required to gather and disseminate them (…)" (article 7.4.4 of the CCPR - FAO, 1995).

It is within the framework of this policy of aid to member states (and in particular to PeDs) that the FAO has, since the 1990s, developed a series of methodologies and instruments, which they have occasionally assisted in putting in place on the ground in the form of support projects. But an examination of the “methodological guidelines” and the instruments disseminated within this context by the FAO reveals significant contrasts. For example, some guides (Flewwelling, FAO-415 - 2003) propose bringing all monitoring into conformity with the standards adopted by the large Western fishery states, striving for the complete collection of all available data (Canada, New Zealand, France, etc.). Other guides (Stamatopoulos, FAO, 2002) more realistically take into account the specific circumstances of PeDs, in which small-scale fishing is dominant, and that in a wide variety of forms. Opting for the use of framework surveys or surveys conducted only every five years as pragmatic stop-gap measures in the absence of perpetually up-to-date lists (of boats or fishing licenses) is an example of this kind of realism.

However, the experts recognise that, in some instances, one can go ever further in facilitating the implementation of operational plans, e.g. by preferring to the regular collection of statistical data more temporally staggered surveys and the use of more indirect methods such as focus groups and testimony by relevant role-players: these are so-called *data poor* methods, already in use for a long time in the small island nations of the Pacific (Johannes, 2002). It is however doubtful that the use of these types of approaches, which do not really yield statistical indicators, will satisfy the requirement of the UNCLOS – though of course the propriety of these very requirements within the context of PEIs can equally be called into question.

The construction of a SIH in Haiti will require that a choice of methods be made following carefully scrutiny of the different options and levels of standards indicated above. In all cases a tailored approach would be preferable, taking into account the configuration of Haitian fishery and such capacity as is available.

The MARNDR has already engaged in the use of a tailored approach though its creation of a statistics unit (USAI in French) and initiating a national fishery survey which, for the first time ever, provides a complete overview at country level of the role-players in the fishery sector, of their means of production and their activities. The amount of data gathered is considerable and can be categorised according to four types, including data making up part of a monthly monitoring and data gathered for less regular updating: every three to five years (moderate frequency), such as regarding the number of fishers and boats; or every ten years (low frequency) such as regarding the names and locations of docking points.

A tailored approach is also required for the creation of the SIH. Because of the limited number of available surveyors, only a small number of sites can be regularly sampled. Three types of data are to be gathered: a) fishing effort and catch size; b) variations within the sector and in relation to prices in response to hauls; c) the efficiency of fishers and their capacity to produce boats and fishing equipment. Should a local fisheries management system be put in place, notably around institutional arrangements with the fishers regarding MPAs/artificial habitats, it would be essential to take advantage of this opportunity to try and induce the fishers to report directly on their own activities. Reporting systems involving fishing logbooks or questionnaires to be completed following each excursion are usually viewed unfavourably, but the widespread use of cell phones presents significant opportunities to engage the fishers in the gathering of fisheries data. Experiments to this end are increasing in many areas where small-scale fishing is practiced, including in Madagascar for the monitoring of shark activity (Jeffers *et al.*, 2019), in the Solomon Islands, Tuvalu or Vanuatu. Haiti could derive much benefit from these experiments.

The participation of fishers in the monitoring of fishing activity could represent an essential stage of their involvement in local management structures. This involvement will not be easy to orchestrate and will require significant effort on the part of the public service institutions and scientists in transferring fisheries information to fishers's associations and in providing them with the means of understanding it. Presented in intelligible fashion and transmitted to the fishers, this information would aid in management efforts, notably in ensuring the *protection of functional zones important to the practice of fishery* (part I) by applying *the primary directives* to monitored areas, i.e. with regards to the prohibition of fishing in certain places (spawning grounds and nurseries) or during certain times of the year, regarding the minimum size of mesh to be used in netting, and which types of fishing equipment are authorised for use.

Beyond their essentially-local operation, monitoring activities should also be part of an arrangement operating at national level, thus to benefit from a certain alignment of methods. From this national level would be provided support and advice to local monitoring efforts, and would also be endeavoured to collect key data emerging from them in order to produce national indicators in response to the needs of the national ministry. These indicators could also be transmitted to international organisations in accordance with the principles of the CCPR (FAO) and the requirements of UNCLOS.

PART III: THE FISHERIES PRODUCTS SECTOR AND THE INTERNATIONAL CONTEXT

Beyond understanding the environment and the instruments used in the small-scale fishing sector in Haiti, it is essential to understand the fisheries products sector as a whole – "from the fisher's net to the consumer's plate".

As noted in the introduction, this assessment engages in an approach to its subject that goes beyond a view of fisheries limited to predator/prey relations. The Fisheries system occupies a primary place in this approach, at the junction between geography, fishery, the biology of fishing and the economy. Six interconnected systems making up this approach can be distinguished. Two are natural systems, being the aquatic ecosystem – a generic term which includes oceanic and coastal biotopes as well as the marine communities they house – and the aquatic space as physical support of the biosphere. Four are anthropic systems: the triad of law/economy/policy, history, technology and the dyad culture/society. Together these six systems make up the environment of the Fisheries system (figure 28).

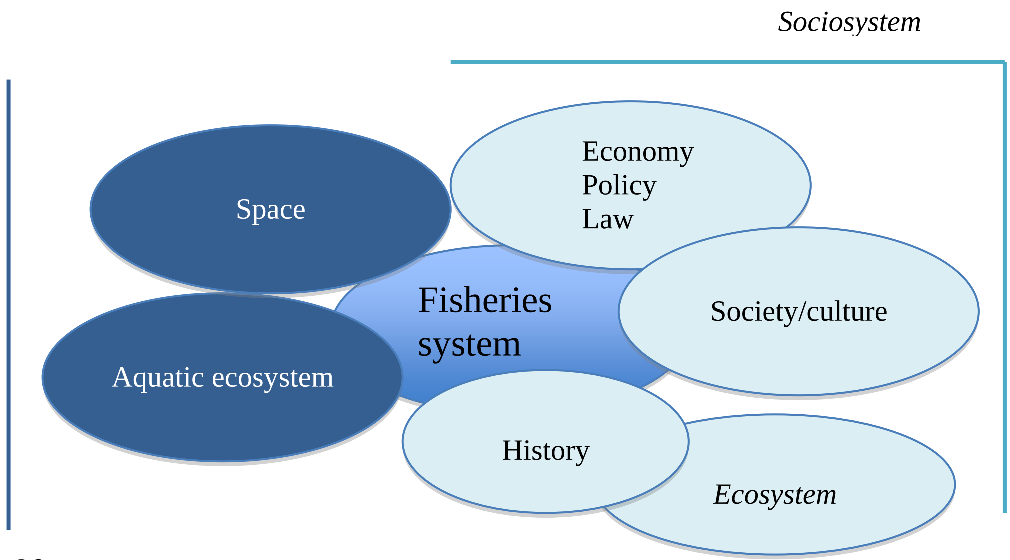


Figure 28
The environment of the Fisheries system.
Source : David, 2020

In Haiti, the Fisheries system is closely associated with the Dietary system, since its primary purpose is feeding the population and contributing to the country's food security. One could even speak of a Fishery-Dietary system of which the fishery products sector constitutes the backbone. But this sector is faced with numerous constraints and contains many deficiencies leading to a loss of efficacy with regards to its distribution chains and to the degradation of the quality of seafood products along these chains - fresh fish is a very perishable commodity. In the open air and at room temperature its flesh is rapidly infected by bacterial spread which causes the degradation of its physical qualities, marked by a bad smell and changes in colour and taste. The collective efforts of experts have enabled the bringing to light of two distinct elements operating within the fisheries products sector. One relates to fish of good market value, notably the large pelagic species caught around FADs, deep-dwelling demersal species and so-called “rose-coloured” fish, which are particularly appreciated by consumers. Cold storage of these products using ice is commonly practiced. The second element of note relates to other species of lesser market value such as small pelagic fish and small demersal species. These fish are not stored in refrigerated conditions. They are sold fresh and those not sold immediately are stored according to a process of salting and drying that allows them to be kept on the market. Because of their low price, these salted and dried fish are often the only source of seafood protein accessible to families of modest means.

Each of these sub-industries is beset by major constraints, whether as a result of the socio-economic context of the country – manifesting itself e.g. in chronic fuel, ice- and electricity shortages, in regular degradation of the road network, in the weak purchasing power of the majority of consumers – as a result of problems related to governance and insecurity which sometimes significantly hinder the circulation of fisheries products, consumption habits and bad practices such as price manipulation by fishers and fishmongers, or the resistance among many consumers to purchasing large pelagic fish in the belief that these are carriers of toxins. A number of these obstacles are the result of a lack of knowledge on the part of consumers, which is why going forward we will be focusing specifically on problems related to product quality and ecotoxicological dangers to which consumers may be exposed. However, marine toxins hardly explain the reduction in product quality observed throughout the sector’s operations. In fact the absence of a proper refrigeration chain and the complexities of distribution pathways are the primary causes, creating a situation which requires a better understanding of the different elements operating within the sector, as well as of the role-players involved.

1. Product quality and ecotoxicological risk

Throughout the country the population favours the consumption of “rose-coloured fish”, a generic term synonymous with quality fish and which denotes fresh reef-based and demersal fish from shallow waters like snapper and sea bass, grouper. Their meat is unanimously described as slender, delicate, soft and tasty. On the consumption side of the sector their price is high, placing them in the top category of fish species (“A”), known as “noble”, along with lobster, aimed at exportation and sale to major restaurants. “White” fish, generally large pelagic species such as dolphinfish, skipjack tuna and small tuna are priced lower and classified as category “B”. These large fish species are usually sold intact and not cut up before being made available to the consumer. The third category (“C”) comprises small pelagic species and other small fish, mostly juvenile demersal species. The purchase of low quality fish can be largely explained by the weak purchasing power of a large number of consumers. At the beginning of the 2000s, 71% of the population earned less than 2 US $ per day (MARNDR, 2010). According to current estimations by the World Bank, Haiti sported a poverty rate of 60% (6.3 million Haitians) in 2020, as compared to the previous official national estimate of 58.5% of 2012[42].

Field studies undertaken as part of this assessment have shown that low-income urban households rarely consume fish, and in those cases freshly-sold fish, albeit of very degraded quality, which explains its low price. The lack of effective means of storage and transportation, notably as a result of an unreliable road infrastructure, is another reason for the poor quality of fish consumed far from fishing boat docking points. Supplying inland markets is difficult, takes long and is costly, and in mountainous regions the consumption of fish is limited to salted and dried stock. As it stands, the further removed a consumption point is from a fishing boat docking point, the higher the price of fresh fishery products is, and the more the quality-to-price ratio is reduced as a result of an inability to guarantee any kind of cold storage.

A/ A recurring problem: conservation of fishery products

One of the primary deficiencies of the sector lies in the lack of storage means for seafood products, such is the fact as established at the end of the first decade of 2000 (MARNDR, 2010; Felix, 2012). This reality is still in force and affects all parts of the sector, from on-board storage immediately following catching to the sales counter when made available to the consumer.

At the moment of catching, fishers leave their catch on the bottom of the boats rather than subjecting them to cold storage in adequate receptacles, on-board refrigeration only being in use on a very small number of boats. At best catches are protected from the sun under a bag regularly drenched with water by the fishers. As soon as fish is caught therefore, they are subjected to a series of progressive changes in their physical quality, all the more so because they are rarely gutted on board, fish guts nevertheless housing a rich bacterial flora which proliferates following the death of the fish. This proliferation is all the more intense when the ambient temperature is high. Thus a fish stored at 20-30 °C will degrade 25 times faster than a fish stored at 0 degrees or at temperatures close to that. A high storage temperature also increases the risk of contamination of the meat by histamine. As comparison, one may consider that, in some small island states of Oceania, coolers filled with water cooled to 4 degrees by blocks of ice are used to store fish not yet gutted. Once on dry land, seawater is drained and the fish covered in ice for transport to market. Without the refrigeration chain being broken, the products retain their freshness for several days and can therefore be transported over long distances and supply markets far removed from fishing boat docking points (box no. 5).

[42] The national poverty rate indicates the percentage of the population living under the national poverty line. National estimates are based on numbers gleaned from population surveys of households. The official lines of poverty and extreme poverty for 2012 was set at, respectively, 81,7 HTG per inhabitant per day (2,41 $ in 2005 PPA) and 41,6 HTG per inhabitant per day (1,23 $ in 2005 PPA) - https://www.worldbank.org/en/country/haiti/overview

Box no. 5: Histamine contamination

The meat of large pelagic fish, notably tunafish, as well as of small pelagic species (sardines and anchovies), is rich in histidine, an amino acid. In a few hours this changes into histamine as a result of the effect of bacteria living in the gills and the intestines. A high temperature will foster the proliferation of these bacteria. Thus it is important to clean caught fish thoroughly and if possible to store them at low temperatures following their gutting, since once histamine is present in the meat of a fish, it becomes resistant to cooking, to freezing and to smoking.

Another obstacle to the development of an effective refrigeration chain in Haiti is that the fishing boat docking points generally lack basic necessities. Running water in particular is often absent. Descaling and gutting of caught fish is often even done on the ground near offloading- and sales points, in unhygienic conditions. It may even occur that water basins used for washing fish might be filled with the guts of previous ones. These problems of hygiene are also found downstream within the sector, at points of sale. In cases where refrigeration is used for storage of catches, ice employed is often made from dirty water and stored in coolers in bad state or out-of-date refrigerators.

The practice of pouring ice over already-degraded products in order to preserve their open-air sales quality is not effective. The fish is already subject to intense bacterial degradation, which can hardly be slowed down by ice. Those few walk-in refrigerators which can be found in the country belong to large wholesalers based in the capital. Some communal unions have benefitted from such equipment, but a lack of upkeep, fuel shortages and power outages disrupt the refrigeration chain nearly all over the country. Installing solar-powered freezers in community fishing centres – a solution proposed as part of a Spanish cooperative project implemented as part of the last development plan for small-scale fishing in the south of Haiti – is an interesting idea provided the upkeep of the equipment can be assured, something which is not always the case. After gutting, fish are wrapped in baggies or placed directly in the freezer where they can be stored for a long time (two months or more) all while preserving their physical qualities.

Salting and drying are "traditional" storage methods. In order to prepare the fish, the scales and guts are removed. Sometimes the head is also severed. Then the fish is washed, spices are added (salt, bitter orange or powdered citric acid, sometimes chilli pepper); afterwards the fish is placed in a bucket of salt for around eight to fifteen days. The fish is then either sold in brine or dried. In the latter case, following rinsing it is placed in direct sunlight on bags or in a winnowing basket (a flat-bottomed basket used for winnowing grain), then strung up from a rope suspended from a transom. The length of time required for the drying process to be completed depends on the type of fish (the thicker the meat, the more time is required), the intensity of the sunlight, the wind, the humidity (thus the season), as well as the drying surface used. Usually three to ten days are sufficient. Once dry, the fish remains suitable for consumption for several weeks. If consumption has to occur sooner, the salting/drying can be made "lighter". During dry periods, the focus is on the drying. Following washing the fish is rubbed with lemon and crushed salt, then marinated in brine for a short period before being expose to the sun. Usually the fish is sun-dried for three to ten days. The dwarf round herring (*Jenkinsia lamprotaenia***)** is one of the rare, small species of fish which can be dried without having to undergo any preparation (photo 9).

Photo 26
Fish stored through drying. A. Desirade, 2020. Village of Torbeck (Haïti). © *A. Desirade*

The Madam Sarahs and the fish sellers are not the only women in the world who practice drying. On a global scale several thousands of women engage in this activity, and many of them benefit from simple and cheap technological means to improve the quality of their products. Already in 1986 a colloquium was organised around this subject in Dakar (Bassey et Schmidt, 1987). The dissemination of these instruments and practices in Haiti is advisable in order to raise both the quality of commercialised products and the income level of those engaged in the processing effort.

From a nutritional point of view, salted and dried fish is, all things being equal, far richer in protein, mineral salts and vitamins than fresh fish (Jardin and Crosnier, 1975). Added in small quantities to starches such as tubers, bananas or rice, it enables – via the sulpherised amino acids it contains, as well as its rich lysine content – better digestion of vegetable protein, allowing for what nutrionists refer to as protein supplementation (David, 1988; Jardin and Crosnier, 1975 ; Kayser, 1970). Adding a few grammes of salted or dried fish to a plateful of corn or rice is enough to increase significantly the amount of protein digested. Because of its low price, salted-and-dried fish is available to most consumers in Haiti, and as a result of the protein supplementation it induces, it is likely that it plays an important role in the food security situation of those consuming it (figure 2).

Sought-after for its unique taste, widely appreciated by Haitians, as well as for its lower price, salted-and-dried fish is in higher demand during the country's religious festivals. Significant efforts are envisioned for inducing a change in consumption habits towards pelagic fish caught around anchored FADs, but these plans have powerful cultural and dietary habits to overcome. Not only does the taste of these fish not suit the palate of consumers, which indicated that even "after long chewing" their meat remains "hard to swallow", but in addition their size results in the consumer not seeing their entirety on the plate, which is culturally hard to accept. Not being subjected to cutting up into smaller pieces makes their storage and transportation more difficult. The advancement of the processing of these large fish species would also lead to job creation and financial gain for the national economy: it would enable the creation of upstream employment and reduce the consumption of frozen products since, when "rose-coloured fish" is not available (i.e. sea bass and groupers, grunts, snappers and wrassers), Haitians readily turn to imported fish, often coming from the United States and commonly known as "Miami fish" (notably horse mackerel), which can also include salted herring or pickled sardines.

B/ Ciguatera and ecotoxicological risk

Ciguatera or ichtyosarchotoxism is a type of food poisoning caused by the ingestion of fish meat contaminated by a dinoflagelate benthic alga, *Gambierdiscus toxicus*, which grows around reefs, notably on dead coral or coral which has been significantly degraded by human influence or climatic effects such as cyclones. This dinoflage produces ciguatoxins which in humans disrupt the flow of sodium ions to the synapses, leading to a general feeling of intense weakness and neurological difficulties which cause itching – from where the name "scratch" also given to this illness in French. Ciguatera can be serious but is rarely fatal[43]. The symptoms are usually digestive and disappear in between one and four days (Hossen *et al.*, 2013). In the absence of national statistical data and any kind of survey of cases based on hospital admission, the actual occurrence rate for Haiti is unknown. Nothing distinguishes a contaminated fish from a healthy one, so information regarding at-risk species and their location remains the proprietary knowledge of local fishers. A Haitian custom is to call any fish suspected of contamination "coppery fish" (box no. 6). In this regard a certain know-how has developed within fishing communities in order to identify fish which are carriers of ciguatera, consisting of four methods: (1) placing the tongue on the fish's eyes in order to see if an itching feeling results; (2) checking the colour of the fish's eyes (red in case of infection); (3) placing the fish on the ground for a few minutes and seeing whether it attracts flies; (4) boiling the fish along with potato which, in case of contamination, will turn black.

Box no. 6: Coppery fish – a Haitian concept

In the media consulted and among the Haitians, the term "coppery fish" indicates fish the consumption of which could have negative effects on a consumer. Such effects may be caused by histamine – which is why large pelagic species are often classified as "coppery" by consumers – by ciguatera or by some other marine toxin. While no one species could be identified as ciguatera carrier in Haiti, interviews conducted have enabled a clearer understanding of the issue. On the one hand, the characterisation as "coppery" could be based on a metallic taste to contaminated sardines (clupeotoxin) noticed by consumers. On the other hand, several species are recognised as possible sources of ciguatera infection, such as barracuda (Sphyraena spp), a fish frequently at the origin of contamination in the region (photo 10).

La békune (Barracuda) © Wikipédia

From bibliographic analysis and piece-meal investigations undertaken within the framework of this joint assessment, it would seems that over the course of the past two decades only a few areas affected by collective dietary toxico-infection (TIAC in French) have been documented in Haiti. It should also be noted that the 2016-2025

[43] According to available literature, 18 people in Haiti have been identified as victims of ciguatera infection. However, this figure should be treated with significant caution, as in Haiti epidemiological studies of ciguatera are rare and lack of documentation results in under-estimation of occurrence.

reference guide of the Caribbean public health agency (CARPHA)[44] does not include ciguatera in its list of monitored illnesses, even though their proposed health measures are meant to apply for decades to come.

Ciguatera is not the only ecotoxicological risk factor. Some species cause painful stings, capable of causing serious skin lesions. The *red lionfish*, also called *fenk Vini*, *minista* or *pwason dife* [*Pterois volitans*] and the *spotted scorpionfish* [*Scorpaena plumieri*[45]] represent the most dangerous of species and can be fatal without medical attention. The remedy currently most in use in cases of encounters with these species is heat treatment, as described by one fisherman from Chardonnières: “Traditionally pain is relieved via heat from fire or by applying a piece of material drenched in lukewarm water to the affected body part.”

Other forms of food poisoning can also be present. According to the World Health Organisation (WHO), illnesses transmitted via food constitute one of the leading causes of death in Latin America and the Caribbean. The presence of pathogen germs by which food can be affected leads to contamination, by for example salmonella or colibacillosis; also at the origin of contamination may be the injudicious use of agrochemical substances and non-approved additives, environmental contamination or unsuitable quality control practices and food manipulation[46].

The absence of global monitoring of the various forms of toxin poisoning and their causes renders their analysis difficult. A number of different approaches can be explored in order to gain better knowledge and to ensure an effective monitoring of this health-related situation, notably via the creation of a national epidemic surveillance network involving doctors acting as “watchmen”, medical centres and dispensaries (VI.3). The Republic of Haiti should set out a national policy to ensure the health safety of food and in this regard should create a legal framework (laws and regulations) in order to guarantee, to the greatest extent possible, the protection of the health of consumers through the production of hygienic food. Then it will be able to operate as a dynamic role-player in international trade in the coming years via the exportation of a certain amount of its animal and vegetable products (R.1)[47].

[44] Agency of reference established in July 2011 for the prevention of disease and the promotion of health and well-being in the Caribbean.
[45] Particularly venimous, as per its other name “twenty-four hours”, the length of time the pain from its sting lasts.
[46] Sometimes also dangerous practices such as the use of DDT (dichlorodiphenyltrichloroethane) for better preservation of the fish during drying, to protect it from ants and other insects.
[47] Refer to detailed recommendations in part 4.

2. The fishery products sector

The sector can be summed up in a single, simple expression: "From the fishing hook to the consumer's plate."

A/ The sector from beginning to end ("upstream" to "downstream") and the role-players involved

Theoretically speaking, every fishery products sector involves five types of role-players. Firstly, the fishers and those role-players upstream of the sector who buy their wares. Then the role-players in the middle who transport the fish from the fishing boat docking points to the various consumption sites, and make them available to operators at the tail-end of the sector who deal directly with the consumers, the latter being the fifth and last link in the fishery products supply chain. This general structure also applies to Haiti, though there matters are more complex as a result of the operation of two sub-industries and the involvement of numerous intermediaries (figure 29)[48].

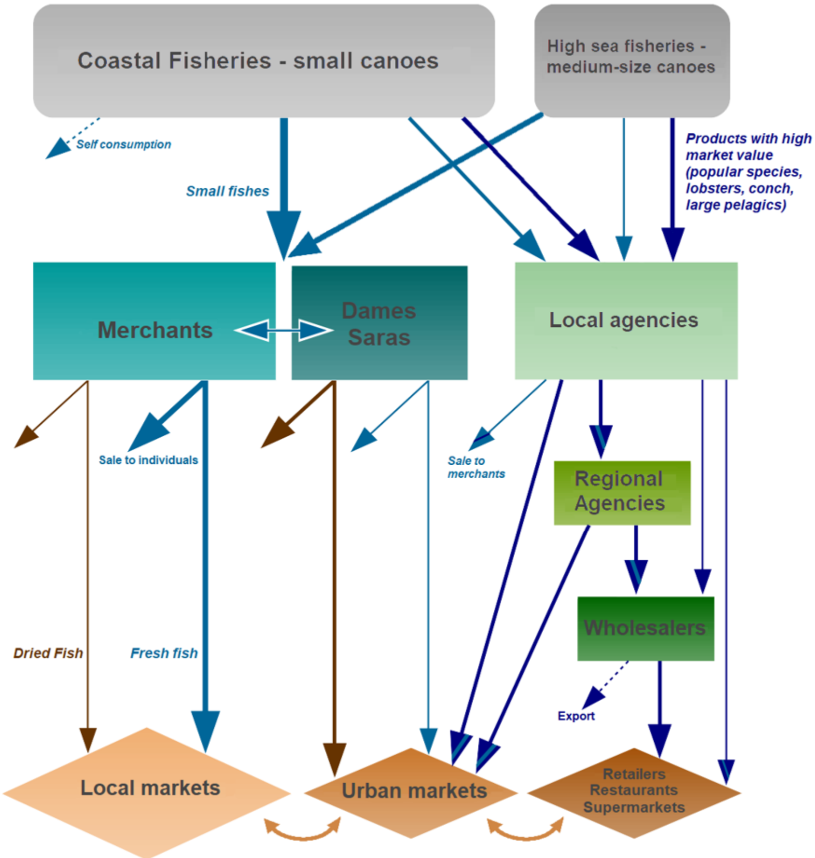


Figure 29
Structure of the small-scale fishing sector in Haiti
According to Desirade (2020), Felix (2012) and Favrelière (2008).

[48] We recall that one of these sub-industries relates to fish of high market value, often preserved via the use of ice. The other relates to small pelagic and demersal species with a much lower market value, often preserved via salting and drying instead.

At the “upstream” end of the sector

Aside from the fishers, of whom we will be speaking more presently, three groups of role-players operate at the “upstream” end of the sector: the sellers, the Madam Sarahs and the local agencies (the first two are almost exclusively women, whereas the agencies are almost all operated by men…with rare exceptions).

Operating in significant numbers, the sellers – who are often fishers’s wives – play a determining role in the distribution of the products generated by the small-scale fishing sector because they operate within both of the two sub-industries. They buy fish directly from the fishing boat docking points. Given their modest financial means, they generally buy very small quantities sold “by line”, by bucket or by batch (photo 11); they then resell the fish around the ports or in local marketplaces. Fish not sold immediately are salted and dried for later selling, though still only locally. Thus these sellers are primarily buyers and small retailers, though they can also occasionally engage in processing.

Photo 27
Fish sold “by line” (left) and by five gallon bucket (right)
© Jean-Marie S., 2019.

The passage of fish from villages where they are first offloaded to places of consumption far removed from the coast is not accomplished by small retailers but by itinerant pedlars known as “Madam Sarahs”, who operate all over Haiti. These women are well versed in trading within all manner of communities, including in the selling of salted-and-dried fish of low market value. In order to make their wandering cost effective, they are obliged to buy fish in bulk, after which they engage in salting and drying for storage. In order to facilitate transportation, they keep the dried fish in baskets or bags, while fish pickled in brine is kept in buckets. Once having arrived at a given location, they sell their products to retailers or directly to the consumer. The Madam Sarahs thus engage primarily in processing and transportation, and only in second place act as direct sellers to consumers.

The term “agency” refers to the distributors who employ ice to conserve the fish in coolers or in dilapidated refrigerators. They generally buy and sell according to weight. Two categories of agency can be identified according to their supply source. The largest are found in cities and operate on a regional level. They are supplied by local agencies which operate in the surrounding rural areas. These local fishing agencies are another major role-player operating at the "upstream" end of the sector. Although small, they keep book of their transactions and dispose of vehicles from which to operate. Their buying power is greater than that of the small sellers. They deal primarily in fish with a high commercial value sporting a high price, and which are only resold to the wealthier segment of the Haitian population. Agencies often possess freezers (called "igloos") filled with ice for preserving their products, something the small sellers often do not have. They buy directly from the fishers and resell either to local restaurateurs and hotels or to other agencies, notably at a regional level (figure 29).

Those local agencies possessing the means have no qualms about supplying fishers with the necessary fuel and fishing material for their excursions in exchange for purchasing their product at reduced prices and/or exclusive sales rights (in addition to receiving a cut of the profit made by the fishers from their own sale of their product). They also often engage in reselling at credit. Thus local agencies fulfill four functions: they act simultaneously as buyers, peddlers, intermediary traders and, in a secondary way, lend support to fishing activities by providing equipment to fishing boats and/or funding excursions.

Box no. 7 – The role of women in the Haitian fishery sector[49]

Mothers with families, small sellers, *Madam Sarahs*, sometimes fishers themselves (notably for Ashellfish and similar seafood, from the shore) women are a key part of the fisheries sector.

At a global level their contributions to the sector seem mostly under-estimated by their societies, by the sector itself and by decision-makers (Harper *et al.*, 2020). This can be explained by the number of women who work for no remuneration, i.e. informally and part-time, and who do not see themselves as "workers". It can also be explained by a conception of the sector as one that is limited to fishing, excluding the nevertheless essential totality of the value chain.

Primarily engaged in activities following the actual catching of the fish, women play a key role in the processing and commercialisation of seafood products. The resources and creativity they employ in order to sell marine products outside of the areas in which these were originally obtained enables access to fish for the entire Haitian population, whether living on the coast, inland or at the capital.

Their contribution goes well beyond their post-fishing activities however, insofar as they also provide support (in varying degrees from woman to woman):
- within the home (domestic work, education, nutrition, financial management, etc.);
- by investing in fishing material (boats, fuel, nets, bait, etc.) to supply certain fishers ;
- by preparing for activities to be undertaken by fishers at sea (preparing cooking equipment and provisions for food preparation);

[49] These elements originate principally from studies carried out on the north and south coasts of Haiti and semi-guided interviews done with, on the one hand, key roleplayers in the fisheries milieu, and, on the other hand, with close to 70 women, particularly in the townships of Chardonnières and Bainet.

- by providing an additional source of income via other professional activities, allowing for the mitigation of financial instability and adaptation, notably during the so-called "hungry gap" period (through raising small animals, agriculture, small-scale commerce, teaching and tailoring);
- by developing know-how (e.g. methods of processing fish for storage such as the practice of *"filet sèch"* or salting) and innovations (fish pellets made from large pelagic fish, etc.);
- by playing increasingly important roles within fishers associations and similar groups.

Caracol, Haïti.
© IRD/C. Sabinot.

Caracol, Haïti.
© IRD/C. Sabinot.

Despite these numerous functions, their full integration into the sector remains problematic: they are notably marginalised with regard to strategic decision-making.

The fact that they are present in the sector in large numbers and that they play different roles particularly in relation to the geographic areas in which they work, that they enable to distribution of fish and that they are able to adjust both their commercial zones of operation and their modes of processing fish quickly, make them indispensible for the food security and economic wellfare of numerous families. ***They are one of the keys to the transformation of the sector and as such all of them should be supported.***

THE SECTOR MIDDLE GROUND

This part of the sector is not always circumscribed, given that sales can be made directly and without intermediary at fishing boat docking points and in the surrounding townships. Three primary types of role-players define this central part of the fishery products sector: regionally-operating agencies, wholesalers and Madam Sarahs. Only the latter do not belong to the middle part of the sector but rather to the "upstream" end. Regionally-operating agencies are supplied by local agencies, then in turn provide those products to urban centres for resale to wholesalers, to fishmonger's stores, to hotels and restaurants or to sellers operating in the marketplaces (figure 29).

Wholesalers are clients of the agencies, whether local or regional. They usually purchase a large amount of fish either for direct resale, or to sell to their partners (fishmongers, hotels, restaurants). Their suppliers may be located in a number of areas in the country. In order to cement their partnership, the wholesalers provide their suppliers with freezers (igloos) and sometimes pay them in advance. The wholesalers operating in Port-au-Prince number less than a dozen. Only the largest of them export product abroad, primarily lobsters to North America.

AT THE "DOWNSTREAM" END OF THE SECTOR

At the bottom end of the sector two groups of women – traders and retailers – engage in direct contact with consumers; both belong to a specific category of merchant which does not deal with fishers at all[50].

- Like wholesalers the traders are also clients of the agencies, and notably urban agencies. They preserve fish in ice and use freezers and refrigerators to transport the fish to the La Rochelle market in Port-au-Prince (the largest commercial fish market in the country). Here they are able to sell directly to consumers or to the final role-players in the sector: the retailers.

- The retailers only purchase a small amount of fish from traders, a few bowl-fulls at most, and that mostly of fish of lower market value than those sold directly by the traders themselves. The retailers also operate in rural areas. None of them sell solely to consumers – some sell their products to other retailers who operate in mountainous regions where they resell their purchases, often in salted-and-dried form.

Apart from the traders operating at the bottom end of the sector, fish can equally be sold in supermarkets and restaurants.

B/ Supply versus demand, distribution circuits, prices and income of role-players in the sector

The national market of La Rochelle is essentially supplied by agencies from the southeast (notably Anse-à-Pitre) via le market at Marigot (near Jacmel), a meeting point for local agencies from the cities and towns of the Sud-Est region and their homologues from Port-au-Prince (box no. 8) [51].

In addition there are three other circuits through which the capital is supplied. The first originates in the departments of Grand-Anse and Sud via the city of Les Cayes. Another pathway proceeds from around the capital (Arcahaie, Léogane, Gonâve Island via Léogane…). The last one includes importation (formal or informal), essentially composed of mackerel, horse mackerel and salted- or smoked- and preserved herring.

[50] Products of low market value also pass through a much simpler trajectory, from fishers to traders, then from the traders to their clients or Madam Sarahs (and then their clients).
[51] As a matter of interest: the Spanish cooperative project (AECID) has laboured for many years to develop small-scale fishing in the Sud-Est region, establishing the foundations for a more advanced structuring of the fishery sector than in the rest of the country.

For a number of years now, these imports have often been of superior quality than local fish (figure 3). It should be noted that the traffic of fish in the upper part of the country is not very well known, making it probable that the fisheries sector is more developed in the north than indicated by figure 30.

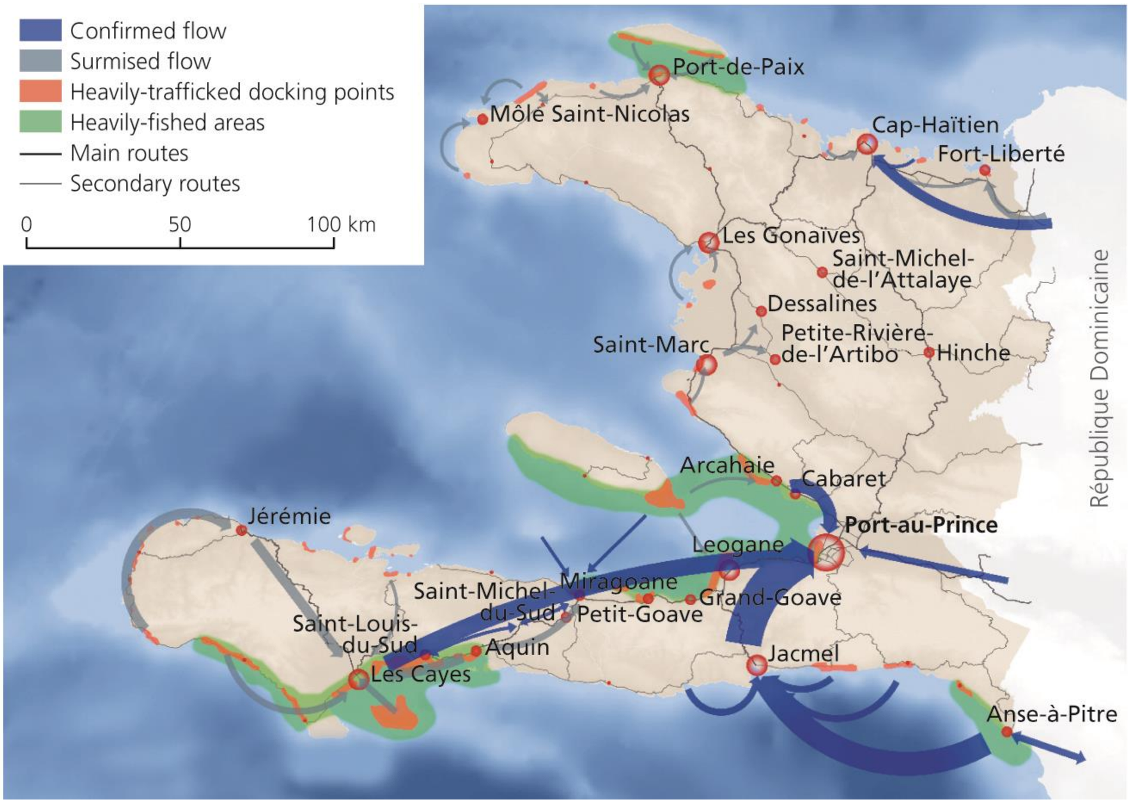


Figure 30
Estimate of the primary distribution flow of fisheries products. The size of the arrows indicates, and is based on, the relative importance of circuits.
Source : G. Touron-Gardic[52].

Box no. 8: Structuration of fish markets, the example of Haiti's south

Four types of fish market can be identified according to their size and their role in the fishery products sector. Local markets link together the entirety of the coastal area. They are found at fishing boat docking points or nearby. A market of sub- or regional importance such as that of Les Cayes corresponds to an urban centre where the demand for fishery products cannot be met locally and which, as a result, "commandeers" a supply area made up of several dozen local markets. Markets of regional importance such as that of Marigot correspond to a supply area which is significantly larger and which fulfils a number of functions: supplying the national market at Port-au-Prince and

[52] Sources : roads : https://data.humdata.org/dataset/hotosm_hti_roads ; administrative limits: https://data.humdata.org/dataset/hti-polbndl-adm1-cnigs-zip ; bathymetry : GEBCO 2019 ; fishing boat docking areas & fishing zones: interpreted based on data from the second MARNDR survey (https://www.haitistatagri.com/statPhase2.php)

the inland towns lacking fishing production, meeting the demand of the urban centre in which it is located, as well as the surrounding towns.

Sub-regional market of Les Cayes

Les Cayes is an bustling city which sports many restaurants, some dozen fishmongers (dealing in about a tonne of fish per week) and a market with twenty-something traders supplying fish to an entire local sector (about 300 to 500 kilos of fish per day, the market operating every day of the week).

Regional fish market of Marigot

Some twenty resellers operate here, supplying restaurants and small local markets. Around 75% of fish sold here comes from the Anse-à-Pitre region on the border with the Dominican Republic, which sports numerous reefs and underwater slopes very close to the shore which create convex currents and upflows of cold water, with a zone of superior primary productivity stretching from Jacmel to Belle-Anse. Every day, excluding Sundays, a truck filled with one- to five tonnes of fish packed into coolers travels the two hours from Marigot to Port-au-Prince.

National market of La Rochelle in Port-au-Prince

Most of the fish sold in the La Rochelle market are premier grade. In order to obtain the best price, these fish are sold separately: "rose-coloured fish" and others (the appellation "rose-coloured" refers to numerous species). One distinguishes two distinct groups, on the one hand the "rose-coloured fish" (e.g. snapper) with sometimes kwokwo (grunts), and on the other hand the rest, e.g. small kwokwos. While the primary supply is done via the Marigot market, the agencies of Port-au-Prince have no qualms about seeking out the remotest towns in order to obtain their merchandise. In parallel fashion the largest local agencies in turn travel regularly to the capital.

The importance of importation raises questions around the limited national supply of fishery products and their unequal distribution across the whole of the territory. In this regard dysfunction related to the organisation of road transport – roads in bad condition, regular fuel shortages, occasional safety concerns on certain stretches of road – has an obstructive effect preventing the flow of product. As seen above, the absence of a reliable refrigeration chain also explains why the most isolated areas are only supplied (when indeed they are) with salted-and-dried fish.

Beyond the organisation of supply circuits, as well as the state of and access to fishery resources (parts I and II), the determination of the sales price of fishery products – from which is derived the fisher's income – is a decisive factor on fishing effort. Each individual decision made by the fisher, i.e. to go out fishing, to curtail or extend his excursion, is mostly based on the operation of the collective process which is the market, and which ultimately determines the sales price. Fishing effort is therefore directly dependent on the anticipation of income to be gained, and indirectly on the sales price of products as set by the market. Of course it is also determined by a lack of other opportunities.

In this respect this assessment has identified a relative homogeneity of prices at those fishing boat docking points visited, even though variations in the availability of products can lead to fluctuations in price. On the other hand, the large number of intermediaries serves as a price raising factor, as do incidental expenses (ice, handling, fuel, transport…). Every time a product passes from one intermediary operating within the sector to another its price increases, notably in transition zones or at final destinations, such as at the Marigot market and the marketplace sales points of Port-au-Prince. In this way the value of unprocessed fish can almost double between its initial sale and its ultimate sale to retailers, even though the profit margin for each vendor is relatively small. Sardines, small fish (clupeides – dwarf round herring [*Jenkinsia lumprotaenia*], atherinidae – hardhead silverside [*Atherinotnorus stipes*], young engraulidae – shortfinger anchovy [*Anchoa lyolepis*], broad-striped anchovy [*Anchoa hepsetus*]) and herring are the products of low market value which are the most widely distributed, whereas yellowtail snapper (*Ocyurus chrysurus*), parrotfish and other "coloured" fish are – along with queen conch and lobster – the species which possess the greatest commercial value. The limited tolerance for storage exhibited by some products (notably the least expensive fish and in isolated areas) obliges vendors to sell them quickly and at a small profit, otherwise having to salt and dry them and sell them at an even lower price. Their sales prices therefore are generally much lower than those imposed by agencies. Among small sellers processing is done only as a last resort, and does not serve as a means of creating significant value addition but rather as a way of reducing losses. The situation is different for Madam Sarahs, who salt and dry their fish when it is still fresh enough to eat as is. In their case the sales price of the processed fish is therefore higher.

The multiplication of role-players across the sector explains the number of people concerned with both direct and indirect income generated by fishing in Haiti. Within the context of significant demographic expansion and a high unemployment rate among active members of the population the multiplication of small-scale employment can be seen as a positive thing[53]. However, it should also be noted that situations do arise in which intermediaries take advantage of the financial precarity of fishers, as well as of their lack of education, to force them to sell their products at prices which are too low for them to make enough of a profit to be able to reduce the effort they have to invest in fishing. This results in an increase in the frequency of small-scale fishing excursions (table 3). Hence overfishing can also be viewed as the result of the limited income level of the fishers[54].

The very low income level *per capita* of fishers constitutes a powerful obstacle to the modernisation of their means of productions. Taking note of the limited return in income in relation to future investment in better means of production, P. G. Lafontant, then-director of Natural resources at the MARNDR declared in 1998 that small-scale fishing in Haiti remained essentially a subsistence practice tending towards marginalisation. Building on this perception, some dozen years later P. Favrelière (2008) confirmed that development agencies considered fishers as second-class

[53] Also provided that the income destined to go to each roleplayer is adequate and that a certain equity governs the redistribution of fishery-based income among all of them.
[54] This income is calculated at the end of each fishing excursion based on the sale of product according to a system of proportional remuneration. For a crew consisting of a boat owner enagaged in the fishing and a sailor, 2/3 of the fishing product is reserved for the owner and 1/3 for the sailor.

economic role-players and that, as a result, small-scale fishing in Haiti suffered from an obvious lack of recognition.[55].

C/ Access to capital and investment

As a result of their lack of adequate income, fishers do not possess sufficient funds in order to grow their fishing activities or even just to restart these activities following a bout of misfortune, such as damage to their equipment or unforeseen familial expenses, which drains the already-limited supply of funds reserved for the operation of fishing activity. At the beginning of the 2000s, the lack of credit was already considered as the primary obstacle to the development of fishery (Damais *et al*. 2007).

As indicated above, fishers can turn to vendors or agencies to advance them the means to enable the undertaking of fishing excursions in exchange for being allowed to buy the product of these excursions at a discounted price, or for exclusive rights to buy the best products, or sometimes even for a cut of the profits resulting from the sales made by the fishers themselves. Apart from these solutions, funding instruments are rare and access to credit is difficult for those engaged in the fishing sector[56]. Within this context diverse adaptation strategies for obtaining credit have emerged, as is the case in other parts of the world. Particularly initiatives driven by women have thus been able to see the light, based on an informal funding model similar to the "tontines" seen in Africa, known as *sosye* or *sòl* (box no. 9).

Box no. 9: Women seeking financial support, between the bank and communal mutual aid. The case of Bainet and Chardonnières.

Generally speaking, rural areas lack commercial banking facilities in Haiti. At Chardonnières there is a microcredit centre, as well as the "Caisse populaire de Chardonnières" mutual aid society which has 245 members, of which only 52 are women. It provides credit to its members based on capital deposited and stability of income stream. None of the women we encountered has had access to this credit which, according to them, is very difficult to obtain. In addition, it should be noted that the interest rate is very high: **it varies between 30% and 40%**. In Bainet, the "Caisse populaire ressource confiance" (CPRC) operates according to the same difficult-to-meet standards. As in Chardonnières, no women encountered have had access to this credit.
In Haiti, as in many other countries, women face real challenges to borrowing money, whether from banks or microcredit agencies. In order to deal with this difficulty, women organise among themselves in order to achieve small savings, particularly via "sosye" or "sol".

"Sosye" or "sòl" is a collective savings endeavour which operates on the basis of a set amount paid regularly over a given period. A person called *"manman sòl"* (responsible for collecting the funds) initiatives the activity in question and informs everyone of the governing modalities (the set amount to pay, the payment period). Interested persons

[55] https://aquaculture-aquablog.blogspot.com/2008/09/hati-la-pche-artisanale-souffre-dans.html
[56] Support by the public authorities remains sector-based in this regard, with facilitated modalities for access for farmers which have not yet been considered for those involved in the Haitian fishery sector.

subscribe, after which a payment calendar is drawn up in order to determine how the rounds of payment among members would be organised, as well as the amount each will receive – this is known locally as "main de sòl". The "sòl" can be daily, weekly or monthly.

In rural communities, such as Chardonnières or Bainet, a weekly "sòl" is the most common, being best suited to activities tending toward instability over time such as trading in fishery products, the operation of which varies from day to day. The "sòl" found in these towns is made up of twelve members and commences in January. Every week members pay 1 000 gourds. The *manman sòl* collects the set amount from each person and then gives the total, i.e. 12 000 gourdes, to a different person each week. Twelve weeks later the "sòl" comes to an end and begins anew, if so desired by enough participants. The same person can decide to take numerous "mains sòl" depending on her financial capacity. She will then also receive her payment multiple times.

Other informal systems of grassroots funding, such as the "Mutuelle de solidarité" (MUSO) are underway in order to address difficulties in obtaining credit. MUSO is based on a relationship of trust among a group of ten to twenty-five people residing in the same area and sharing common interests and objectives. Based on saving, borrowing and solidarity, it is made up of a central committee which establishes a set amount for its members corresponding to the subscription each member pays into MUSO, and which evaluates borrowing requests. Members pay regular subscription fees toward growing their accounts, thus increasing MUSOs overall capital base. This organisation enables members to borrow sporadically an amount determined by this total capital base. The interest rate varies between 5% and 10%. These activities enable women to obtain some money for stimulating their business activities, to buy cattle, to invest in agriculture, to pay for their children's school supplies – all in light of the fact that banking systems are unavailable to them.

At an international level, the increase in micro financing institutions and the development of microcredit associated with it also show that solutions to this problem do exist. However, the paucity of the funds engaged in micro financing does serve as a constraint to innovation. Thus microcredit is probably insufficient to equip a motorised fishing boat with an owner also acting as skipper, though it could be able to equip a sail-fitted canoe or, with two or three lenders pooling funds obtained from more than one microcredit agency, for purchasing a fibreglass boat. One can therefore imagine the separation of the owner and outfitter of a fishing boat from the equipment he uses. Thus at Bainet one of the women interviewed was the owner of a fibreglass boat which she lent to fishers on a day-to-day basis, contributing 50% of the price of fuel, in exchange for them providing her with 50% of their product for each day. This model is quite close to that of a fisher's cooperative, which equips a fibreglass boat and employs alternating groups of partners to do the actual fishing.

3. The international dimension

Even though Haiti is not capable of meeting domestic needs, species of high market value are still exported. This outward-looking economic model is common for many poor countries, in which the limited purchasing power of its consumers constitutes a constraint on the development of a national economy based on a substitute to importation. This model is nevertheless hampered by the need to strengthen the food security framework around food products in order to ensure their quality and to allow greater access to international markets.

A/ Exporting small-scale fishing products

During the 2012-2015 period, the export of fishery products increased to around 800 t per year (figure 3). Species suitable for export are few, consisting mostly of crustaceans, notably three lobster species (the Caribbean spiny lobster, *Panulirus argus*, the spotted spiny lobster, *Panulirus guttatus*, the smoothtail spiny lobster, *Panulirus laevicauda*), as well as Norway lobster: Atlantic deep-sea lobster, *Acanthacaris caeca*, and the two-toned lobsterette, *Nephropsis rosea.* In the future, perhaps tuna fish caught around FADs could be exported, provided they are properly preserved, as could deep sea demersal species, these having the added advantage of not being susceptible to ciguatera. The main export markets are the North American continent and the Dominican Republic. Exports to Europe (Martinique and Guadeloupe) are closed due to hygiene criteria and insufficient quality in relation to European standards. Even though Haiti is not a signatory to the CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), countries to which Haiti could potentially export its products are. Thus the exportation of queen conch to the United States and Europe has become impossible following a CITES prohibition on all international trade in queen conch, enacted in 2014 (box no. 10)[57].

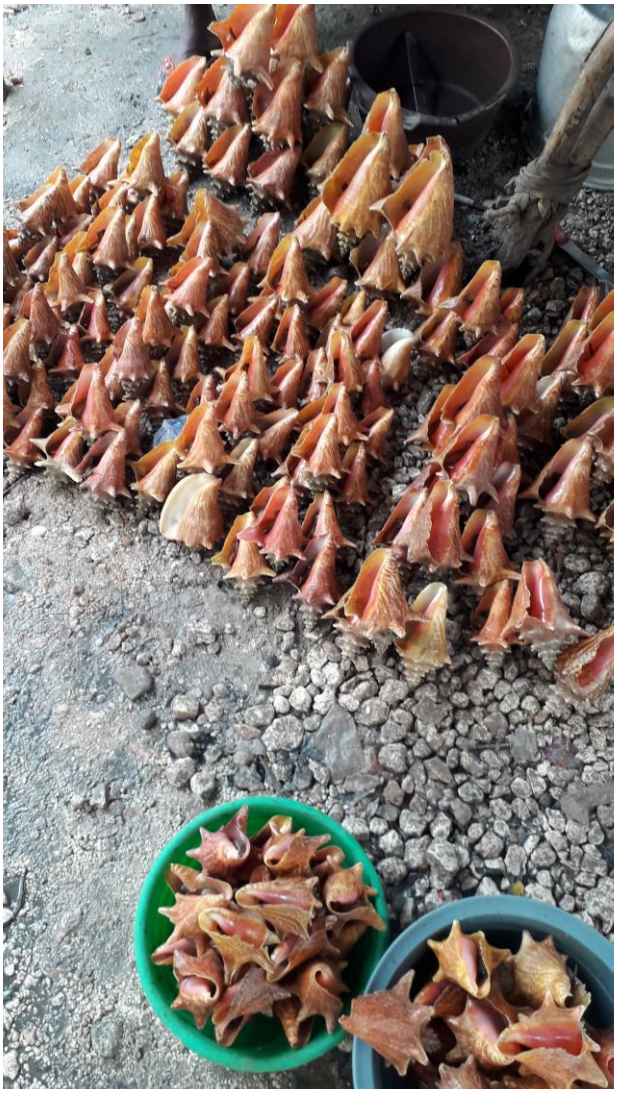
Photo 28 – Fisherman selling live lobsters resting on the ground, Miragoane (Nippes department) - September 2019.
© G. Touron-Gardic.

[57] https://cites.org/fra/news/pr/2003/031001_queen_conch.shtml

Box no. 10 : Queen conch, a monitored Haitian mollusc

The queen conch (Lobatus gigas or Strombus gigas) – “Caracol rosa” in Spanish – is one of the most emblematic species of the Caribbean.

The rarity of queen conch in Haiti is caused by the pollution of the bay of Port-au-Prince, by uncontrolled exportation, fishing too-young conch and lack of regulation of coastal fishing. For a sustainable exploitation, fishing queen conch should be limited in relation to their capacity for self-replenishment which takes into account their reproductive cycle and their growth rate. Trading in queen conch is heavily regulated, to the point where, in 2014, the CITES required all its signatory nations to halt its import from Haiti. Up to that point, France was the second import market for queen conch, still far behind the United States.



Queen conch for sale in Haiti
©: G. Touron-Gardic

Like lobster and sea urchins, queen conch live in sea grass beds and at the bottom of reef slopes. Feeding of detritus and waste materials, it lives off of dead organic matter, preferably vegetable in nature, and as such helps maintain the ecosystemic balance of coral reefs and sea grass beds. The female queen conch can lay up to 400 000 eggs eight times per year, though very few of these ever reach the stage of adulthood. After five days the eggs hatch and integrate into surrounding zooplankton, allowing themselves to be carried by the ocean currents for three weeks to a month. After this planktonic stage the queen conch larva sinks to the sandy seabed. Its shell grows and becomes heavier, and after a number of metamorphoses it reaches the juvenile stage. During the day it remains buried in the sand and only comes out by night to feed. Having reached a size of some 100 mm, young queen conch move on to ocean spermatophyte seagrass beds where their concentration makes them particularly vulnerable to fishing. After three to four years they reach their adult size of 20 to 25 cm.

Alignment with quality standards of more developed countries is a frequent strategic concern (Fargier, 2014). Côte d'Ivoire (COMHAFAT, 2015), Morocco (ANDA, 2018) and the countries bordering Lake Victoria in East Africa (Porhel, 2011) for example take great care regarding the quality of their products in order to ensure integration into European markets. In the Caribbean, British cooperative efforts promote a process of certification by the MSC (Marine Stewardship Council) in some states (Jamaica, Guyana) (McManus *et al.*, 2019), something which is also the focus of projects in Vietnam and Mexico (UNEP, 2009; Fargier, 2014). Although this effort is orientated towards the foreign market, some consider it a means of generating added value for the product.

B/ The decorative marine species trade

International trade in aquatic species to serve as decoration[58] is not well known, ill-defined and subject to little regulation. In coastal areas it operates in direct competition with product extracted for food: 60% of species having value on the aquariophile market are also appropriate for human consumption. Research regarding this trade is rare even though it has seen an expansion over the last thirty years, and also given that the number of private and public aquariums globally has not stopped increasing.

Recent studies have focused on the largest international market, that of the United States. According to customs declarations, between May 2004 and 2011, 11 003 181 ocean fish from Haiti were imported to the United States. Between 2008 and 2011 Haiti was the biggest exporter (supplier) among Latin American- and Caribbean countries to the decorative ocean fish market in the United States. According to a 2017 study, on a global level Haiti comes second on the list of exporters to the United States, after Indonesia (Rhyne, 2017).

Apart from the Pseudochromidae family, other sought-after species can certainly also be found in Haiti as part of the population of coral reefs and seagrass beds. Not all individual specimens caught survive until their arrival at aquariums, or even until their arrival at export points, with estimations of mortality ranging wildly, from 2% to 73% (Stevens *et al.*, 2017). Good practices would enable the reduction of this mortality rate to 5% (Monticini, 2010). Before any new exploitation takes place, further study will need to be done.

Apart from the preservation of biodiversity and the rights of the sea, international institutions are also active in the framing of global or regional trade by setting forth norms, directives and procedures with a view towards directly and indirectly protecting the health of consumers by ensuring the sanitary quality of international animal and plant exchanges, as well as of animal and vegetable products. The implementation of the OMC in 1995 has resulted in the creation of two main agreements: the Agreement on the Implementation of Sanitary and Phytosanitary Measures (SPS in French) and the Agreement on Technical Obstacles to Trade (OTC in

[58] These species include fish destined for aquariums, but also other marine species such as certain shellfish and corals of esthetic value.

French). The former advises that sanitary and phytosanitary measures necessary for a country's protection be scientifically-based and applied without discrimination or prejudice towards participation in international trade. The latter aims at guaranteeing that technical regulations, norms and procedures for the evaluation of alignment to technical regulations related to the protection of national producers do not create obstacles to international trade.

C/ Diplomatic implications

Apart from the optimisation of these possible outlets to commercialisation, Haiti sports an exceptional oceanfront which could benefit its maritime activities as well as derive value from its EEZ. In this regard Haiti is one of a few countries within the Caribbean region of which the precise delineation of its EEZ is still subject to ongoing legal dispute (figure 4). As it stands, the Republic of Haiti claims sovereignty over the 13 934 km^2 surrounding Navassa Island, which would increase its total EEZ to 117 752 km^2, i.e. a gain of 13% in relation to the surface area of its current EEZ (103 818 km^2). Navassa Island is situated to the southwest of Haiti, 50 km off the coast of Anse d'Hainault. Currently the island is under American administration but is still claimed by Haiti, which considers it a part of its own territory and which is contesting the limits of the current EEZ (figure 4). Cuba and Jamaica both support the Haitian claim, and in terms of how the Haitians relate to the island, a small fleet of Haitian fishing boats based in the Grand'Anse department occasionally engages in fishing around the island, which could also potentially serve as a refuge for fishers in cases of shipwreck.

Navassa is a small island with a surface area of 5.2 km^2, annexed by the United States in 1857 within the framework of the Guano Act one year after its adoption. The Guano Act authorises any American citizen to claim as US territory any uninhabited and otherwise unclaimed island likely to contain guano. The Navassa Phosphate Company, based in Baltimore, extracted around 10^6 t of fertilizer from the island before abandoning their operations there in 1898. In 1917 a lighthouse was built on the island, and in 1997 the island was entrusted to the management of the State Department, which in turn charged the NMFS[59] to organise scientific excursions there from 1998 (Grace *et al.*, 2000). In 1999 Navassa Island was declared a National wild fauna reserve, and included in this designation was a maritime stretch of 12 miles all around the island (Miller, 2003).

The ongoing legal dispute over the island is of regional significance since its bears on the exact size and delineation of the EEZs of Haiti, Cuba, Jamaica and the United States (Fournier, 2012), currently obstructing such final definition (figures 4 and 31).

[59] NMFS: National Marine Fisheries Service or NOAA Fisheries.

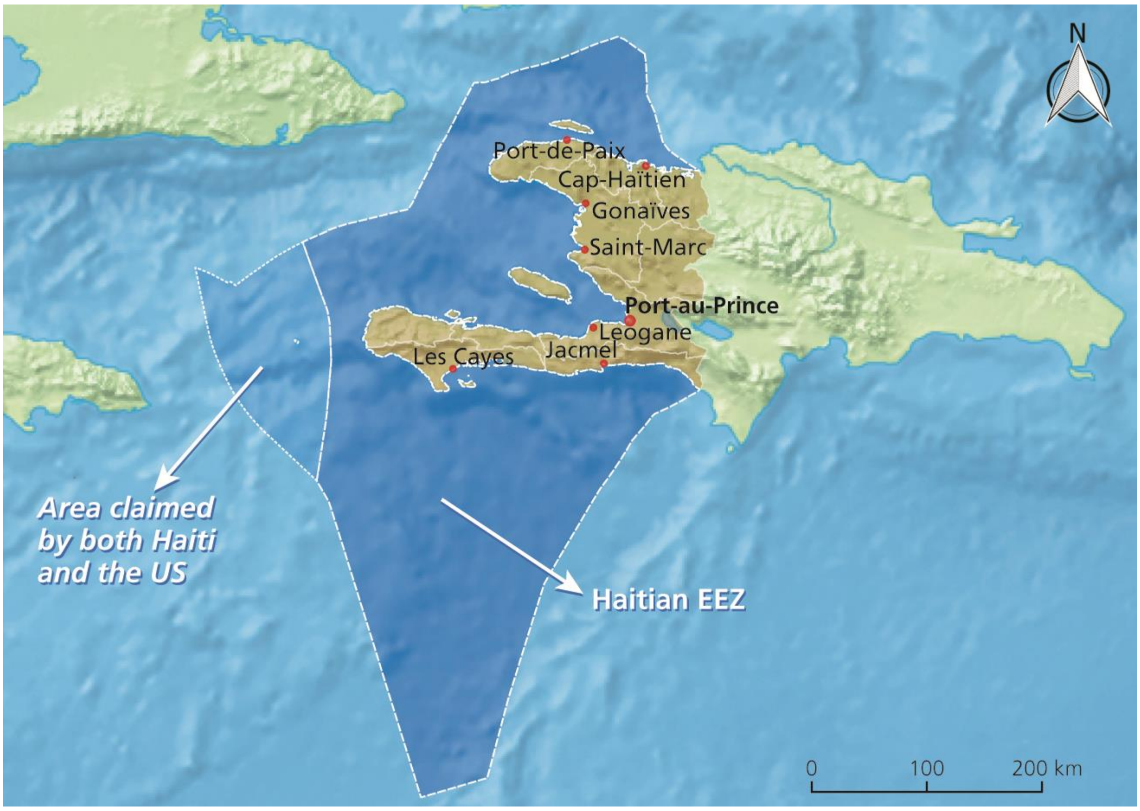


Figure 31
Maritime border claims around Navassa Island (including Haitian EEZ and area claimed by both Haiti and the US)
Credit: G. Touron-Gardic – EEZ data from the Marine Flanders Institute, 2020

GENERAL CONCLUSION

Many events, both political and natural, have shaken Haiti, and continue to do so. In 2005 hurricane Dennis brought destruction, torrential rain and mudslides. In January 2010 it was a magnitude 7 earthquake with an epicentre situated some twenty km from Port-au-Prince, and more recently in August 2021 a lethal 7.2 magnitude earthquake wreaked destruction notably in the Les Cayes region in the country's southeast. In 2016 the category 5 hurricane Matthew forcibly struck the two best-developed reefs in Haiti (Jérémie/Abricots and Barraderes). In 2017 two other category 5 hurricanes, Maria and Irma, this time struck the Trois Baies area. This exposure to natural disasters, combined with a political situation characterised by instability and uncertainty, serves to aggravate the country's food insecurity.

It is within this context that this joint scientific assessment has conducted a survey of the state of small-scale fisheries , this being an essential element in addressing the dietary and nutritional needs of Haiti. The assessment has presented the state of the Haitian marine landscape and of its fisheries sector, the structure of the latter and its management, part of its challenges regarding sanitation and oversight, as well as initiatives underway aimed at ecological improvement and the promotion of aquaculture.

Currently the national fisheries sector is not meeting the protein needs of the population. Marine resources have to be managed in such a way as not to compromise the available fishing stock. Room for improvement seems limited with regard to coastal fishing, which is already over-exploited, but nevertheless a number of approaches can be envisioned. One important one is that of ecological intensification along with the putting in place of interconnected spaces linking artificial reefs and marine protected areas. The development of integrated multi-thropic aquaculture is another, as is strengthening of fishery in general with an eye to ensuring the sustainability of fish stock. In term of this latter concern the exploration of deep sea demersal fishing has produced interesting solutions, provided that it is practiced with extreme care given the precarity of the resource. It is essential to find a balance between fishing effort and the health of marine ecosystems, which can sometimes be very fragile, in order to enable Haitian fishing to maximise its role in the provision of food security and nutrition. Apart from production and the sustainable conditions in which it should develop, the supply chain can also be improved, including with regard to the storage of fishery products all the way to distribution circuits. Science, along with the totality of Haitian role-players – from the state to all the men and women working within the fishery sector – have an important role to play.

These few approaches toward improvement, set forth in the "recommendations" part of this assessment, point to a "modernisation" of the Haitian fishery sector, all while retaining and strengthening the existing know-how and practices of its many role-players. These men and women have developed an impressive capacity for resilience and adaptation in order to deal with changing socio-political- and climatic conditions. As an example one may note the importance of preserving and strengthening useful practices such as fishing from sailed boats, which is both less expensive and more independent. Further investigation should be done towards creating complementarity between better motorisation and the advantages to be had from non-motorised but well-mastered navigation. The Haitian fisheries sector is subject to improvement, but sports a number of assets lending themselves to adaptation in the face of crisis situations or lack of economic opportunity. The sector is "adaptable" due to the diversity of role-players participating in it, creating a significant and very resilient economic interconnectivity.

According to fishing families, the sharing and exchange of knowledge and know-how around fishery also lies at the heart of achieving success. These fishers are receptive to experimental ideas around new techniques advanced by researchers, though such ideas have to be accompanied by proper training and also be properly transmitted. Also, fishers have a lot to learn from each other, as proven by interviews conducted at Chardonnières and Bainet. As much as shared experience, transmission of knowledge from one generation to the next also remains an important instrument. Then too, fishers would like to be more involved in scientific investigations – for example, some expressed the wish for a boat staffed with scientific researchers to conduct experiments over the course of a year to include them on board as well. Some fishers boast of their abilities and their wish to impart their skills to other members of their community or to newcomers wishing to enter employment in the fishing sector. These fishers hold themselves up as ideal teachers for encouraging the use of new techniques and the progressive modification of dietary customs. Making use of them would be one way of ensuring a successful transition.

Beyond sector-specific effort and initiatives to be developed and strengthened, some cross-cutting concerns should be highlighted which will ensure Haiti possess the capacities and a favourable environment necessary for sustainable fishery. These concerns are structural in nature, being the necessity for strengthening the scientific, technical and institutional capacities of the sector, as well as putting in place an integrated management and programmation structure with a framework geared towards the driven long- and medium term implementation of decisions taken.

Meeting these challenges is a *sine qua non* for ensuring the effective and sustainable development of small-scale fishing in Haiti. International cooperation through its different forms and instrument could show itself to be a key support for taking on these many difficulties. Of course such support would be reciprocal, as many other parties, from states to civil society organisations, could benefit from Haitian experience and the country's capacity for resilience and adaptation.

PART 4: RECOMMENDATIONS

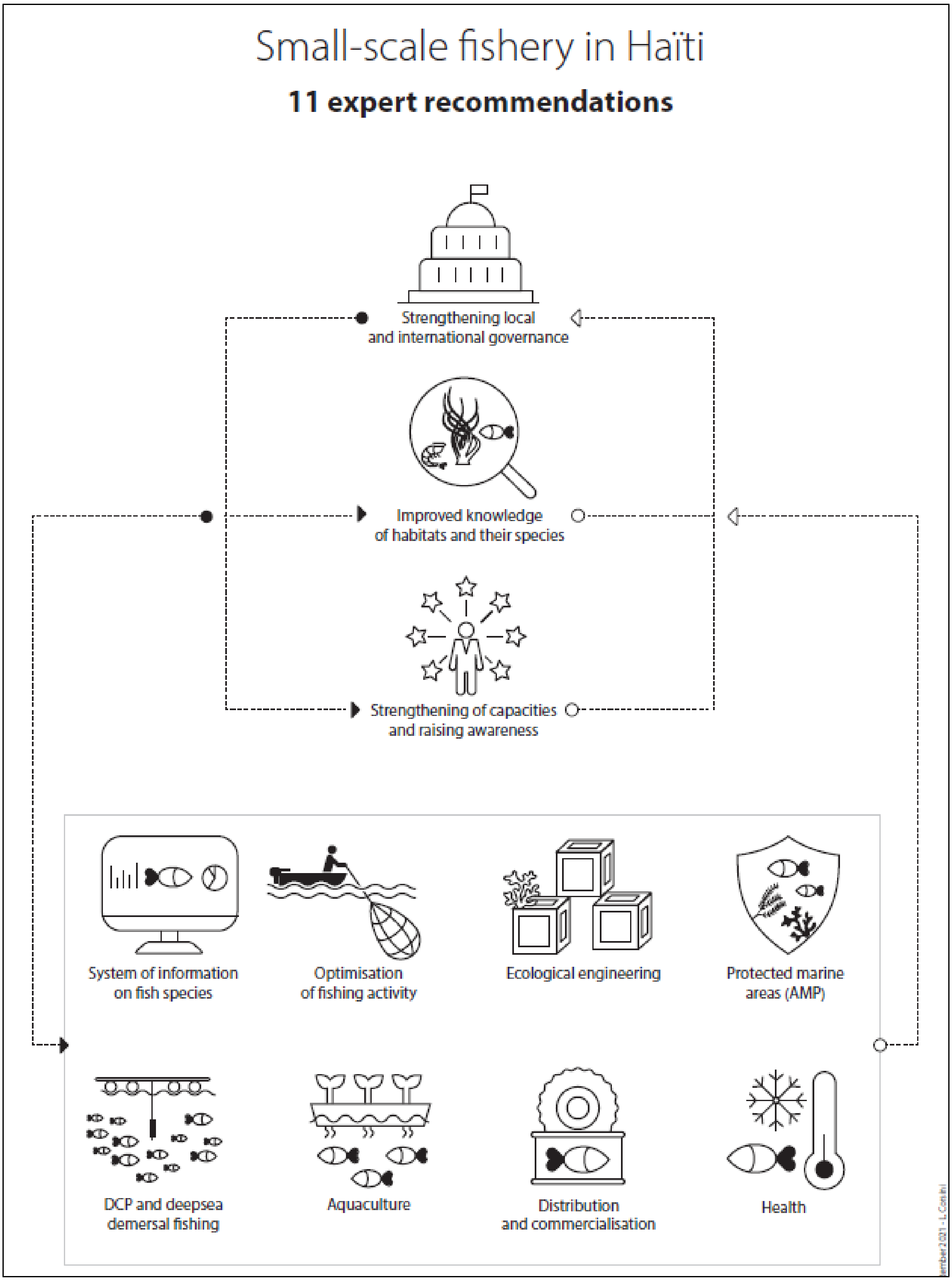
Requested by the Ministry for Agriculture, Natural Resources and Rural Development (MARNDR) in 2017, this joint scientific assessment proposes, apart from a summary of available knowledge (parts I-III), a number of operational recommendations to advance the development of sustainable small-scale fisheries in Haiti. Highlighted in the introduction to this work, we remind the reader here that *"the economic and political situation of Haiti differs from those of its neighbours, and that the application of such norms and practices as are commonly accepted (on an international level) with regard to conservation, to the development of fishing capacity and to management may not be appropriate for, or applicable to, the Haitian situation*".

Eleven sets of interconnected recommendations (see the diagram below for an overview of all sets together) have therefore been formulated. They should be engaged with in a systematic way, and are addressed to decision-makers and role-players responsible for managing marine biodiversity and fishery resources for millions of Haitians. They align perfectly with the 2030 agenda and its sustainable development goals (SDG) and within the Haitian context aim at *"preserving and exploiting in a sustainable way the oceans, seas and marine resources for the purpose of sustainable development"* (SDG14). Through this specific objective, they also aim at addressing several challenges linked to food- and nutritional security in Haiti (SDG2), health (SDG3), education (SDG4), gender issues (SDG5) and poverty (SDG1). As nexus point between numerous development challenges, the small-scale fishing sector in Haiti is characterised by its multiple dimensions.

These recommendations are formulated around cross-cutting actions such as the strengthening of participative management necessary for the emergence of policies and programmes which are both properly suitable and effective over the long term; strengthening the technical capacities of the many role-players in the sector; and also the strengthening of knowledge about the seascape and its socio-ecosystems. These structural recommendations are essential for creating an environment favourable to the sustainable development of Haitian small-scale fisheries . This assessment contains recommendation both sectorial in nature and technical, addressing specific elements of the fishery sector such as the putting in place of a system of information on fish species appropriate to the Haitian context, the development of a system of epidemiological monitoring, the creation and co-management of artificial reefs connected to marine protected areas, and also the strengthening of the system of processing and commercialisation. Apart from the fishery sector, the potential of multitrophic integrated aquaculture with a system of independent production is also explored.

Apart from these timetables, and the means required, it goes without saying that their success depends in large part on political stability and the strengthening of the state's capacities, this being a *sine qua non* for ensuring the creation of an environment favourable to their proper implementation.

Collective view of the sets of recommendations



R1 - GOVERNANCE

Strengthening the capacities of the Haitian state is a *sine qua non* for modernisation, for the regulation of fishing effort and for assuring the long-term preservation of fishery resources and their sustainable exploitation. The current legal framework seems outdated and unfit for purpose. Apart from these aspects, relations between role-players in the sector and decision-making processes at different levels are inadequate. Despite the current difficulties faced by the Haitian state, this assessment proposes a few structural recommendations. These are aimed at the establishment of a system of equitable distribution of benefits derived from the responsible management of small-scale fisheries and of its ecosystems to the benefit of the fishers and those working in the sector, women as well as men. They are also aimed at strengthening inclusive approaches to the drawing up of fishery policies and related programmes, involving participants in the sector. These approaches are essential for ensuring their proper implementation, effectiveness and duration over the long term.

Strengthening participative governance of fishery activities and the management of fisheries resources

From this point of view it is incumbent on the state to involve all participant parties in Haitian fishery (fishers, distributors and others working in the sector – specifically ensuring the equitable participation of women) in the conception, planning and implementation of measures related to the management of the fishery resources on which they depend. Whether the involvement of these role-players in the sector occurs before, during or after engagement in the fishing activities themselves, they possess the knowledge, perspective and specific needs to be addressed which are essential to take into account for the development of sustainable fishery in Haiti. Systems of participative management and co-management agreements between the government and local participants should be encouraged with this in mind. Within the framework of this participative process, the government should take care to ensure that the roles and responsibilities of the parties involved are clearly defined, accepted and commonly understood. In this way all parties will be held to account for following the rules and playing the roles to which they agreed. In this way key role-players in the sector (national and especially local) such as professional associations and governmental bodies engaged in oversight of fishery activities can play an active part in the decision-making process and the creation of a fisheries management policy. To enable this, training and the strengthening of capacities are crucial, (R5)[60], as are financial resources.

Proposal for a pilot project

Marine protected areas (R7) and the shallows of the Aquin and Jacmel regions housing artificial habitats/reefs (R6) are preferred locations for putting in place a co-management project based on territorial fishing rights (TURF).

[60] References correspond to detailed recommendations.

The strengthening and implementation of appropriate monitoring-, control- and surveillance systems adapted to small-scale fisheries in Haiti (R3) can also constitute a pilot project for such a management system. From this point of view, the government should ensure the real-world participation of role-players in the sector by promoting participative mechanisms functioning in the spirit of co-management. The result will be a much more ready social acceptance of regulations and greater efficacy of its implementation given the involvement of the exploiters of the resources in question themselves. Three zones of co-management are envisioned: the village, the township, the fishing ground. Each of these areas should be tested in the fishing grounds in the Sud and Coteaux region where investigations have already been undertaken as part of this assessment (figure 16). Two townships would be selected, one on the coast of an MPA (a Sud fishing area), the other further removed (Coteaux fishing area). At first two villages in each township would be selected for setting up a co-management structure between the MARNDR and the local associations belonging to the National association of Haitian fishers (ANPH). After having learned the relevant lessons from this pilot venture, it would subsequently be extended to all the fishing villages in the township, and thereafter to all the villages in the fishing area.

It is also important to overcome the hostility between the fishery sector and fishers working in it and certain civil society environmental organisations. The former may be seen by the latter as obstacles to the conservation of biodiversity, while inversely the conservation of marine biodiversity is often perceived by fishers as an obstacle to fishing activity. However, there are many synergies and common interests between these groups. A first step towards capitalising on these could be strengthening the knowledge exchange between them so that fishers can have a clearer view of the functioning of an ecosystem, of the impact of fishing on trophic chains and on the biology of the fish species they pursue. At the same time the environmental NGOs can learn better to integrate the knowledge of the natural environment possessed by the fishers into their work.

Strengthening the national legislative framework, as well as interinstitutional collaboration and coordination

The current and past political situations in Haiti make it difficult to implement the fisheries law of 1978. That said, the law is mostly obsolete and should be reconsidered when possible so as to adapt the legal means available to the current needs of all participants in the sector, taking into account the evolution of fishery activities and the modernisation of techniques and management instruments (such as artificial reefs, MPAs and FADs) as well as numerous related challenges such as safety at sea and the required financial investment. Respect for the rules governing the protection of species and their habitat, taking into account their spatial distribution and seasonal variations, should also be clearly set forth. Apart from its content, the challenges facing its implementation should also be kept in mind, and notably doing so through participative management processes involving governmental bodies overseeing fisheries and the other role-players in the sector. Also important is the putting in place of transparent, joint monitoring mechanisms and the appropriate allocation of budgets.

It is also essential to establish and promote institutional structures, linkages and networks – notably between local, national, regional and global levels – necessary for ensuring an alignment of policies, as well as intersectional cooperation to ensure a proper integrated management of fishery resources. In this regard relations and collaboration between the MARNDR and the Haitian Ministry of Environment (MDE) should be strengthened. Thematic working groups and ad hoc decision-making bodies would benefit from being created in order to enable the pooling of means and the hosting of integrated discussions around common challenges as required. An important step toward such interministerial collaboration could be the putting in place of an **integrated marine planning** effort relying on maps of habitats and cognisance of the connectivity between them, as well as of their vulnerabilities to anthropic pressures (R2 and R7) with an eye to creating a national network of MPAs and artificial habitats/reefs which are biologically interconnected.

Apart from linkages between ministries, pooling efforts and coordination should be strengthened inside the ministry responsible for fishery. This assessment advises narrower links between the MARDNR departmental directorates for agriculture (DDA) – notably its services charged with driving activities on the ground at a level that is closer to the role-players in the field (the service for natural resources and that for animal production) – and the Directorate for Fishery and Aquaculture (DPAQ).

In order to ensure the effectiveness of these measures, it is imperative that they be accompanied by the strengthening of technical capacities within the MARNDR's services, notably with regard to fisheries management, aquaculture and extracting value from production (R4).

Strengthening regional and international cooperation

It would be a good idea for the Haitian state to strengthen its regional and international cooperation in order to improve its capacities for the sustainable development of its fishery sector.

Notably the following objectives should be pursued:

- refining and improving its understanding of problems related to fishery through participation in more fora where engagement with these problems takes place, such as the International Commission for the Conservation of Atlantic Tuna (ICCAT)[61] and the Centre-West Atlantic Fisheries Commission (COPACO)[62]. This would enable Haiti to derive more benefit from the advice and points of view expressed by these organisations, but also to put to good use the country's generation of fishing statistics;
- strengthening the capacity for resilience in the face of global challenges though the support structures and regulations emerging from the Rio conventions, such as the Convention on Biological Diversity (CBD) and associated funds such as the Green Climate Fund (GCF) or the Global Environment Fund (GEF). Apart from these support instruments, it is crucial that Haiti participates fully in

[61] https://www.iccat.int/fr/
[62] http://www.fao.org/fishery/rfb/wecafc/en#Org-Contacts

international environmental management efforts. The participation of representatives of the Republic of Haiti in technical committees and participant conferences related to international and regional agreements – such as the Carthagena agreement for the protection of and capitalisation on the ocean in the Caribbean region – should be supported;

– alignment with international standards related to the hygiene of products and the preservation of endangered species could be part of a strategy for improving the exportation of fishery products. In this regard the adherence of Haiti to the Convention on International Trade in Wild Endangered Species of Fauna and Flora (CITES) should be considered.

R2 - HABITATS AND THEIR SPECIES

Haitian marine habitats and their ecological functions (nursery, growing pool, transit area for larvae and juveniles…) find themselves in an unfortunate situation due to overfishing, erosion of watersheds, urban growth and various forms of man-caused pollution. In order for small-scale fishing to develop in a sustainable way in Haiti, it is imperative to be more familiar with these habitats, as well as with the marine species exploited for fishery for which they provide a home and an existence. This assessment has extensively highlighted the limited knowledge available on the physical and biological environment within which the Fisheries system operates. New data should be obtained and such knowledge as is generated should be better disseminated, notably among those who operate within the marine environment, and notably fishers. The latter themselves possess important knowledge of the seascape which supports them, or which has supported them, so it is also important to collect, integrate and put to use this knowledge as part of the effort to improve our overall knowledge of the subject.

Better knowledge of coastal shallows

These coastal shallows of less than 40 m represent the primary zone of operation of fishing activity performed from small boats and house the most productive habitats of the Haitian coastal area, as sunlight in these zones is sufficient for photosynthesis. The unique depth measurement profile for the country is provided by the international database GEBCO (General Bathymetric Chart of the Oceans), with a spatial resolution of around 450 m at the equator, being insufficient for providing understanding of the geomorphology of the coastal shallows or a high-resolution mapping of the habitats.

Two complementary actions are proposed:

- *creation of a bathymetric map of the coastal shallows on a country-wide scale* by using ATLAS (Advanced Topographic Laser Altimeter System), lidar operating from the NASA ICEsat-2 satellite since 2018. A project aimed at testing the method is set to be initiated on Mayotte and in the Seychelles, led in partnership by the IRD and NASA involving the Centre for coastal geo-ecology at the "École pratique des Hautes Études" (EPHE) and the marine hydro graphic and oceanographic service (SHOM in French). Haiti could be the first Caribbean country to benefit from this technological and scientific innovation.
- *creation of a geomorphological map of the coastal shallows* of sites of particular interest with regard to fishery based on the bathymetric map and using a small Remotely Operated Underwater Vehicle (ROV) for verification of the terrain in actuality.

Improved knowledge about marine habitats and their vulnerability

Coral reefs, spermatophyte seagrass beds and mangroves are the three marine habitats most emblematic of the Caribbean. The regular passage over Haiti by very high resolution satellites currently enables the real-time monitoring of surfaces occupied by these habitats, with ground-level verification of the terrain allowing for the completion of surface data with information on the state of health of these ecosystems.

Four actions are proposed.

1. *Establish mapping of the coral reefs and their interconnections on a country-wide level*

Based on the feasibility study conducted on Gonâve Island as part of this assessment, mapping of the reefs would follow the method perfected by the French Initiative for Coral Reefs (IFRECOR in French) and used in the totality of the French overseas territories (Nicet *et al.*, 2015). It is recommended that the map thus obtained be updated every twenty years and that special attention be given, at shorter intervals, to areas under threat from human activity. This endeavour would provide an opportunity to strengthen the country's capacities in mapping its critical marine habitats and to engage in the monitoring and evaluation of its reef ecosystem (R4).

The map of reef interconnectivity would be created on a national level and cross-referenced with the map of the individual reefs as well as that of the currents.

2. *Establish mapping of mangroves and seagrass beds at a country-wide level*

By completing the Cyprus study (2016) but using better spatial resolution, this mapping would follow the method developed by IFRECOR (Taureau *et al.*, 2015). Sentinelle 2 satellite images (10 m spatial resolution) would enable the creation of a map of mangroves and seagrass beds across the entire country. Locally the Pleiades satellite images (70 cm spatial resolution) would enable detailed mapping of mangrove sites threatened by anthropic activity. It is recommended that the map created be updated every five years because of the high amount of anthropic stress placed on the two ecosystems. This endeavour would create an opportunity to strengthen the country's capacities for mapping its critical marine habitats and to carry out monitoring and evaluation of its mangrove- and seagrass bed ecosystems (R4).

3. *Mapping of marine habitat vulnerability at a country-wide level*

On an island sporting numerous steep breakwaters and a population concentrated on the coastal areas, coral reefs, mangroves and marine spermatophyte seagrass beds are all vulnerable to sediment flow from the breakwaters, resulting from soil erosion, as well as to pollution from adjacent urban areas. Based on the mapping of the three habitats (reef, seagrass bed, mangrove) together, a further mapping of their vulnerabilities would be carried out by cross-referencing with the following three parameters:

A. the importance of these habitats in terms of their ecological function and their contribution to small-scale fisheries ;

B. the amount of exposure suffered by the habitats to pollution, taking into account their distance from urban centres and current patterns;

C. the amount of exposure to erosion, which would be evaluated via a model combining four parameters: the type of soil, the shape of the surface, precipitation and soil occupation.

4. *Establish participative mapping of fish spawning*

In collaboration with the National Association of Haitian Fishers (ANPH), a map would be created around the spawning of the main fish species known to fishers in order to be able to protect spawning sites during periods of reproduction.

Improved knowledge of marine species

The international database of species of regional interest is currently the primary source of knowledge about the marine species of Haiti. This assessment has managed to find 1 935 animal- and 246 algae species on this database, information which is set to be consolidated in an upcoming work edited by the experts P. Vendeville, W. Célestin, H. Vallès et S. Jean-Marie with participation by the FAO. However, it would be helpful if one could go further and pass on this information to the fishers so as to strengthen their knowledge of the ecology of relevant fish species.

Two actions are proposed.

1) *Establish an electronic catalogue of Haitian fish species*

Every species would be listed along with its scientific name, one or more photos, the different vernacular names used in the different part of the Haitian coast and a description in both Creole and French of its different ecological characteristics and behaviour, as well as the regulations applying to it – notably with regard to fishing seasons and minimum- and maximum sizes of fish species eligible for catching once these will have been determined.

Provided the electronic support and means are put in place and ensured over the long term (creation and management of a database based on the catalogue, adapted electronic interfaces and applications, etc.), the electronic nature of the catalogue would enable a fruitful interactivity via-a-vis the fishers. On the one hand, fishers's- and traders' associations would be able to consult the catalogue using the cell phones of those of their members with an internet connection; on the other hand, these associations could assist in the expansion of a database based on the catalogue by posting new photos or information such as the sales price of fish species.

2) *Gathering information on the ecology and abundance of fish by in vivo observation*

By definition the seascape is impenetrable to observation from the surface, and numerous fishers have never engaged in underwater diving. Putting in place small underwater cameras for periods of 24 hours or more would enable evaluation of the abundance of fish at different times of day and night at pilot sites chosen for their representation of ecological conditions and for the stress placed on them by fishery activities. Emphasis would be placed on coral reefs in good state, degraded reefs, seagrass beds in good state, degraded seagrass beds, sedimentary areas lacking seagrass, artificial habitats. Each of these 6 ecosystems would be studied at different depths, 5 m, 15 m, 25 m, 40 m and with regard to 3 distinct fishery stress levels: strong, medium, weak, the latter corresponding to MPAs. Hopefully these sites would be sampled on a yearly basis at the same time in order to evaluate changes in the abundance of their fish populations. As there would be film of the habitats, these could also be used as ground-level verification of habitat mapping done, and thus serve as complement to the ROV. These data could be combined with analyses undertaken by some civil society players such as the NGO Reef Check, which is currently monitoring shallow-water reefs.

Disseminating and assigning to rightful place scientific and local knowledge alike

Scientific data and local knowledge on the Haitian seascape should be disseminated at an international level in order to feed into intra- and interregional comparisons regarding marine biodiversity. The same should also be done at local level in order to enable fishers to use these as part of their activities.

To these ends, two actions are proposed.

1) *Collection and storage of knowledge about marine habitats, the species populating them and their vulnerabilities*

This collection and storage process could take place in the form of the archiving of georeferenced occurrence data on biodiversity in international databases, i.e. the system of biographic information related to the oceans (OBIS)[63] or/and the global information system on biodiversity (GBIF)[64]. Such archives are essential for enabling decision-making on the basis of scientific knowledge.

2) *Restoring knowledge to coastal role-players*

The experts recommend that authorisation for research to be undertaken be made dependent on a code of good conduct and the obligatory restoration of results obtained to public institutions and fishers's groups having participated in the research.

[63] https://obis.org/
[64] https://www.gbif.org/fr/what-is-gbif

R3 - FISHERIES INFORMATION SYSTEM

Currently, as indicated in the summary of this assessment, information regarding fishery activities is only obtained at intervals and bears solely on part of the territory. This lack of visibility is all the more regrettable given that the stress on resources is considerable, requiring management. In view of local constraints, it appears inadvisable to aim for the creation of a fisheries information system (SIH) that would operate at a high level (quasi-exhaustive and in real time) such as those used in the large Western fishing nations. Within this context our assessment advises improved structuration, coordination and strengthening of role-players and statistical monitoring of fish in order to ensure a sustainable management and development of fisheries in Haiti. This first step appears necessary towards the elaboration of a more flexible, functional and open SIH, which can be maintained over the long term. Such an SIH could be called an "observatory".

Creating the institutional framework for a Haitian fisheries observatory

The creation of such an observatory would enable the structuration of existing technical means and establish a functional framework for allowing for their participation in a shared project on data and information related to the fishery sector.

Within this framework, the assessment advises the putting in place of a **coordination** authority uniting concerned role-players through statistical data on Haitian fishery: professional associations, administrative structures, scientific projects. In terms of administration, such role-players as can be *a priori* members of this authority would be (listed in probably non-exhaustive fashion): the agricultural statistics and data processing unit of the MARNDR (USAI); the customs service. Further participants in this authority should include key civil society role-players, i.e. NGOs and development projects involved in the collection of data, as well as fishers's organisations and those involved in commerce (traders and agencies alike). Participants would then go on to serve as pilot committee for the observatory.

This authority will further be able to define, though joint agreement, the scope and objective of a **permanent technical cell of the observatory** with the purpose of carrying out the latter's daily activities. This cell should be imbued with sufficient, permanent means and technical capabilities, and should possess a legitimacy recognised both by the pilot authority and by the MARNDR.

One of the first goals of the observatory would be **drawing up a charter setting out the roles**, rights and responsibilities of each role-player in relation to the observatory's operations: collection, transmission, storage, processing, analysis and dissemination of statistical information.

Putting in place instruments suitable for the operation of the observatory: collecting, centralising, storing and analysing data to produce indicators beneficial for fisheries management

Following the adoption of the charter, it will be necessary to develop and apply the instruments and methods designed to fulfil the various functions to be carried out by the observatory (both those for which the participating partners would bear responsibility and those delegated to the technical cell).

The functions which the observatory (operated by the partners) would undertake would be, at the least:

- the repeated undertaking, at certain intervals, of the national fisheries survey, keeping in mind that this survey collects data of which the updating depends on two timeframes: the short term, which corresponds to data requiring updating every 3 to 5 years – e.g. data relating to fishing boats – and the long term, which corresponds to structural data – e.g. mapping of docking points – requiring updating every 10 to 20 years;

- monitoring of fishing activity through fishing logs kept by boat crews and declarations of hauls, both of these in cases where fishers are willing to participate actively. As indicated in the summary of this assessment, it is essential that the fishers play a voluntary and proactive role in the process, and that they report directly on their activities. *The widespread use of cell phones* creates considerable possibilities for involving fishers in the gathering of fishery-related data. The issue of obligatory declaration of caught fish brought to shore can be considered within the framework of new fisheries regulations. With regard to this, a pilot project can be undertaken in instances where sufficient support (e.g. FAD-related projects) is provided to participants;

- economic monitoring of the role-players as well as organisations/commercial agencies, based on activity registers and, ultimately, investigations carried out via sampling at marketplaces and excursion sites;

- an on-going process of processing and analysis for the regular production of occurrence indicators and monitoring of Haitian fishery, collected in the form of bulletins, maps and displays;

- exhaustive and coherent cataloguing and archiving of data obtained from the monitoring of fisheries activity (aligned to the relevant nomenclature and matched spatial referencing).

In order to facilitate the operation of all these functions, the creation of a computerised platform of shared instruments would constitute an essential step. This platform would provide all participants in the observatory with a library of methods and information. The library would contain, for example, models of **basic survey sheets** for the monitoring of activity, hauls obtained and commercial activity; tables of referential nomenclature (fish, boats, equipment, product types); geographical reference norms; maps, examples of displayable formats adapted to local requirements (pictures and

Creole terminology). This platform would also provide instruments enabling data transfer (e.g. via a shared Cloud space) by ensuring data gathering is done in complementary formats.

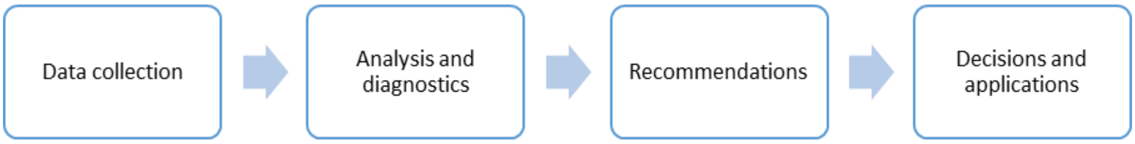
Finally, strengthening of the capacities for using these different instruments and methods should be done, for example via training workshops held in each of the fishing areas, as well as for the main team involved.

A test implementation of the operation of the observatory and its instruments could initially be done (for corrections and verifications) at the site of a small fishing ground or for a few fishing operations engaged in pursuit of species of particular interest or overfished species. After confirmation of functionality, another test would be done in a much larger fishing ground, before proceeding to national implementation.

R4 - FISHING EFFORT

Located at the heart of a major sector operating as part of the national economy, fishers concentrating their activities on Haiti's currently overexploited coastal areas number around 46 000[65]. Based on current knowledge regarding fishing effort in Haiti, our assessment recommends several stages in the optimisation of this activity, following a policy of **controlled exploration** and **putting in place regulations**. It is nevertheless imperative that the current knowledge be improved (R1) in order to engage with and optimise to a greater extent the potential for fisheries exploitation. Apart from the improved perspective that would result from this, the participation of the fishers and other role-players in the sector in data collection activities and project design across the sector is a *sine qua non* for maximising production while simultaneously maintaining fishery sustainability.

Summary of the key steps towards management of marine resources



Evaluating the potential for the exploitation of fishery

There are three main methods for evaluating the potential for exploitation of fishery: exploratory fishing; visual observation via underwater cameras and acoustics; collection of data on fishing effort, hauls and size category of catches from the fishers. All three methods are practiced by scientists and require significant ocean-based investigation. Their cost therefore is quite high (tens of thousands of euros) in cases of sampling done at a national level.

Within the Haitian context, attempts to use **underwater cameras** in order to estimate the size of fish populations could be carried out within the framework of site visits undertaken as part of mapping of marine habitats and shallows. Data gathered from these could be combined with those from organisations having already produced similar information such as Reef Check (R2). One can envision this method being used every year at the same time in a limited number of observation points. On the other hand, using it on a national scale over a long period of time (twenty years or more) is not feasible given the current state of equipment available. It is therefore no substitute for the monitoring of fishery activities and the production resulting from them. Within this context the creation of a **Haitian fisheries observatory** (R3) is key in ensuring the putting in place of procedures for gathering properly-aligned data enabling both the monitoring of the evolution in fishery output and the size category of the main species targeted, and that at national level, at the level of individual fishing grounds, or at a smaller geographical level. In the case of obvious overexploitation, examining the size categories is enough. The majority of production involves individual specimens of a smaller size than the minimum marking sexual maturity. In other cases, using the

[65] According to the third phase of the fisheries survey (MARNDR, 2021).

Schaeffer model calculating the relation between fishing effort and the size of hauls resulting from it enables the characterisation of fishery activity and the estimation of the maximum balanced yield, corresponding to maximum effort, which can be extracted from a single stock without its regenerative capacities being compromised[66].

Maintaining spawning grounds in a healthy state is a necessary condition for stock adequate for beneficial exploitation[67]. These areas should therefore be protected from anthropic activity which can degrade habitats, such as chemical pollution or repeated anchoring by boats, and fishing in them should be entirely prohibited during periods when fish gather there to reproduce.

Seeking out new areas with an eye to sustainable exploitation

In light of present knowledge, as indicated in the summary, coastal marine resources are overexploited and above all demand suitable regulation of fishering effort.

However, the question arises of how to approach species found in the deepest parts of the ocean – in depths of more than 50/100 m – about which we have very little information.

Notably taking into account Haitian fishing equipment, our assessment hypothesises that the biotope is possibly not everywhere fully exploited, and that some of the species targeted for fisheries may remain out of reach at these depths (notably adults of reproducing age), thus escaping fishing activity brought to bear by the great number of boats operating in shallow waters. In order to test this hypothesis, placing underwater cameras (as noted above) both by day and night should provide the necessary information on the daytime and night-time numbers of species present in a given location, as well as on their size and the habitats in which they seek refuge. Once such sites identified, it would be advantageous for them to be made part of an MPA in order to preserve their potential as reproduction zones.

The base of rocky outcroppings at depths of 100/200 m serves as habitat for deep sea demersal species which are still not well known and not greatly exploited. Exploratory fishing will be necessary in order to obtain a better knowledge of these fish populations. A variety of fishing gear (traps, lines/longlines) could be used in concert for targeting these species in line with a sampling strategy to be designed (according to a fixed pathway or arbitrarily). In this way the species could be identified and measured. Biological data (ratio male/female, maturity, size, weight…) would be gathered and the number caught per individual attempt (CPUE in French) recorded for each piece of equipment utilised.

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[66] Each unit of stock is made up of species sharing a particular habitat and depth category. Thus coral reef-based species and those favouring rocky seabed at less than 70/100 m (the limit of the euphotic or uppermost zone) where sunlight still reaches can be considered as a unit of stock. The same holds for demersal species occupying sandy seabeds or mangroves, or deepsea demersal species.

[67] We should recall that that each new batch of fish entering into an exploitable age category constitutes a stock to be targeted for fishing.

Co-design indicators for evaluating stock with an eye to sustainable fishery

Continuous evaluation of stock provides information with which to guide the management of fishery by enabling those responsible to detect fluctuations in the state of fish stock over time. This is done based on defined indicators which should be simple, easy to understand and easy to measure (R3). In order to ensure both their usefulness and effectiveness, these indicators should be developed in collaboration with role-players in the sector, primarily the fishers – notably representatives of the ANPH – resource managers – particularly the MARNDR and the ANAP operating within the framework of MPAs – and scientists. These indicators have two main functions:

- on the one hand, reporting at a national level such information as is gathered locally in order to enable a global analysis, by the MARNDR, of the state of small-scale fisheries in each fishing ground. On this basis an evaluation of existing regulations can be made and possible changes proposed;
- on the other hand, self-evaluation of the situation at local level (see below).

Defining regulatory policies with regard to fishering effort at local and national level

Based on these elements, effective management of fishery at local level can be established in two ways:

1) Through defining a minimum size limit for fishing eligibility for each fish species and crustacean, and in some cases both a minimum and maximum limit for molluscs, the reproductive capacities of which increase over time. Ensuring the respecting of these rules would require that templates for size measurement be widely disseminated among fishers operating out of fishing villages.

2) Through creating fishing areas and the putting in place of co-management agreements implementing user's territorial fishing rights (TURF) or, in addition and more generally, through creating Marine Protected Areas taking into account both fisheries activity and the conservation of resources (R7).

It should be emphasised that marine habitats are not only areas of daily operation for professional fishers, but that they also function as veritable pantry for the totality of the coastal population in times of crisis negatively affecting agricultural activity, such as cyclones or during periods of letting land lie fallow. During these periods fishing activity is intensive and even very small fish are caught. Effective fisheries management at a local level should enable the optimisation of this "pantry" function by reducing fishing for small demersal fish at other – i.e. non-crisis – times.

Sustainable fishery and the regulation of fishing effort related to it both depend on a better understanding of the biology of targeted species. Through an inclusive dialogue among role-players, primarily the fishers, a calendar of *mating periods* of the main shallow demersal species can be created, and a *mapping of spawning grounds* done so as to enable temporary restrictions on fishing in these areas to be co-determined in consultation with the fishers, thus to preserve the reproductive potential of resources and the renewal of stock into the future, the replacement of one generation of demersal species by another being mostly determined by the mortality of adult reproducers via fishing practices.

Given the significant fragility of deep demersal species inhabiting the 100-1 000 m depth category, that their growth rate and the age of their initial sexual maturity generally increase by depth of habitation, as well as the potential for exploitation they present, it is essential to monitor their exploitation via fishery and to set forth, at a national level, suitable regulations to ensure the sustainability of this exploitation. Some simple rules could be put in place:

a) subject authorisation for their exploitation to the purchase, by boat owners, of a licence;

b) prohibiting the use of any piece of fishing equipment other than a handline[68] - a fishing licence holder would commit to this condition on the understanding that its violation would result in the seizure of his boat and the suspension of his rights to a new licence for a period of ten years.

c) granting a license depending on a commitment, by the boat owner, each month to provide data on fishing effort and catches so as to allow for the calculation of the potential for exploitation inherent in every fishing ground.

Involving role-players in the fishery sector in data gathering and results obtained, and raising their awareness in this regard

Effective management of fisheries requires clearly defined objectives, as well as the participation of all role-players in the sector in the development of management tools and rules for controlling exploitation and for the verification of success in achieving the objectives.

Apart from the gathering of data, it is crucial to involve role-players in order to derive benefit from their knowledge, and of course also to increase the likelihood of their accepting rules and regulations/restrictions related to fishing activates. The fishers are at the heart of this policy and have to be considered as: generators of data, exploiters and regulators of marine ecosystems. In order to optimise the exercise of these various roles the strengthening of their capacities, as well as those of other role-players in the small-scale fishing sector (administrators, distributors), is essential (R5).

[68] While it may be tempting to engage in longline fishing in relation to these deep stocks given the size of hauls obtained that way and the prospect of higher income thus generated, the acute vulnerability to any intensive exploitation on the part of these stocks argues for the adoption of a principal of caution, restricting fishing activity to the use of equipment having been proven in other parts of the world, when subject to regular monitoring, to enable sustainable fishery (Cillaurren *et al.*, 2002).

R5 - CAPACITY BUILDING AND AWARENESS-RAISING

The implementation and effectiveness of the recommendations made as part of this assessment depend on the proper training of the role-players involved in fishing activities; training with regard to the maintained practice of their profession as well as with regard to changes to be made, but also with regard to the seascape, with which adequate familiarity is often lacking. Currently in Haiti there are no school- or university programmes dedicated to the ocean- or reef environment, despite the social and economic importance these hold for the life of the Haitian people. The provision of training should go hand-in-hand with the modernisation of the sector with a view to the sustainable development of fisheries activity. Once engaged as participants, the fishers should also be more involved in decision-making. **Such strengthening of capacities should take place at different levels and in relation to a variety of role-players operating all along the value chain.** It should be based on existing knowledge and know-how, with flexible training curricula adapted to individual needs – for women as well as for men. It should also involve instructors who themselves are products of the fisheries sector.

It should be noted how important it is for the administrative powers to ensure they have access to the necessary knowledge and skills to ensure support for the sustainable development of small-scale fisheries (including shared project creation- and co-management methods). In this regard, particular attention should be given to local governmental bodies engaging in the process of management and development along with local small-scale fishing communities.

Creating a “sea school” for sustainable fishery in Haiti (participants; format and sub-themes)

This project is part of the desire, on the part of the government – and notably the Haitian maritime and navigation service (SEMANAH) – to create a national institute for maritime training in order to offer two- or three-year training programmes to provide a theoretical- and practical foundation for carrying out fishing excursions, to commandeer a small-scale fishing boat or for the undertaking of aquacultural exploitation. The “sea school” we are proposing would instead focus on short training courses.

Participants: key actors in the sector (fishers, sellers, representatives of associations), but also local agents and personnel attached to local branches of the National Agency for Protected Areas (ANAP) and the MARNDR, such as DPAQ (matriculant level).
Objectives: acquiring and strengthening theoretical and practical knowledge related to the exercise of ocean-based professions, such as support for the monitoring/management of marine areas possessing national heritage value (such as MPAs, etc.).

Format: Three levels of training are envisioned: basic (second-year college level), intermediate (early third-year college level), advanced (Masters level). Each level would be made up of training modules, the cumulative completion of which would earn students a diploma recognised by accredited Haitian institutions of higher learning. Each training module, lasting for one to two weeks, would combine theoretical and practical courses with site visits which would enable particularly employees of government services to observe and improve their knowledge of the activities carried out by fishers and by the totality of the role-players working in the fisheries sector.

A central element of the training would be the training of instructors able to operate in a professional environment; the primary candidates would be representatives from the national association of Haitian fishers (ANPH) and the national association of seafood traders (ANAMPROM). Along with the training they would receive at the "sea school", they would also be furnished with textbooks written in Creole and French which would assist in their teaching efforts within their respective associations.

Selected sub-themes:

- introduction to the seascape: physical aspects (waves, currents, tides, bathymetry, geomorphology); chemical aspects; biological aspects (primary productivity, trophic chains);
- introduction to the ecology of species targeted for fishing; to conditions of their subsistence (biological rest, etc.); to the effects of fishing on their demographic growth and on trophic chains;
- introduction to marine habitats: coral reefs, mangroves, spermatophyte seagrass beds;
- modalities and management systems related to sustainable fishing (co-management of MPAs, LMMA, TURF, artificial reefs, biological corridors, etc.);
- fishery associated with anchored FADs (conception and construction, maintenance and management of FADs);
- niche fishing (sustainable fishing technique in demersal areas; queen conch, etc.);
- instruction in navigation and "reading" of the ocean and the sky;
- aquaculture, notably integrated multi-trophic aquaculture (Amti) and visits to aquaculture farms;
- shipboard working conditions and marine safety for all kinds of fishing boats;
- hygiene, preservation of products and optimising their value: traditional drying/salting/smoking techniques, but also hoisting nets, preparation of fish pellets, etc. Specific focus on women working in the sector (traders, Madam Sarahs, etc.) is strongly recommended.

Synergies and complementary aspects should be explored with other "sea schools" in the Caribbean (exchange programmes, lecturer pool, etc.), notably those in Martinique, the director of which is a contributor to this assessment.

Strengthen university courses on different aspects of the Fisheries system

A number of Haitian universities, notably the Haiti State University and the University of Quisqueya could, with the support of the government and international cooperation, offer both long-term undergraduate and graduate courses in environmental studies and the management of fishery resources (at third-year college and Masters level). Thus Haiti would see the creation of a university discipline exclusively dedicated to marine studies aimed at training the national experts the country needs. Apart from specialist instructors, these courses should also feature instruction by professionals working in the sector, as well as researchers.

Select training modules:

- anthropology of fishing;
- ecological engineering and sustainable value-extraction from the environment;
- economy of fishery;
- fishery statistics.
- geography and history of fishery;
- growth of exploited marine populations and the ecosystemic approach to Haitian coastal fishing;
- integrated approach aquaculture, from the hatchery to the extraction of economic value from products;
- methods and instruments used in fishery research;
- regulation and co-management of fisheries;
- seaside tourism and ecotourism;
- spatial planning with regard to fishery;
- territorial perspective related to the coast and fishery;

These programmes could be based on international university cooperation, notably regional cooperation within the Caribbean, as well as South-South cooperation. Where possible the creation of a joint Masters degree between a Haitian institution and an international counterpart within the region or from a francophone country would be encouraged. In this regard the Directorate-General for the Caribbean of the University Agency for Francophone Studies (AUF in French) based in Port-au-Prince could play a major role. These kinds of cooperation would enable Haiti to emerge from its isolation and would also allow for the training of tomorrow's crop of administrators of the Haitian fishery sector, as well as the country's future instructors and teachers working in the field.

Proposing flexible and occasional training courses (summer schools)

In partnership with the university system and other national and international partners, summer schools for sustainable fishery and aquaculture in Haiti should be arranged. Multidisciplinary in nature, these summer schools would serve as complement to the training modules suggested above. Tailored to the participants (fishers, traders, government representatives…) these training courses, being flexible in structure, practical and short (one or two weeks) could be arranged according to two formats:

- classroom-based courses;
- excursions and fieldwork for practical application of lesson learned.
- The ideal number of participants would be 20 to 25 people, allowing for a division into 4 or 5 groups of 5 people each.

Raising awareness of challenges to sustainable fishery and healthy marine habitats

Apart from the above-mentioned training interventions, other teaching methods, as well as raising awareness of challenges to small-scale fishing in Haiti, of its role in Haitian society and nature and the numerous challenges facing it, could be promoted. With regard to environmental awareness-raising, new instruments such as interactive games combining a pedagogic and entertainment-based approach – such as the MARECO educational toolkit put forth by the IRD – should be used in order to enhance the understanding, by children, of marine ecosystems, their importance for sustainable fishing and their vulnerabilities. More adult games, of a roleplaying variety, like FishBanks[69] would allow adults to engage with the complexities of managing a fishing fleet within an imaginary environment where the dynamics of resources and economic concerns meet.

Expos on small-scale fishing in Haiti and the current and future challenges it faces could also be arranged, disseminated and presented in diverse locations, from primary schools and universities to fishers's associations. This type of expo could be arranged within the framework of local markets and festivals in partnership with associations operating on the ground as well as government ministries, all aimed at highlighting the value of fishery as profession as well as the environments within which it is practiced. In this regard, competitions to identify "the most beautiful fishing villages" could also be organised.

Near MPAs, protected educational areas (APE in French) could be put in place for primary school-level instruction. These could be based on the original APE model developed in 2012 on the Marquesas island archipelago (French Polynesia), which is currently seeing rapid dissemination.

Inducing families and fishers to continue teaching sea craft to their children

Concurrently with the development of new practices, it is important to strengthen the independence of Haitian fishers via highlighting the value of, and strengthening, local know-how, notably skills related to "reading" the weather, to steer and maintain and repair small boats, and to be cognisant of the supply chain related to boat construction – notably involving the necessary use of noble trees. Maintaining these forests is also a necessary condition for the sustainability of small-scale fisheries , given that the majority of boats are made of wood.

[69] It is noteworthy that FishBanks is one of the oldest adult games in existence, apart from war-themed games; it was created by D. Meadows at the Massachusetts Institute of Technology more than 40 years ago.

R6 - ECOLOGICAL ENGINEERING

The submerging of artificial habitats (AH) and their potential for attracting fish was unanimously approved of by the fishers interviewed as part of this assessment. Proof of their effectiveness has already been established in three cases, such as the "ampil poisson" project which attracts a significant lobster population (summary: part II/II). AHs recreate the kinds of natural habitat having been degraded or which are rare or over-exploited, and enable larvae to settle and juveniles and adults to find shelter, to feed or to reproduce.

Integrating cartographic data in order to target the installation of artificial habitats (AH)

At a national level the identification of areas where AHs would be most useful requires the cross-referencing of five types of data:

- mapping of the shallows (R2);
- mapping the main habitats (reefs, seagrass beds and mangroves) as well as the local geomorphology;
- the study of currents (currentology);
- the productivity of fishing boats (data obtained from fishery survey) in relation to the surface area of specific shallows, which would enable an estimation of the potential stress resulting from fishing activity and thus of the size of the HA necessary in order to ensure the continued presence of exploited species;
- the location of MPAs, enabling the creation of a chain between them and the AHs, thus developing and strengthening ecological corridors.

Once the most suitable areas for the placement of HAs have been selected, a final decision would be made regarding the most effective submerging sites within them, and that at a local level using information provided by the fishers and obtained from diving excursions.

Developing artificial habitats at three pilot sites in the south of the country

At the bay of Jacmel (a city with the advantage of being linked to the Port-au-Prince market by a regularly-running bus service); the bay of Aquin; and near Cow Island, between Cow Island and the coast (figure 32).

Based on lessons learned from this experiment the implementation of a national AH programme, having as objective the creation of one site per fishing community, could be envisioned. This application at a larger scale should **involve the integration of the HAs into a network (via biological corridors) with MPAs in order to maximise the efficacy of the whole.**

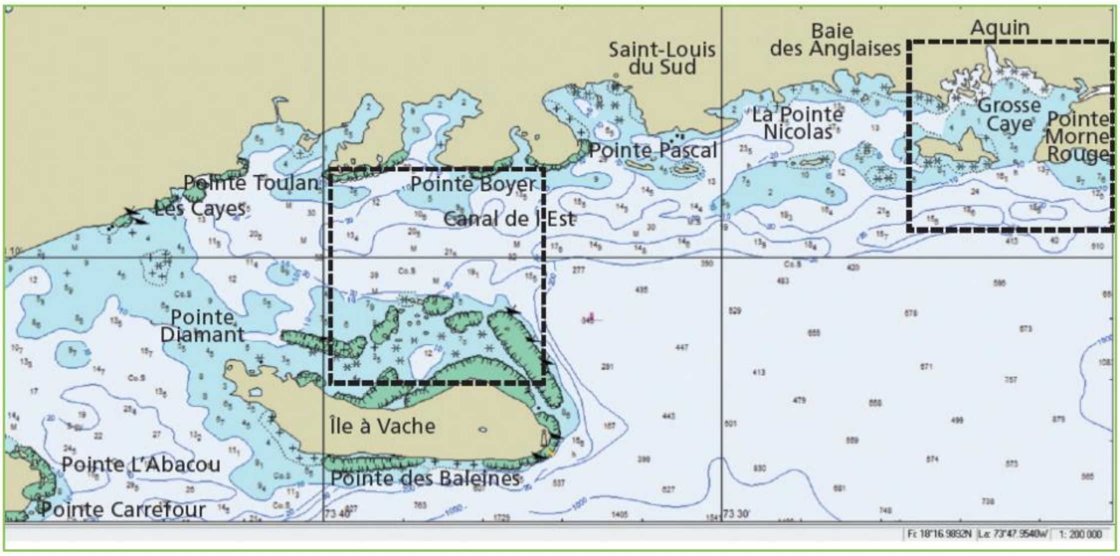

Figure 32
Pilot sites at the bay of Aquin and Cow Island (source: freemap).

Optimising ecological engineering and strengthening the sustainability of small-scale coastal fishing would require a veritable marine spatial planning effort, based around the mutually beneficial interrelation between artificial habitats and MPAs.

Simplifying the fabrication and submerging of HAs by using local means

The fishers are keen to continue working on the project undertaken in the south in partnership with the ANAP: designing habitats adapted to targeted species, determining the species to be targeted and the areas of deployment. Their involvement in the planning and placement of AHs is key in encouraging the acceptability and effectiveness of the HAs over the long term. Specific instruction for the propagation of a method of ecological engineering would be required – for example within the framework of a “sea school” (R5). This method would include: a) biophysical studies to enable the selection of sites suitable for the location of AHs; b) construction and management methods for AHs; c) monitoring and evaluation of the ecological and socioeconomic performance of AHs.

Creating networks of HAs and including marine protected areas (MPAs)

The efficiency and efficacy of AH submerging will depend on the possibility of combining them into a network and linking them to the location of MPAs. A “AH unit” should be created in fishers’ associations to enable the planning and operationalisation of this network, collaborating closely with the MARNDR and the ANAP also to carry out marine spatial planning around AHs and MPAs. The HAs could constitute a useful basis from which to negotiate with fishers regarding engaging in stock management processes, currently difficult in overexploited natural locations.

Training administrators to ensure the proper implementation of the HA network

The training of local representatives of the two ministries, the MARNDR and the MDE, could be undertaken in order to strengthen competencies and to ensure the proper monitoring of artificial reefs – notably within the framework of the "sea school" (R5). A specialist in AHs should be appointed at the MARNDR to monitor pilot sites and, in collaboration with local fishers, to draw lessons from doing so. These insights would enable the implementation of HAs at a national level within the framework of future marine spatial planning in Haiti.

Aligning Territorial Use Rights in Fisheries (TURF) to linked AHs and MPAs

When a community of fishers engages in the construction of an HA, its members all hope to benefit, within two or three years, from an increase in the number of fish in the area, and thus to increase the yields of their fishing activities. Within the framework of free access to the entire ocean, nothing prevents fishers from other villages with the necessary seafaring means also to engage in fishing near such an AH. However, an increase in the number of beneficiaries of an AH leads to a proportional decrease in the individual returns to be had from the exploitation of the HA by these beneficiaries. And if the actual returns of local fishers turn out to be far smaller than they had hoped, this creates the risk of also strongly diminishing their acceptance of the HA concept, as well as that of any possibly-neighbouring MPAs. Such a situation would be regrettable, as it would serve as obstacle to the AH implementation project. It is therefore essential that the principle of free access not be applied in close proximity to AHs and that Territorial Use Rights in Fisheries (TURF) be instituted to ensure that the community of fishers having put in place a particular HA would be granted the right to its exclusive exploitation. The terms of such rights should be jointly defined by all the relevant role-players engaged in fisheries activity within the framework of applicable co-management agreements concluded with the MARNDR. Given that the Haitian state has extended legal recognition to joint directives as of 2010, the putting in place of TURFs of this kind, including jointly defined rules, seems suitable.

Linking AHs to management tools

Within the framework of co-management agreements, each fishing community enjoying territorial fishing rights-of-use would be in charge of monitoring access to the AHs, as well as of preventing any attempted usurping of these rights by others. The creation of an AH site would be made dependent on the acceptance of a charter of use, particularly given that AH sites (future "new fishing zones") would be primarily created in areas of little interest to fishers: those with sandy sea beds. The fishing community would also have full authority to authorise fishing within the entire AH site or to prohibit it within a particular space (a protected core) while authorising it in the surrounding waters. The choice of type of AH would also influence fishing conditions, while the use of tools such as "decoy reefs" and an "underwater policing" system (absent hooks and fishing lines…) would optimise the protection of the species by making them inaccessible to poachers.

R7 - MARINE PROTECTED AREAS (MPAs)

Several MPAs s are currently in the process of being created in Haiti (figure 24 of the summary). It was only in August 2013, following the creation of the ANAP (National Protected Areas Agency) operating under the auspices of the MDE (Ministry of Environment) that this process began. Every MPA is a legal territory which divides a space into zones to which rules are applied to limit access and use, and even to prohibit entry altogether (as is the case for sanctuary zones). At first MPA were not created specifically for regulating fishing, but given their immediate effect on overfishing they are increasingly being thought of as a tool for the regulation of fisheries activity by environmental managers, albeit less so by fishers. The social acceptance of the role of MPAs in fisheries management is therefore subject to debate, both on the international level and in Haiti. Convincing the fishers that they stand to gain from the creation of every MPA in the long term is a challenge that needs to be taken up, and it is to this end that our assessment makes its current recommendation, something lent even more importance given that the 2021-2030 strategic plan for biological conservation is set to propose the increase of MPA surface areas to 20% or even 30% of the EEZs [70].

Strengthening the acceptability, sustainability and effectiveness of MPAs

Planning the creation of MPAs as part of networks based on scientific data and the sampled knowledge of fishers (coral reefs, seagrass beds and mangroves, currentology)

To be accepted, every MPA should be effective in regenerating marine habitats and increasing the populations of fish, crustaceans and molluscs inhabiting it. This imperative to be effective demands that the creation of an MPA be undertaken not only according to local considerations but that it should be inscribed as part of a marine spatial planning project based in part on knowledge of currentology and the biological connectivity between reefs, seagrass beds and mangroves at both national and regional level, as well as on the map of coastal vulnerabilities to human activity undertaken on watersheds.

Experts recommend that such planning be based on the mapping of coral reefs, seagrass beds and mangroves (recommendation no. 1 Habitat) informed by currentology data, thus to clarify the operation of connectivity notably between the totality of coral reefs and MPAs. When the latter are located upstream of the current, they occupy a source position and distribute gametes, larvae and juvenile fish towards coral reefs situated downstream. When MPAs are located downstream of the current, they occupy a position of wells vis-à-vis upstream coral reefs and in turn receive the gametes and larvae emitted by these.

Maximising the MPA spillover effect

[70] Plan currently under discussion within the framework of the Convention on Biological Diversity (CBD)

To be accepted, every MPA must maximise the spillover effect resulting from the regeneration of marine habitats and the increase in the amount of fish among species targeted by fishers. This imperative requires firstly that sanctuary zones of adequate size be created within every MPA or within an MPA network such as the one in the bay of Aquin (figure 3), thus to ensure the greatest number of larvae, juveniles and adult fish possible is displaced into neighbouring waters.

Secondly, the spillover effect should be spatially extended and serve to the benefit of the greatest number of fishing communities possible through putting in place artificial habitats allowing adult fish and juveniles alike to take necessary shelter while allowing larvae to settle there (R6). Larvae and young fish are carried along by the current. As a result, it is logical to place AHs under the currents running through the MPAs. Nevertheless, it is also useful to place a small number of them upstream of the MPA currents to allow adult fish to shelter there, they being decidedly less dependent on the current for their movements.

Ensuring the full participation of fishers through Territorial Use Rights in Fisheries (TURF)

In order to be accepted, no MPA can be perceived by the fishers as an economic or territorial loss or a loss of their former rights to exploitation, but on the contrary has to be viewed as an opportunity to increase the visibility of their fishery activities. In this context, two measures are proposed.

In the first instance, as a compensatory measure in exchange for the creation of an MPA, AHs should be installed in the fishing areas of the neighbouring communities.

Secondly, it would be proper to extend to them Territorial Use Rights in Fisheries (TURF), which would grant them exclusive fishing rights in authorised parts of the MPA. Given their status as legal and administrative domains, MPAs are ideal sites for testing legal innovations such as Territorial Use Rights in Fisheries. The MPAs of the bay of Aquin (figure 33) could serve as pilot sites for putting in place such rights.

In fact, the putting in place of MPAs, related AHs and TURF all contribute to the same ultimate objective: marine spatial planning that will simultaneously ensure the sustainability of fishery activities and the marine resources on which they depend.

Developing co-management agreements between the government and fishing communities in order to combat poaching

Given that MPAs operate best with the consent of the fishers, it is proper to aspire to their joint management by these and the government, which implies a close collaboration between the Ministry of Environment and the MARNDR. MPAs tend to attract poachers, especially where fishery resources in the surrounding areas are over-exploited. Their daily monitoring therefore constitutes an absolute necessity in order for ecosystems to be able to regenerate. Because of the high cost of boats, which are required for a maritime surveillance of MPAs, the managers of the MPAs will have substantial difficulty in carrying out this task on their own. Co-management agreements with coastal fishing communities would enable the sustainable participation of the fishers in the surveillance effort, especially if these agreements also extend to them territorial exploitation rights. Thus made into co-owners of the protected resources, they would have a vested interest in retaining their rights to exclusive exploitation of same, and would be sure to make this well-understood to any potential poachers.

Sustainable funding for MPAs (possible approaches to be explored via fiduciary funds and the conversion of public debt for the protection of biodiversity)

As part of the development of MPAs, Haiti will also be asking itself about the means of paying for them. Protected areas are always expensive. In order to be effective, it requires the deployment of a team composed of about a dozen members possessing both competence and proper motivation (the exact number varies according to the MPA in question). Ensuring adequate funding for an MPA's development and operation poses a serious challenge in the Haitian economic context. Fiduciary funds are considered a promising avenue for procuring the funding for MPAs. However, a considerable amount is required, several million or even tens of millions of dollars in order to allow for the possibility of dividends obtained from frozen funds to ensure the proper operation of an MPA network. A new method of funding biodiversity recently applied in Gabon and the Seychelles is the conversion of debt. The Republic of Haiti could conceivably combine these two methods. Whatever the case, the country will have to ensure more political and social stability in order to win the trust of international fund raisers and of its financial partners.

Figure 33
MPA network in the bay of Aquin. (Source: CNIGS)

Investigating the value of MPAs on the high seas

Studies of fishery resources and biodiversity on the high seas, as well as on the value and the necessity of putting in place MPAs extended to include these areas, could be undertaken. While the exploitation of deep demersal resources is rapidly increasing and the management of fishering effort proves problematic, the creation of sanctuary MPAs enabling the protection of such resources from overfishing lends itself to consideration, although it does pose the question of how these areas would be monitored in order to prevent poaching.

R8 - FADs AND DEEP DEMERSAL FISHING

The putting in place of anchored FADs has been done in Haiti for some twenty years already. This type of fishing presents a threefold advantage: firstly by transferring part of the fisheries activity brought to bear on the overexploited shallows to offshore resources which "traditionally" are far less exploited, if at all; secondly by diversifying the fisheries products market by introducing species "traditionally" little represented on traders' counters; and finally by generating twice the income per excursion compared to small-scale fishing.

Installing an anchored FAD is simply the most effective way to catch large pelagic fish, notably the tuna and dolphinfish which are found in Haitian waters. As these species are very mobile, the probability of running into a shoal while arbitrarily drag-fishing is very small. The ability of rafts to assemble fish in one place spares fishers from many hours of fruitless drag-fishing. Experience gained over twenty years enables the identification of such constraints as are created by this type of fishing, of which both the means and the marketing have to evolve in order to improve the working conditions and the safety of fishers, along with the quality of their products and the competitivity of local fishery in relation to imported product, and thus to enable the Haitian people to have prime access to those resources crossing their maritime territory in a sustainable way. Based on this recognition, strategies for improvement can be identified in order to enable this type of fishing to continue its growth and to become a cornerstone of sustainable fishing in Haiti.

By comparison, fishing for demersal species at the depth level of 200/1 000 m is still in its infancy. It is practiced regularly only by a few boat crews employed by entrepreneurs based in Port-au-Prince. Keeping in mind the surface area spanning these deep habitats, there is a real potential for development, but advancement in that direction needs to be done carefully, always cognisant of the fact that deep demersal species are very sensitive to intensive exploitation, and that this low resilience can result in the complete erosion of the stock's sustainability in just a few years.

Initiating exploratory fishing for improving knowledge of exploitable species and their potential for being exploited

Exploratory fishing around FADs would be done at different depth levels and at various times of the day and night. By day a large bathymetric section would be explored between the surface and a depth of 600 m, while at night fishing would be done between the surface and 100 m deep using an on-board vertical longline (handline), an on-board horizontal longline, and a vertical drifting longline (Taquet *et al.*, 2000). Two species would be specifically targeted: the blackfin tuna (*Thunnus atlanticus*) and the giant squid.

Under the FAD's current and far away enough to prevent the line from becoming entangled in the rope anchoring the FAD to the ocean floor, test fishing using the vertical drifting longline can also be done. As this piece of equipment can be used by small fishing boats measuring only a dozen metres or so in length, there is potential in Haiti for deploying a number of these boats simultaneously.

The choice of FAD to be used for testing depends on three criteria:

– the depth at which the FAD is installed, from 4 000 m to less than 1 000m;
– the distance from the shore, from 1 000 m to more than 40 km;
– the currentological context, a distinction being made between FADs which are subject to general current flow, FADs subjected to the effects of gyres and FADs located in areas sheltered from the effects of currents.

Tests of vertical longlines should also be conducted on deep-lying sea beds. It is advisable that 4 to 9 depth levels be investigated every 200 to 100 m of a bathymetric section of 100 to 1 000 m at several sites within each fishing ground.

Whether for exploratory fishing around FADs or fishing targeting deep demersal species, different types of bait could be tested for efficacy based on three main criteria: their efficacy vis-à-vis the targeted species, their availability throughout the year and their purchase price.

It is to be hoped that exploratory fishing would be done continuously for a whole year in order to allow estimation of the seasonal availability of targeted species, a condition which could prove very important for evaluating the economic viability of fishery targeting large pelagic or deep demersal species year-round.

Organising fishery for the proper utilisation of FADs (planning, constructing, repairing, renewing, adapting equipment and fishing tools)

Close collaboration with the fishers' associations is essential for this objective, with government support of FADs made dependent on their proper management by the associations. This co-managerial approach to usage, with rules drawn up in an inclusive and participatory way appears to be increasingly in step with the reality on the ground.

A number of actions could be taken in this regard.

– Firstly, the formulation of a management plan from scratch, developed in consultation with the associations, is an essential prerequisite. This plan should regulate all aspects of FAD usage, whether social (who can use them and when?), economic (including an obligation to provide information regarding income and expenses), biological (which species can be fished, with which types of equipment, in which FAD and when?) and management (in case of conflict, how is this to be resolved? When and where should new FADs be installed?). This planning of the installation of FADs at the national level should be integrated into a process of marine spatial planning taking into account the three parameters highlighted as part of the exploratory fishing undertaken earlier: depth of installation, distance from the shore and the hydrological context – to which should also be added the presence of shipping routes that will have to be avoided.

– Depending on the results of exploratory fishing it is possible, based on international experience, to anticipate that the deeper a FAD is located in a

strong current area, the more effective it will be and the more it will attract good-sized fish, albeit with a higher risk of rafts being lost due to the significance of the hydroclimatic constraints to which it will be exposed. On the other hand, the further a FAD is from the shore, the longer the time required to reach the fishing areas and the higher the costs of excursions, and thus the more powerful needs to be the boat engine used and the larger needs to be the boat itself. The fibreglass boats operating in Haiti are of insufficient size and their engines insufficiently powerful to guarantee the profitability of excursions. In addition, in the absence of cold storage means, the bacterial and physical quality of caught fish tends to degrade rapidly. A new type of boat not subject to these constraints should therefore be made available to fishers.
Current boats could be reserved for use in those FADs which are located closest to docking points. Thus the steep bathymetric and geomorphological profile of many Haitian sea beds justifies the placing of FADs at 1 000 m from the coast in many fishing grounds, notably in the northwest of the country, from Pointe Jean-Rabel to Cap à Foux, north of Turtle Island, in the south, near Jérémie, from Chardonnières to Port Salut, from Jacmel to l'Anse-à-Pitres.

– Involvement of the fishers in the construction of FADs by drawing on their know-how and by lending them technical support so as to ensure notably conformity to seamarking rules and the protection of underwater equipment. For reasons of maritime safety, it would be useful to outfit the FADs with markers so as to make them possible to locate by night as easily as by day by fishers and others, if possible outside of shipping lanes. However, one unavoidable danger remains: the theft of the very material used to ensure easy location of the FADs – the more sophisticated the techniques used to ensure location, the higher the risk!

– Given that shallow FADs are widely used by Haitian fishers, it would also be beneficial to work with them in order to improve the effectiveness and the sustainability of these devices.

– Prepare stock of material for rapid replacement in case of damage or FADs which may be lost.

– Investigate the willingness of fishers to participate in a system based on the principle of access to a FAD being conditioned on a financial contribution, by them, to contribute to its maintenance (changing the shackles, for example) or to its replacement.

– Selection, from among the boats currently in use in island territories where FAD-adjacent- and deep demersal fishing are practiced, a model allowing for both to be undertaken (see photo 2 of the summary for a detailed illustration of such a model). This type of multifunctional boat, being equipped with strong and cheap manual reels – like the model used in western Samoa (Preston *et al.*, 1993) on which draglines easily convertible into vertical longlines are installed – as well as with means of cold storage, would enable drawing financial value from an unproductive excursion to a FAD by targeting deep demersal species on the return trip.

– Improving the logistics related to fisheries activity by developing credit services, the fishing gear trade, commercial activity related to the supply of boat engines, to boat maintenance, to the provision of fuel and ice, etc. Particular attention should be paid to providing support to shipyards in order to enable them to evolve towards the building of rafts more suitable for the pursuit of fish species with high market value, sometimes located at distances of several dozen km from docking points.

Ensuring the sustainability of fishery

Ensuring the viability of pelagic fishery around FADs, as well as of fishing for deep demersal species, is vital to ensure that the more powerful boats engaged in these activities do not end up becoming more of an expense to their users than a source of income. In cases where excursions yield little or no significant return, there is a danger that fishers will return to pursuing shallow-water demersal fish and end up competing with their small-scale coastal counterparts in areas which are already overexploited. **This "nightmare scenario" must be avoided at all cost!** This implies:
– outfitting boats used for fishing for large pelagic species in specialist fashion so as to rely on the employment of horizontal longlines, vertical drifting longlines and, on the largest boats, horizontal drifting longlines, and also to limit their number so as to enable them to operate at the same level of productivity year-round;
– practicing a balanced exploitation of deep demersal species. Given that these are very vulnerable to any kind of intensive fishing, it is advised that the use of only the on-board vertical longline be authorised, and that only Haitian fishers be allowed to pursue this resource (R5);
– coming to an agreement on good practices with fishers making use of FADs and/or fishing for deep demersal species, according to which they agree in particular not to compete with small-scale coastal fishers in the latter's fishing areas. Apart from agreement in this regard stemming from a co-management approach, monitoring fishing activities by a maritime police force to ensure compliance would be beneficial.

Deriving full value from hauls

– Sharing and strengthening Haitian small-scale fishing techniques of processing and storage with regard to salting, drying and smoking fish (*filet sèch* and others) (R10).
– Outfitting boats with cold storage means, which would enable the fisher to obtain proper value for his work as a result of being able to preserve the quality of his product, selling it for a higher price than that offered for fish stored at an "ambient temperature".

Training fishers and other role-players operating upstream of the fishing sector

– Training of craftsmen to enable them to build larger boats, able to operate further from the coast, but also lighter and even longer so as to reduce fuel consumption.

Adopting the use of composite materials seems an interesting option for consideration. However, it is also essential to maintain and strengthen the fleet consisting of oar-driven- and sailing boats, which in Haiti implies the preservation of wooded areas sufficient for enabling carpenters engaged in boat construction to build quality boats. The construction of wooden boats able to use both engines and sails is also an option that could be explored with Haitian boat builders.

– Training fishers in good practices for the exploitation of fishery resources, including the preservation of its quality and its management with an eye toward the sustainability of their activates.

R9 - AQUACULTURE

In a tropical setting, the development of aquaculture is mostly viewed with an eye towards exportation. In Haiti aquaculture would primarily enable the provision of more protein to the population and thus limit their dependence in imports. As matters currently stand, a few projects of this kind have been created. Our assessment indicates that aquaculture practiced in basins on top of tans in mangrove-inhabited areas should be pursued rather than aquaculture in cages in the middle of the ocean. The latter method is more polluting and also more dangerous given that solid runoff can turn into sediment underneath the cages in cases where the current is too weak, because of greater susceptibility to pathogens (particularly parasites) as a result of their location in open sea, and because of possible destruction from cyclones or storms and the resulting escape of fish bred as part of the project and capable of having a negative effect on thropic chains (in the case of predators not indigenous to the Caribbean, which could act as an invasive species – as is the case of the lionfish).

Prioritising a species of lagoon-based tilapia and a multi-trophic integrated model of aquaculture (Amti)

This assessment recommends the breeding of a species of West African lagoon-based tilapia, a consumer of waste and able to adapt to a wide range of salinity, *Sarotherodon melanotheron heudelotii* (Blackchin tilapia), able because of these characteristics to ensure full value is obtained from agricultural by-products, as well as to live in seawater. As noted, it is a detritivore perfectly suited to an Amti where bred in a basin, since it requires food of only a low protein content, provided by the organic material feeding into its breeding space. It feeds off of fatty acids and proteins produced by micro-algae, as well as agricultural by-products of animal and vegetable origin in the form of granules created during primary production via planktonic development.

Added to the substantial savings made from the halting of expensive importation is also a much more ready social acceptance of aquaculture that comes from demonstrating that it is possible to do without foodstuffs derived from fish, as well as other types of food which should rather be reserved from human consumption.

Prioritising aquaculture on tans and carrying out pilot projects in the Aquin region

Tans are stretches of over-salinated mixed sand and clay covering the back of mangrove areas. Untouched by tides except when these are raised to maximum height, these areas are marked by extreme salinity, which renders them unsuitable for any kind of effective farming. As they contain only sparse biomass, installing aquaculture basins within them would have only a limited impact on the “Mangrove” ecosystem. On the other hand, the mangroves surrounding the edges of the tans could protect the basins from inclement weather (notably cyclones) by acting as windbreak and breakwater. The replacement of the water in the growth basins would be done by the interplay of tides, as well as by renewable energy using the water from the natural tidal channels which “irrigate” the downstream side of the mangrove-covered mangrove.

The Aquin region, on the southern coast of Haiti, has been selected as pilot site for putting in place this mariculture, since it is located on the site also selected for the creation of a protected marine area (MPA). The MPA will result in a reduction in fisheries effort and thus of the catching of fish within its protected waters. Experts have identified three tan sites (n^{os} 1, 3 and 4, photo 12) suitable for the development of this kind of aquaculture via satellite imagery, and their selection has been confirmed by site visits.

Photo 12
Sites identified for the construction of growth basins in the Aquin region (2018).
© Google, DigitalGlobe

Tan no. 1 has a length of 1.5 km and an average width of 500 m with a surface area of 95.4 ha (photos 13). It offers considerable scope for the installation of a growth area. Its accessibility is very good. The importation of water into the basin should be from the other side of its location in relation to the city of Aquin, thus to avoid any man-made contamination.

Photos 13
Ground-level and satelite view of tan no. 1, suitable for the development of the Amti
© IRD/S. Gilles. © Google, DigitalGlobe.

Tan no. 2, being too close to the city of Aquin, was not selected.

Tan no. 3 offers good accessibility, guaranteed clean water and surroundings, and a surface area of significant scope, covering 11.9 ha (photos 14).

Photos 14
Ground-level and satelite view of tan no. 3, suitable for the development of the Amti
© IRD/S. Gilles. © Google, DigitalGlobe.

The accessibility of tan no. 4 is less ideal than that of the preceding sites, but it sports a surface area of good scope:15.9 ha (photos 15).

Photos 15
Ground-level and satelite view of tan no. 4, suitable for the development of the Amti
© IRD/S. Gilles. © Google, DigitalGlobe.

Other regions of the country also contain mangroves of sufficient size for the large-scale development of basin aquaculture on tans (figure 34) – notably a few slices of coast in the departments of l'Aribonite (between Grande-Saline and Anse-Rouge), Nord-Ouest (between Jean-Rabel and Saint-Louis-du-Nord) and Nord-Est (between Limonade and Fort-Liberté).

This assessment advises undertaking a complete scouting of sites and conducting of feasibility studies for the installation of basin aquaculture involving a detritivore, saline-resistant West African tilapia species (*Sarotherodon melanotheron heudelotii*) within the next five years. Aquaculturers who will be involved in the eventual breeding in designated areas will have to be trained accordingly (R5).

Figure 34
Location of the main Haitian mangroves of which the surfaces have been evaluated by FoProBiM
Sources : WIENER (2014), Google earth.

Installing nursery- and growth sites (basins) and strengthening capacities for the processing of aquaculture products

Every aquacultural installation dedicated to the integrated multi-trophic breeding of the tilapia *Sarotherodon melanotheron heudelotii* will be made up of two sites.

1) *The nursery*, on the ground, will be used for reproduction, from the spawning stage to the pregrowth stage. Starting with fry of 40 mg, the objective is to produce, at the end of 4 months, juveniles of 40 g, ready to be transferred to basins for the next step in their breeding.

2) *The basins*, located on top of the tans, will serve as site for the tilapias' growth from 40 g to 400 g in 6 months.

In total, 10 months will be necessary to complete one breeding cycle.

Sarotherodon melanotheron heudelotii is ideal for selling whole as a fresh product. And given that there is a potential demand for its sale in filet form, plans should be made for its processing so as to ensure optimal profitability is derived from the aquacultural production. In this regard contact could be made with the operators of the Taïno aquaculture farm, which houses equipment suitable for fileting fish (R10).

Here it is essential to facilitate the participation of women in sectors which are in the processing of being created, notably to strengthen and diversify processing processes, or to change dietary habits (R10).

Putting in place a multi-participant programme of South-South cooperation on circular aquaculture

Given that the basin-based breeding of *Sarotherodon melanotheron heudelotii* is currently in development in Senegal, it is recommended that a South-South cooperation programme specifically dedicated to the development of the circular aquaculture of this fish species be put in place between that African country and Haiti in order to ensure the training of Haitian aquaculturers as well as the exchange of experiences. Such a programme, involving role-players from the private sector, academia, the public sector and both male and female entrepreneurs, should enable the reciprocal exchange of best practices.

R10 - DISTRIBUTION AND COMMERCIALISATION

The organisation of the distribution sector is a fundamental challenge to be addressed. Problems related to the improvement of the sector are varied, running from lack of sanitation, transportation and access, though challenges posed by lack of acceptance of certain seafoods, to local production and consumption.

Improved response to sanitation standards

In line with such recommendation as were made regarding the strengthening of capacities and health (R5 and R11), it is advisable to put in place training programmes in:

– hygiene as relating to the handling, gutting and cleaning of fish, to the identification of toxicity and to good practices aimed at reducing the production of histamine in pelagic species;
– the use and maintenance of cold storage infrastructure, both at the level of the fisher and at that of intermediaries and retailers.

Mapping distribution and commercialisation circuits of fishery products at a national level

Lack of sector transparency, the organisation of transportation and access to fuel, as well as difficulty in accessing villages in the interior of the country are all factors acting as constraint on the distribution of fishery products. The development of an adequate road network and the provision of electricity are services for which the government bears responsibility and in which regard care should be taken that any inadequacy not contribute to malnutrition suffered by populations located far from cities. In order to ensure better governmental planning towards improved flow along these distribution and commercialisation circuits, mapping exercises of certain fishing grounds (figure 16) could be undertaken. Thus three pilot areas could initially be selected:

1) the Sud-Est department, which supplies Port-au-Prince *via* Marigot;

2) the Coteaux department, containing the village of Chardonnières (of which fisheries activity is mostly concentrated around a FAD);

3) the departments of Nord or Nord-Est (given the proximity of the city of Cap-Haïtien).

Knowledge of these circuits would also enable better monitoring of post-fishing exchanges and fluctuations in the price along the entirety of the sector, thus to help map the value chain. This is important given that the cost of a product can double between its first selling and its eventual sale to consumers.

Maintain and prioritise the development of processing fresh fish to transform it into dried, salted and smoked fish

These processing techniques, alone among all the rest, do not require permanent access to two resources in short supply these days – electricity and fresh water. As in many other countries, notably in Africa, smoked, dried and salted fish is a commodity that can be kept for a long time, and as a result can circulate and be sold many weeks after being caught. It is a source of protein available to all, even to those located far from the coast. Should the fishing of large pelagic species become widespread in Haiti, it will be necessary to develop different methods of preserving the large individual fish caught, in which regard notably the salting and drying technique can be practiced by anyone, requiring minimal financing and without involving the consumption of wood.

Strengthening existing practices, and supporting the development of new ones related to the preservation and preparation of fish (notably those derived from aquaculture)

While it is important to maintain and support traditional and inexpensive preservation methods, it is also essential to prioritise the development of new preservation and preparation practices related to seafood products, on the one hand to diversify the means of preservation and on the other to encourage changes in dietary habits (introducing pelagic fish into the menu alongside the increasingly scarce – but still preferred by Haitians – coloured fish).

Installing cold storage rooms and solar refrigerators in communal fishing centres[71] is a promising solution if accompanied by a good equipment maintenance management system. After being gutted, fish could thus be preserved for a long time (two months or more), retaining the quality of their physical characteristics the whole time. In order to ensure the proper upkeep of the equipment, a small technical unit with an adequate budget could be created within the MARNDR.

Among possible approaches that can be envisaged one may mention that, should aquaculture on tans develop in a promising enough fashion (R9), a unit engaged in the fileting of tilapias could be created, based on the example set by Aqua Taïno Ferme. Unique in its approach to fisheries exploitation in Haiti, this farm has achieved commercially-viable dimensions, employing 86 workers and sporting a production capacity of 10 MT/week. A frozen packaging unit and administrative areas have been installed on the shores of a lake, sheltered by containers (photo 16). A very productive nursery supplies the farm with fry for growing into juveniles. The market catered to is reserved for a niche clientele of high-income consumers, restaurants and hotels. There is a very real potential demand, and could eventually extend to deep demersal species as much as to the large pelagic ones.

[71] A solution notably proposed as part of a Spanish cooperation project as part of the previous development plan for small-scale fishing in the south of Haiti.


Photos 16
Fileting and wrapped in ice in the Taïno Aqua Ferme packaging unit (photos: S. Gilles, 2018).

Needless to say, these recommendations imply concomitant innovative and inexpensive training practices in order to ensure maximum value is obtained from products, and that these are stored in optimal fashion (among other training interventions, such as those related to the proper hoisting of fishing nets or the preparation of fish pellets) (R5).

Recognising and strengthening the role of women in the sector

Women play an essential role in the fisheries economy, in particular through ensuring the circulation of fishery products within villages, within provinces and among provinces. The fact that so many of them participate in the sector and that they are able quickly to adjust their trading routes as well as the techniques they use for processing their fishery products makes them indispensible for providing food- and economic security to numerous families. They constitute one of the key factors for accomplishing the evolution of the sector, and as such should be supported. In order to maintain a fisheries sector which is advantageous for the Haitian population this female diversity, as also the diversity of intermediaries operating in the sector, has to be preserved. It would also be useful to open new markets for fish and to facilitate, where possible, the transportation of fishery products.

A competition could conceivably be launched within each department to generate the creation and publication of new fish recipes in order to raise the profile of these products, and particularly of the large pelagic species, and to improve hygiene in their preservation. Such a competition could be held in collaboration with local associations, the MARNDR and the ANPH (national association of Haitian fishers). If the competition is successful at department level, a national final would be organised, in Port-au-Prince the first year, thereafter in the capital of the department of origin of the previous year’s winners.

It is also important to encourage women joining forces and their participation in decision-making in different associations, both formal and informal, engaged in the buying, processing or selling of fish. Through facilitating women joining together and providing financial support for their groups, both women and the sector as a whole will increase their autonomy, their visibility and their adaptability. Prioritising women's access to credit (strengthening the capacities of the MUSOs, local savings banks, creating programmes dedicated to male and female role-players in the fisheries sector, etc.)[72], as well as to boats owned by associations (including the right to reserve boats for hire) would be equally beneficial to the entirety of the sector. Finally, women should be encouraged to engage in fishing as profession themselves, as well as professional aquaculture, and to participate in training courses at the envisioned "sea school".

Ensure consumers are better informed in order to raise the profile of local products and encourage acceptance of pelagic species as food by the population

The aim is, on a national level and supported by both the Spanish cooperation project undertaken in the south of the country as well as the winners of the departmental fish cooking competition, to ensure better knowledge of new means of preparation of large pelagic species (tuna, skipjack, sea bream) - notably the preparation of fish pellets. In addition, the population is to be better informed of the fact that large pelagic species are entirely safe for consumption when fresh and properly preserved. Such a promotional campaign should contribute to decreasing importation of certain species such as frozen horse mackerel, saur herring, etc. In parallel further campaigns should be undertaken, and dedicated industries developed, to encourage the consumption of large pelagic fish specifically among the well-to-do, as well as in school- and government department cafeterias.

An awareness-raising strategy aimed at consumers via a campaign dealing with hygiene and sanitary issues related to fish should be developed, the effects expected to be felt along the entire production, processing and distribution chain. Equally important is to communicate the nutritional value of fish, and notably the benefits of protein supplementation to the daily diet. Madam Sarahs and fish sellers in particular could use this information to increase the attractiveness of their products in the eyes of consumers, as well as to increase the importance of the role played by fishery products in improving the country's food security (R11).

[72] It would notably be useful for women participating in the agricultural- or fishery sector, e.g. "Madam Sarahs" to be taken into account as part of legislation regarding the status of farmers drafted by the MARNDR in 2014 and transmitted to the Prime Minister's office for eventual passage into law, thus to allow them the same benefits as the men.

R11 - HEALTH

While fish is indispensable for maintaining a protein-balanced diet, particularly among the poorest population groups, one of the main shortcomings of the Haitian fisheries industries is a lack of means of preserving its products. Pelagic species are fragile and pose risks linked to the absence of proper hygiene and disruptions in the cold storage chain "from the fisher's pole to the customer's plate", but also to a lack of knowledge and epidemiological monitoring of toxicity.

Training related to a lack of proper hygiene and disruption of the cold storage chain

An effective cold storage chain should be maintained from the fishing boat to the consumer, but ice is in short supply in Haiti and in the absence of proper organisation of the sector around this issue, as well as in view of the multitude of informal practitioners of small-scale fishing, it is hard to ensure hygienic storage. Ideally the entire small-scale fishing fleet should be re-outfitted as decked vessels equipped with hosepipes and ice wedges in the case of those operating in the deep seas, thus to enable on-board gutting. Sometimes such boats are seen in Haiti as part of collaborative undertakings involving European and Haitian fishers[73], but the widespread use of such vessels, far too expensive to purchase and to operate, for the moments appears inconceivable.

In addition, this assessment advises the training of small-scale fishers and fish sellers alike. Experience has shown that mere encouragement to improve the cold storage chain is not sufficient, or even without any effect at all. Two types of training/information provision could lead to addressing this basic issue in an effective way:

1) training in preservation in ice undertaken within a) the fishers's associations and b) traders' associations by specialists from the MARNDR or the "sea school" once the latter is operational (R5);
2) putting in place pilot efforts within fishers's- and traders' associations addressing practical challenges, e.g.: the distribution of coolers and a machine for creating ice packs so that coolers can be filled with water cooled to 4°. Fish taken from the coolers would then be covered in ice and taken to market. These pilot efforts should be combined with training in the maintenance of ice machines.

Improving **hygiene in marketplaces and docking points** requires certain arrangements to be made for which the government bears the responsibility. Groups/associations/cooperatives benefitting from these could be induced, in return, to conform to a set of operational principles constituting an "**awareness-raising and dissemination of good practices**" effort.

[73] Thus the association "Solidarité Pêche de Concarneau" sent several boats to Haiti from 1998 to 2017, when its activities ceased.

Training in best practices of salting and drying

Through training programmes (R5) and awareness-raising efforts, the best "traditional" practices for salting and drying (Which types of products are best for salting and drying, and under which conditions? Which procedures, recipes and timeframes should be followed with regard to the different stages of salting and drying? Etc.) can be promoted

At the same time, pilot operations in solar drying could be developed in collaboration with Madam Sarahs and traders' associations in order to improve product quality (R10). These techniques would reduce waste and forestall the use of harmful methods of preserving dried fish (spraying with DDT, for example).

These actions can be undertaken in two phases: first determine, in consultation with the women, the solar drying technique best suited to the Haitian situation. Then, disseminate the selected model among the members of the traders' associations, accompanied by information about microcredit opportunities – practically non-existent in Haiti – or on the availability of grants linked to public demonstrations of the technique in question.

Organising an epidemiological monitoring network

Regarding epidemiology, there is a clear need concerning the **strengthening of local expert capacity** for lending assistance to the decision-making process and the management of declared cases of collective toxic food infection (TIAC). **With regard to TIAC**, our teams advise undertaking in Haiti an experiment first carried out in the Indian Ocean and which has proven effective: training role-players in the seafood sector to identify harmful microalgae, **training for and putting in place an adaptable epidemiological monitoring network**, training of "watchman" doctors and veterinarians, creating medical centres, specialised services in hospitals. A group of people sharing a high-level overview of the whole picture (figure 35).

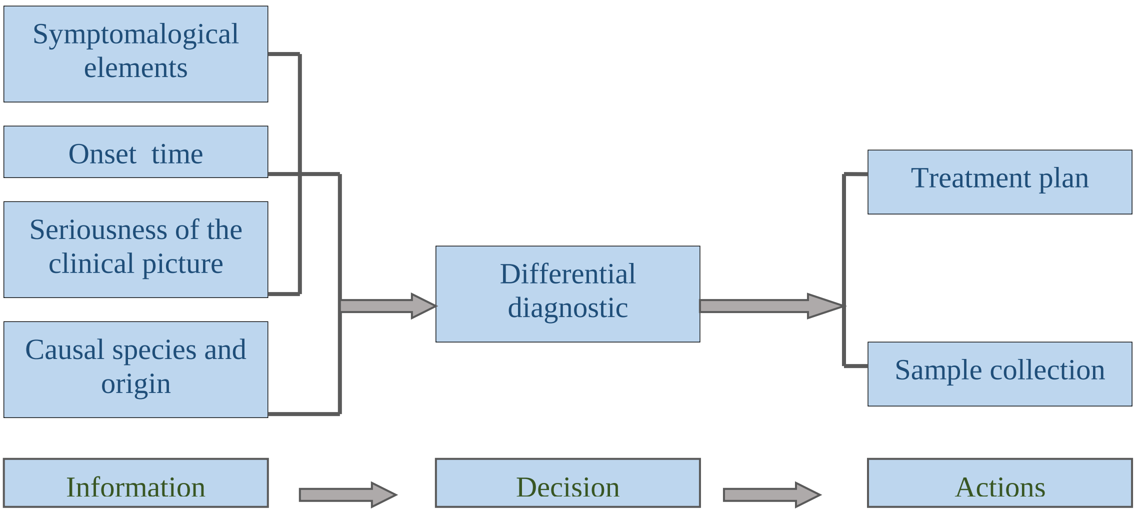

Figure 35
Schema of assistance in the decision-making- and management processes applying to an epidemiological crisis (JPQ 2020).

The primary concern should be the capacity for detecting ciguatera in Haiti. As a result of the absence of national statistical data and a census of cases of hospitalisation, the rate of occurrence is not known for Haiti. At regional level the incidences of ciguatera are always under-estimated because of being under-documented. The 2016-2025 work plan of the Caribbean Health Agency (CARPHA) should include ciguatera in its list of monitored illnesses.

Ensure better risk management

- **Through information gathering** (know-how, a cultural practice, has also been developed within fishing communities in order to identify individual carriers).
- Through putting in place a multi-year programme of **monitoring stations in coral reefed habitats** (employment of simple protocols of proven effectiveness as part of networks also including local expertise and internal and external research institutions).
- **Through research:** classification of species (six families represent more than 50% of ciguatera-carrying species (Bagnis, 1981) or at-risk habitats (as toxic algae grow on dead coral or coral subject to on-going bleaching).
- This identification could lead to the **creation of a poster** similar to that created in Guadeloupe (figure 36).

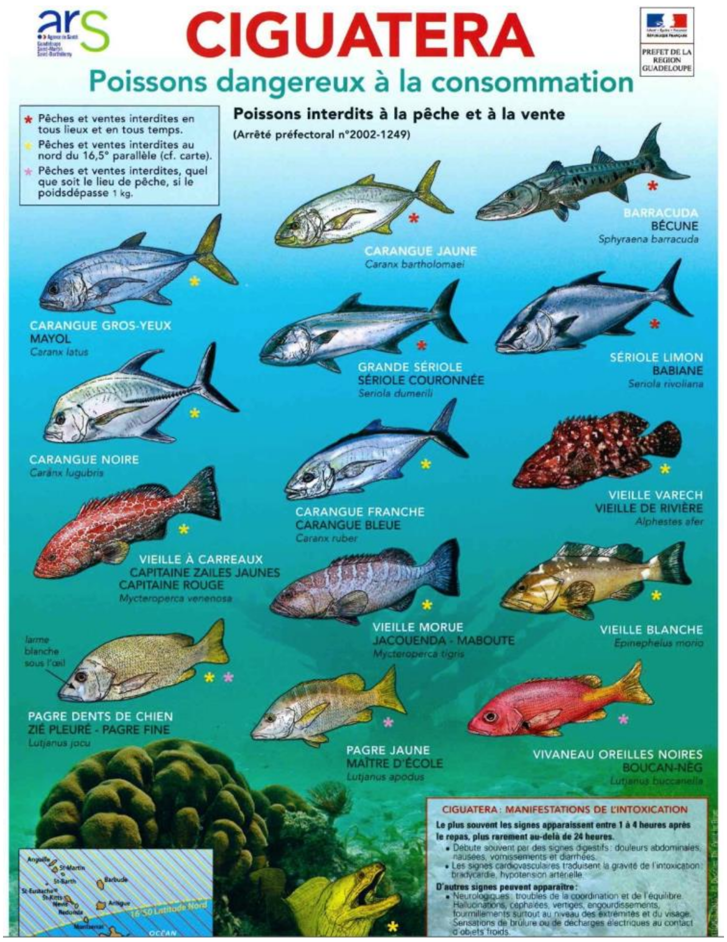

Figure 36
Poster aimed at prevention, identifying the risks of ciguatera disseminated by the ARS in Guadeloupe. (Source: ARS, Guadeloupe).

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