A Snapshot View of the Moored Fish Aggregating Device (FAD) Fishery in South Haiti

Una Mirada Rápida sobre la Pesca Asociada a Dispositivos de Concentración de Peces Anclados (DCP) en el sur de Haití

Un Coup D'œil sur la Pêche à Dispositifs de Concentration de Poissons Ancrés (DCPa) dans le Sud d'Haïti

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ABSTRACT

Moored Fish Aggregating Devices (FADs) are anchored floating objects placed in the sea to aggregate pelagic fishes so as to facilitate their capture. Over the past three decades, there has been a rapid development of a small-scale artisanal FAD fishery in some Caribbean states, including Haiti. However, the current state of the FAD fishery in Haiti remains poorly documented. Here, I report the results of FAD fishing trip surveys and meetings with FAD fishers in January-February 2015 at selected localities along 610 km of coastline in the south of Haiti - an area with about 21,700 fishers - so as to provide baseline data on the FAD fishery. At that time, a total of 21 FADs were being used across locations by about 10% of the fisher population (and fishing vessels). Most fishing vessels were small (≤ 7 m long) and equipped with small outboard engines (15 hp). Main fishing techniques were drift lines with live bait and trolling. The main species landed were yellowfin tuna, blue marlin, blackfin tuna and dolphinfish, with yearly landings (all species combined) being non-negligible in some localities (≥13.6 tonnes per year). FAD data collection systems were weak, except where fishers were supported by external aid. Overall, the FAD fishery in south Haiti contributes to food security and helps support fishers' livelihoods. However, there is urgent need to develop national fisheries management plans and improve fishery monitoring systems to ensure a profitable and biologically sustainable FAD fishery and facilitate Haiti's integration into key regional fishery management organizations.

KEY WORDS: Fish Aggregating Device, Haiti, pelagic fishery, fishery management, artisanal fishery

BACKGROUND

The use of moored Fish Aggregating Devices (hereafter FADs) has increased notably over the past decades across the insular Caribbean CRFM (2015), providing access to oceanic pelagic fish stocks to artisanal fishers (CRFM 2015), and helping increase food security in the region, particularly in fishing communities where alternative livelihoods are rare such those along Haiti's rural coastline (Vallès 2015).

In Haiti, a few FADs were introduced for the first time in the early 1990s in the Grande Anse department (southwest of Haiti), and about 50 units were subsequently deployed across the Haitian coastline by a private operator in the late 1990's (Damais et al. 2007). However, most units were lost before they were actually effectively exploited, with the exception of those in Grande Anse (Damais et al. 2007). Since then, there have been further attempts, mainly funded by (international and local) development aid agencies to multiply the number of FADs accessible to artisanal fishers. In 2010, the Haitian Government produced a National Fisheries Development Plan (NFDP) for the period of 2010 - 2014 supporting the development of an improved small-scale artisanal fishery. One of the key specific objectives of the NFDP was to increase the revenue of fishers through the diversification of exploited fishery resources. Moored FADs were one of the tools explicitly outlined in the NFDP to help achieve such diversification, thus gaining formal government recognition and support.

The rapid increase in FAD use across the Caribbean region has also raised a number of concerns at the biological (e.g. risk of overexploitation of migratory oceanic species), socio-economic (e.g. potential conflicts among users), ecosystem (e.g. lack of evidence of a reduction of fishing pressure on coastal resources) and governance (e.g. uncontrolled multiplication of FADs) levels, which need to be addressed to ensure a sustainable FAD fishery (CRFM 2015). A major hurdle to begin tackling the aforementioned issues is a pervasive lack of biological and socio-economic data on FAD fisheries across the region (CRFM 2015), although efforts to address this are currently being undertaken by some nations (Mohammed and Masters 2015).

The present study seeks to help fill some of the existing data gaps on the current FAD fishery in Haiti. To do so, it provides a summary of the main findings of a short field study on the FAD fishery conducted in south Haiti in early 2015. This study sought to:

i) Estimate the number of FADs being used at the time, determine their approximate location, and describe their design;
ii) Estimate the number of fishers and vessels involved in the FAD fishery;
iii) Describe gross spatio-temporal patterns in fish landings associated with FADs along the study area;
iv) Describe current monitoring systems associated with the FAD fishery;
v) Summarize some of the existing data on fish landings associated with the FAD fishery; and
vi) Describe fish catch composition from fishing trips to FADs during the study period.

Between January 25th and February 8th 2015, a series of meetings were held with FAD fishers at seven different localities in south Haiti where FADs were being used. Meetings were also held with (government and non-government)

officials involved in projects supporting FAD fisheries in the area as well as some members of the fishery entrepreneurial sector. The various meetings facilitated access to some of the few datasets available on FAD landings in the area. Furthermore, a total of 51 fishing trips on FADs were monitored across five of those locations, during which fish catch composition and other fishing trip attributes were recorded. A summary of the findings is given in this communication; for a more detailed account see Vallès (2015).

Study Area

The study area extends along approximately 610 km of coastline and includes the departments of Southeast, South and Grande Anse in south Haiti (Figure 1). This represents approximately a third of Haiti's coastline. This area is characterized by a relatively narrow shelf, except for the areas directly west and south of the Grand Anse and South departments, respectively, which exhibit a wider shelf (Figure 1). From east to west, the localities visited were Belle Anse, Marigot, Cayes-Jacmel, Bainet in the Southeast department; Port-Salut and Tiburon in the South department; and Anse d'Hainault in the Grande Anse department (Figure 1).

Brief description of the fishery sector in the study area — The most recent national-level study estimated that there were approximately 21,700 fishers distributed across more than 200 locations along the study area (Damais et al. 2007). Other departmental-level studies jointly estimate about 16,000 fishers in the same area (Célestin 2004, Favrelière 2008, Schill et al. 2012). Fishing is typically an unrestricted and diversified artisanal activity mainly concentrated on demersal and nearshore resources, with the relative importance of main fishing practices (e.g. cast nets, gillnets, trammel nets, seines, spears, traps, and hand lines) varying considerably among localities (Célestin 2004, Damais et al. 2007, Favrelière 2008). However, some fishing communities in Grande Anse have been known to also exploit offshore populations of tunas and tuna-like species through the use of FADs since the 1990's (Célestin 2004). Many fishers also engage in alternative non-fishing activities (such as agriculture, livestock, transportation) to supplement their income (Favrelière 2008, Schill et al. 2012). Nevertheless, the degree to which the latter happens varies considerably across localities (Favrelière 2008) due to marked differences in economic opportunities and social context (Breuil 1999).

There are approximately 10,700 fishing vessels in the study area (Damais et al. 2007). The vast majority of these fishing vessels are small (≤ 7 m long) and lack outboard engines. The relative importance of the different boat types changes across locations, with wooden flat-bottomed boats ("koralen") being the predominant fishing vessel in most localities of the Southeast department (Favrelière 2008), and dugout woods ("bwa fouye") dominating in most localities of the South (Schill et al. 2012) and Grande Anse departments, where wooden sailboats ("kanots") are also quite prevalent (Damais et al. 2007). There is also a small fraction of fishing vessels made up of small fiberglass boats (5.5-7 m long) equipped with outboard engines donated by (mainly) international development aid agencies (Vallès 2015).

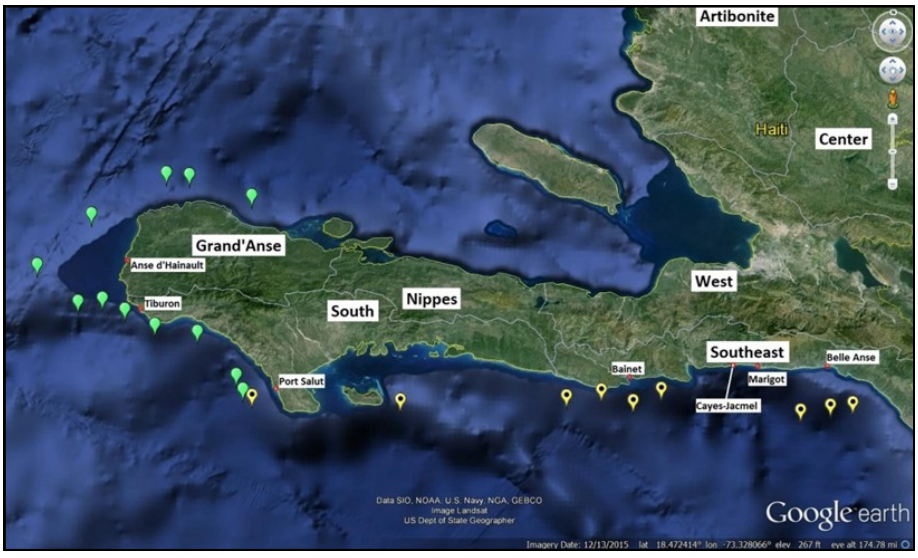

Figure 1. Location of FADs along the coastline of the Southeast, South and Grande Anse departments of Haiti. Yellow pins (with black dots) indicate location of FADs with known GPS coordinates. Green pins indicate the approximate location of FADs based on exchanges with local fishers (as GPS coordinates were not available at the time). Small red circles indicate the location of the seven localities within which meetings with fishers and monitoring of FAD fishing trips were conducted in early 2015. For completeness, departments that were not surveyed (Nippes, West, Artibonite and Center) are also labelled in the map.

The commercialisation of the fishery products is an activity numerically dominated by women and typically conducted with very limited access to refrigeration. There are different actors within the commercialisation chain, including the "marchandes" who are often the spouses of the fishers and who buy and sell locally the lowest-valued fish products, and salt and dry the fish that is not sold; the "marchandes saras", who come from the big urban centres to buy (dried or fresh) fish and take it back for sale; and the representatives of the "agences", who exhibit the greatest purchasing power and refrigeration capacity and acquire the highest-valued products (conch, lobster, highly-valued fish) to sell back to grossistes, supermarkets, and restaurants in the big urban centres (Célestin 2004, Damais et al. 2007, Favrelière 2008).

RESULTS

Number, Design, Location, and Life Expectancy of FADs Currently Present in South Haiti

At the time of the study, a total of 21 anchored FADs were identified throughout the coast line of the three departments (see Figure 1). There were differences among departments in the design, cost, and FAD components as well as on FAD ownership. All the identified FADs in the Southeast department were deployed by the Project for the Development of the Fishery in the Southeast (PDFS), funded by the Spanish Cooperation, in collaboration with the fisherfolk associations in the Southeast. In contrast, in the South and Grande Anse departments, there was a combination of FADs that were privately owned and FADs deployed to the benefit of fisherfolk associations with the support of other development aid agencies such as the United Nations Environmental Program. The FADs in the Southeast deployed by the PDFS followed the Martinique-IFREMER design (for details, see Figure 5 in CRFM (2015)). These FADs were made up of high quality, locally unavailable, materials and so were considerably expensive (approx. 5,000 USD per unit). The FADs used in the South and Southeast departments were a modified version of the Guadeloupian artisanal FAD design (see Figure 6 in CRFM (2015)); they were less expensive (approx. 1,500-2,000 USD per unit), much simpler in design, and built using locally available materials (Figure 2; see also Vallès (2015)).

There seemed to be a relatively high turn-over of locally made low-cost FADs along the study area, with FADs being lost and new FADs being deployed relatively frequently. At the time of the study, at Belle Anse (Southeast), fishers using FADs had been informally contributing through the Union of Fisherflok Associations of Belle Anse towards a fund that had been used to purchase material for one FAD. In the South, the Fisherfolk Association of Port Salut (APPS) had gathered sufficient funds and materials for the deployment of three additional FADs, whereas the Fisherfolk Association of Chardonnieres (APC) had just lost one FAD within several months of deployment. Further west, the Fisherfolk Association of Tiburon (APT), indicated that since 2009, there had been multiple (and often unsuccessful) attempts to deploy locally made FADs. The reasons as to why FADs get lost relatively quickly remains largely unknown. Generally, FAD operators and fishers in Haiti attribute FAD losses to boat traffic, but other factors cannot be discarded. In that regard, there is a pervasive lack of knowledge on the typical life expectancy of a FAD in Haiti. Exceptionally, the PDFS deployed 14 FADs (Martinique-IFREMER design) between December 2010 and January 2012 in the Southeast at depths between 1,000 and 3,000 m, and monitored their fate. At the time of this survey seven units were lost and seven remained; thus their data indicated that, on average, the specific units deployed could be expected to last a minimum of 2.5 years in the Southeast (Vallès 2015).

Figure 2. Photographs of different components of a low cost FAD unit about to be deployed in Port Salut, South department, Haiti. The left panel shows the mooring component, a drum filled with concrete and miscellaneous metal elements; the top right panel shows several units of two types of buoys (used for the floating component) attached to a polypropylene main line and cable wire (the latter usually follows the main line for the first 50 meters); the bottom right panel shows the surface aggregator made up of palm leaves. Further details can be found in Vallès (2015). All photographs taken by H. Vallès.

Numbers of Fishers and Fishing Vessels Associated with the FAD fishery

About 450 fishers using 136 fishing boats were currently actively engaged in fishing on FADs across the seven localities visited at the time of the study (Table 1). This implies that, overall, about 10% of the fishers and fishing fleet (median value across localities) fished on FADs in the study area, although this proportion varied considerably among localities (Table 1).

There were marked differences among localities in the type of boats used for fishing on FADs. In the South and Southeast, the dominant type of boat used was a small (5.5 - 6.7 m long) fiberglass boat (often Eduardoño brand) donated by development aid agencies to a fisherfolk association. In contrast, at Anse d'Hainault (Grande Anse), fishing on FADs was conducted predominantly using privately-owned small (5 m long) wooden sail boats.

Irrespective of boat type, all boats used for fishing on FADs were equipped with small (15 - 18 hp) outboard engines, which were strongly favoured in detriment of larger, more powerful, engines so as to minimize costs associated with fuel consumption. The proportion of privately-owned engines (as opposed to engines donated by development aid agencies to fisherfolk associations) used for fishing on FADs increased as you moved from the southeast to the southwest, reflecting broad spatial patterns in current support to fisherfolk communities by development aid agencies.

Distribution of Fishing Effort Through Time and Fishing Techniques

Exchanges with fishermen across the seven localities indicated that fishing on FADs took place daily and year long, with the number of fishing trips increasing during the high season (June to November). In some localities, the same boat could be used by two different crews over the same day during the high season. Fishers reported that there would typically be 3 - 4 boats fishing on the same FAD at any given time at most locations, and in some locations there could occasionally be up to 16 boats on the same FAD (Table 1). Fishing on FADs was carried out using highly selective techniques involving mainly a mixture of surface trolling for smaller individuals (some of which will be used as live bait) and drift line fishing (often using drift buoys attached to the fishing lines) with live bait for the larger ones (personal observations; MER-SUD 2013).

Broad Spatio-temporal Patterns in the Composition of Landings

Conversations with fishers indicated that the main fish target groups on FADs were similar across localities and included mainly large and small tunas, bonitos, billfishes, dolphinfish, mackerels, and rainbow runners (Table 1). However, there were apparent differences in the relative importance of the different fish groups across localities. Whereas landings at the localities in the Southeast appeared to be dominated by tunas and dolphinfish, those of the South and Grande Anse department appeared to be dominated by billfishes (Table 1). Seasonal changes in catches of main fish groups on FADs, as inferred from exchanges with fishers, followed the expected overall pattern with a high catches between June and November and a low catches between December and May for three of the four dominant fish groups, i.e. tunas, dolphinfish, and billfishes (Figure 3), although there appeared to be some differences in temporal patterns for selected target fish groups across localities (for details, see Vallès 2015). There were, however, some differences in seasonal patterns across target groups. For example, the seasonal pattern for billfishes was less marked than that of dolphinfish and tuna, whereas the mackerels appeared to follow a temporal pattern opposite to that of the other fish groups, with higher catches during the February to June period (Figure 3).

Management of FAD Use

In general, activities associated specifically with the management of FAD use such as the collection of fishing fees were more likely to be implemented in localities where fishers were also financially involved in setting up the FADs. For example, in the localities of the South and Grande Anse departments, the use of privately owned FADs implied that many fishers paid a fee (typically, 10% of sale) to the FAD owner. In contrast, in the Southeast, access to the FADs donated to fisherfolk associations was generally open and free to all. On the other hand, if the boats and engines used to fish on FADs belonged to a fisherfolk association, their use was rotated among fishers within the association in exchange of a fee to the association, which was either a fixed amount (e.g. Fisherfolk Association of Port Salut) or based on a small percentage of the fishing benefit (e.g. Fisherfolk Association of Tiburon). Finally, across the three departments, it was forbidden to moor the boat on a FADs or to spend the night at a FAD. Overall, fishers declared that they rarely entered into conflicts over FAD use and that they complied with the local rules when it came down to the use of private and associative FADs.

Table 1. Summary table showing, from left to right, the number of FAD units, the number of FAD fishers, the number of boats used for FAD fishing, the common (and maximum) number of boats fishing around a FAD at any given day, and the main fish landings associated with FADs (listed by decreasing order of importance in the catch) as well as total number of fishing boats and fishers (including those not associated with FAD fishing) at each of the seven localities visited in south Haiti in early 2015. Data source for Total boats and Total fishers at each commune are based on Macías et al. (2014) and personal communication from Dario Nôel (MER-SUD project). DF- dolphinfish; TN- small and large tunas; BF- billfishes; MK - mackerels; RR- rainbow runners. N/A – information not available

Commune	FAD units	FAD fishers	FAD boats	Boats per FAD (max)	Main FAD fishing landings	Total boats	Total fishers
Belle Anse	3	100	46	6 (14)	1) DF; 2) TN; 3) BF; 4) MK & RR	171	1785
Cayes-Jacmel	0	30	21	3-4 (16)	1) DF; 2) TUN; 3) MK	140	301
Marigot	0	40	9	3 (10)	1) DF; 2) TUN; 3) BF; 4) MK & RR	128	910
Bainet	3	60-70	16	3-4 (10)	1) DF; 2) TUN; 3) BF & MK	124	411
Port Salut	3	60	13	4-5 (7)	1) BF; 2) DF; 3) TUN	N/A	350
Tiburon	3	80-90	10	2-4 (4)	1) BF; 2) DF; 3) TUN	205	230
Anse d'Hainault	3	70	21	3 (15)	1) BF; 2) DF; 3) TUN	200	900

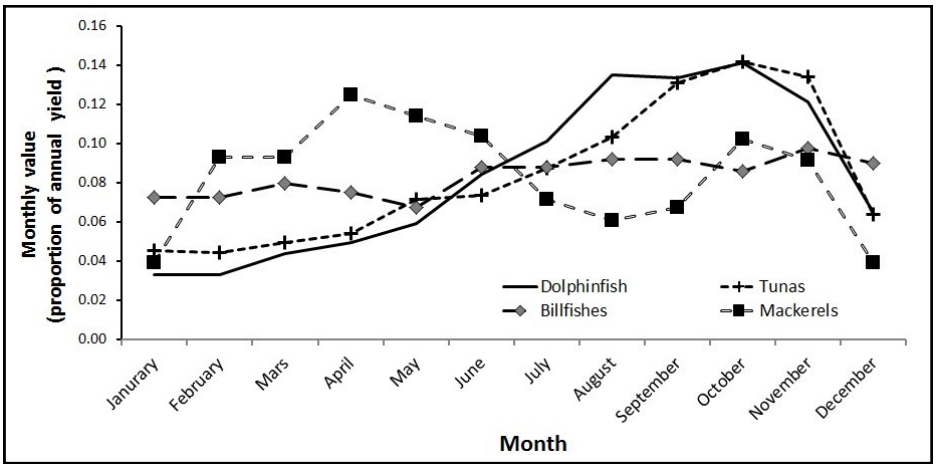

Figure 3. Temporal changes in FAD-associated catches of main fish groups (as proportion of total annual yield), as perceived by FAD fishers in south Haiti.

Current Monitoring Systems Associated with FADs

The Direction of Fisheries and Aquaculture (DFA) of the Ministry of Agriculture is responsible for the monitoring of fish landings in Haiti. However, it is currently understaffed and does not have the resources to undertake such monitoring (Haughton and Mateo 2002), although efforts are currently being undertaking to help improve monitoring (Laurent Mérisier, Director of Fisheries and Aquaculture, personal communication). Thus, any fishery monitoring usually gets conducted at a specific location either through the implementation of fishery development projects (by aid agencies and/or externally-funded government projects) bringing the necessary additional funding for follow-up or by the entrepreneurial sector. Generally, once a given project comes to completion, the monitoring activity either ceases or loses consistency in its quality in the absence of follow-up. In that regard, there were considerable differences across localities visited in how fish landings on FADs were being monitored and in the spatial and temporal coverage of the monitoring. At one extreme, Anse d'Hainault was the only locality visited where no monitoring of FAD landings was being conducted at the time. In the past, the Asssociation of Marine Fisherfolk of Anse d'Hainault (AMPAH), the main local fisher organization had conducted monitoring of FAD landings, but unresolved conflicts within the association had rendered it dysfunctional and so no monitoring was now being undertaken. On the other extreme, the Communal Centres for Marine Fisheries (CCPMs) supported by the PDFS in the Southeast (at Marigot, Bainet, Cayes-Jacmel, and Belle Anse, respectively), jointly had one of the most complete time series of landing records (from July 2013 to the time of this study), and covered landings associated with all FADs present in the Southeast, providing one of the best datasets in landings to date. These centres had been specifically set up to help improve the commercialisation of fish landings derived from the FAD fishery in the Southeast. In-between were the records kept by the Fisherfolk Association of Tiburon and the Fisherfolk Association of Port Salut, which were associated with FAD landings covering a smaller geographic area in the South.

All the aforementioned monitoring systems focused on recording variables aimed at informing the economic activity associated with the FAD landings, with little emphasis on systematically recording descriptors of fishing effort (e.g. it is uncommon to record fishing trips with no catch) or of the biological state of the exploited species (e.g. catch data are rarely disaggregated at the species or family level). Further details on these monitoring systems can be found in Vallès (2015). Overall, the data presently available are probably more useful for helping assess the profitability of the activity than to inform fisheries management.

Two examples of fish landing datasets — In the Southeast department, the Communal Centres for Marine Fisheries (CCPMs) supported by the PDFS exhibit reasonable levels of standardization of data collection and uninterrupted monitoring so that their data are particularly valuable to help assess fish landing patterns across space and time. Landing data for the period between June 2013 and December 2014 were generously provided by the CCPMs of Bainet, Cayes-Jacmel, Marigot, and Belle Anse. These are the localities most actively involved in fishing on FADs in the southeast. These data indicated considerable fish landings associated with FADs. For example, yearly total landings (dolphinfish, tunas, bonitos and billfishes combined) averaged 10.8 metric tons per commune, with Cayes-Jacmel exhibiting the lowest total landings (8.6 tons) and Bainet the largest ones (13.6 tons). Overall, the four localities combined accounted for a yearly landing of 43.4 tons for all FAD-associated fish. Tunas singlehandedly accounted for the major proportion of fish landed (48% of landings), followed by dolphinfish, with billfishes accounting for a small proportion of the landings (≤ 8%). More detailed data on landings can be found in Vallès (2015).

In the South department, the Fisherfolk Association of Tiburon generously provided landing data covering a period between December 2012 and July 2014. Interestingly, these data are dominated by billfish landings (97% of

records), and although the association did not record the weight (nor length) of the individuals landed, it did record their number. These data are shown in Figure 5. Between December 2012 and July 2014, a total of 516 individual billfish were recorded. Using a full uninterrupted year of records (from June 2013 to May 2014) yields an average of 30.7 (± 23.2 standard deviation) individual fish landed per month and a yearly estimate of 370 individual billfishes landed. There was considerable monthly variability in the number of fish landed with some months reaching up to 66 individuals and others yielding just a few specimens (Figure 4). These data support the assertion that FAD landings in the South are dominated by billfishes, in contrast to the landings of the Southeast, which are dominated by tunas and dolphinfish.

A Field Survey of Fishing Trips to FADs During the Low Season

Yield per fishing trip — A total of 51 fishing trips across five localities were monitored during the study. On average, a fishing trip yielded about 18.7 kg of fish per boat, including both large oceanic pelagic and smaller neritic species (Table 2). However, there were marked differences within and among localities in fishing trip yields, with a considerable number of boats (12 out of 51; 23.5%) returning to port with no catch (Table 2). At the time of the study, Anse d'Hainault exhibited the lowest success in catches (75% of boats returned empty, apparently due to the presence of dolphins interfering with fishing on FADs), whereas Belle Anse exhibited greater success

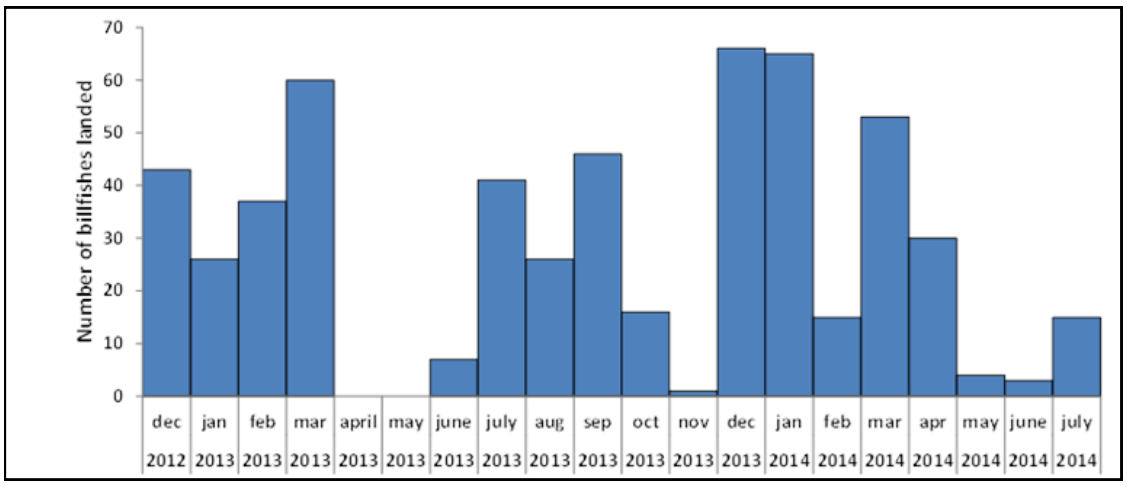

Figure 4. Number of fish landed per month as recorded by the Fisherfolk Association of Tiburon in the South department during the Dec 2012 – Jul 2014 period.

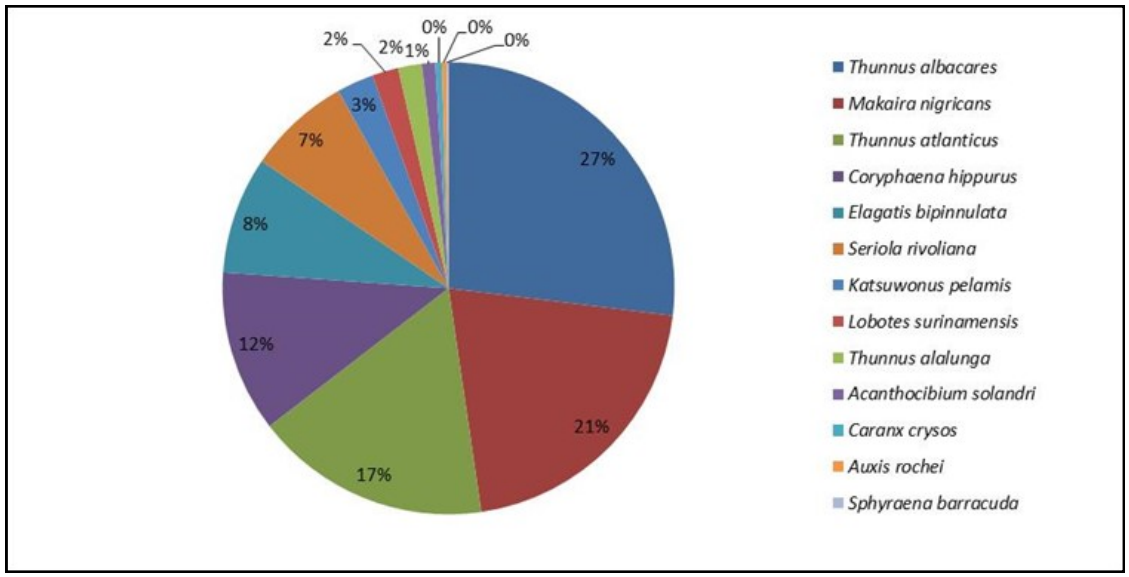

Figure 5. Relative contribution to overall catches (by fresh fish weight) of 13 species recorded across 51 fishing trips associated with FADs across five localities in south Haiti in early 2015. Species names in legend are ordered (from top to bottom) by decreasing order of importance.

rates in catches, with only 5% of the boats returning to port empty (Table 2). Overall, most boats (69%) returned to port with a yield that was likely insufficient to cover fuel expenses. Further details on these fishing trips can be found in Vallès (2015).

Species composition of the catch — Overall, a total of 720 individual fish belonging to 13 species and 5 families were recorded across 51 fishing trips (Figure 5). Four species jointly accounted for most (77%) of the landed biomass; these species included, yellowfin tuna (*Thunnus albacares*), blue marlin (M*akaira nigricans*), blackfin tuna (*Thunnus atlanticus*), and dolphinfish (*Coryphaena hippurus*). More details on the catch can be found in Vallès (2015).

DISCUSSION

About 10% of the fishers and fishing vessels across the Southeast, South and Grande Anse departments were actively engaged in the FAD fishery at the time of the study. This represents an non-negligible percentage of the fisher population in south Haiti, although this percentage is still considerably lower than that of other Caribbean islands engaged in FAD fishing such as Martinique, Guadeloupe, Dominica and St Lucia (CRFM 2015). During the meetings with fishers, it was highlighted that many more fishers wanted to enter the FAD fishery, but they were limited by the lack of suitable boats and outboard engines. Furthermore, those who were already in the fishery wanted to see more FADs deployed. Thus, an expansion of the FAD fishery was favourably perceived by the fishers encountered during the study.

A favourable perception of an expansion of the FAD fishery by fishers in south Haiti is not surprising, particularly in light of the fact that traditional nearshore and demersal resources are overexploited (Célestin 2004, Damais et al. 2007, Favrelière 2008, Schill et al. 2012), and that in some localities (e.g. Anse d'Hainault and Belle Anse) there are no alternative livelihoods. The two examples of year-long landing datasets here presented, and of sufficient quality to help evaluate the importance of the FAD fishery, show that fish landings from FADs can be substantial, although some care is warranted in the interpretation of these data. Indeed, although these data likely underestimate total fish landings, it still remains unclear how much of the contribution comes from FADs and how much comes from other types of offshore fishing, such as fishing under free-floating *Sargassum* patches. Furthermore, the fishing trips that were individually monitored during this study indicated that fishing yields were relatively low at the time (about 18.7 kg per fishing trip), with some boats returning to port with insufficient catches to cover fuel costs, highlighting a tangible financial risk associated with FAD fishing. However, these fishing trip data are clearly not representative of the average yields because this study was carried out during a 2-week period in the low fishing season and so additional data throughout the year are clearly needed to provide a complete picture. Yields of fishing trips to FADs across the Caribbean region typically exceed 50 kg per trip per year (CRFM 2015); whether similar or greater yearly yields per fishing trip are being obtained in south Haiti is likely in at least some localities, but remains to be confirmed. For example, using an additional historical dataset of FAD landings covering the 2005-2006 period, Vallès (2015) estimated an average of 0.8 to 2.1 large pelagic fishes (most likely billfishes and large tunas) being caught per fishing trip on FADs throughout the year at Anse d'Hainault. However, no data were available on the actual weights of these large fish landed, precluding rigorous comparisons.

Overall, these findings underscore the need for an objective cost-benefit analysis to help identify where and when FAD fishing is most likely to be financially viable, given the specific socio-economic context of each locality, and keeping in mind the different ways in which the economic performance of fishing trips on FADs can be assessed (Guyader et al. 2013). This is particularly so in light of the current levels of subsidization of the activity by aid agencies in some localities, where equipment, FADs and/or boats are facilitated to fisherfolk organizations and thus not necessarily factored into the real costs. At the moment, the lack of a standardized and reliable monitoring system on FAD landings throughout most of the area of intervention will continue to preclude a clear evaluation of the long-term viability of the FAD fishery in south Haiti, although efforts are currently being made to help remediate this situation (e.g. CCPMs of the Southeast; Laurent Mérisier, Direction of Fisheries and Aquaculture, personal communication). Having said that, independent project evaluations do support that the introduction of FADs has had a tangible positive impact on fisher communities in the localities of the Southeast, where the strengthening of fisherfolk organizations preceded the development of the FAD fishery (Macías 2014). The latter is consistent with the increases in fisher's revenues and food security observed in coastal areas of the Indo-Pacific through the use of moored FADs (Monintja and Mathews 1999, Prange et al. 2009, Yusfiandayani 2013, Albert et al. 2014), and

Table 2. Summary table of fish landings over 51 fishing trips to FADs across five localities in south Haiti. sd- standard deviation

Commune	No of fishing trips	Fish catch (kg) per fishing trip				Per cent of trips with zero catch
		average	min	max	sd	
Anse D'Hainault	4	0.5	0.0	1.8	0.9	75.0
Bainet	18	15.0	0.0	45.6	16.9	22.2
Belle Anse	20	26.9	0.0	73.6	25.9	5.0
Port-Salut	6	21.9	0.0	74.7	29.9	50.0
Tiburon	3	3.8	0.0	10.7	6.0	33.3
Overall	**51**	**18.7**	**0.0**	**74.7**	**22.7**	**23.5**

helps explain the current sustained development of the moored FAD fishery in other nations of the Caribbean (CRFM 2015).

Although fishing trips to FADs did take place throughout the year, fishers also reported that catches on FADs generally increased between June and November for the main target fish groups, i.e. tunas, billfishes and dolphinfish, thus highlighting a broad seasonal pattern. The extent to which these seasonal patterns in catches reflect true changes in fish abundance on FADs (due to fish migrations) versus seasonal changes in the suitability of fishing conditions (e.g. weather, wind and sea conditions; availability of live bait; interference by cetaceans) remains unclear (Célestin 2004). This aspect also requires further study because some of the factors associated with fishing conditions could be reduced through the provision of better equipment (e.g. better boats; artificial baits), potentially helping improve fishing yields.

Interestingly, there appeared to be differences among departments in the composition of the fish landings, with the relative contribution of billfishes increasing as you moved from the southeast towards the southwest. Whereas spatial differences in the FAD landing fish composition are expected across distances of hundreds of kms (CRFM 2015), the underlying factors remain unclear given that fishing techniques appeared broadly similar across the three departments. Distance from shore and depth are important factors driving FAD catch composition (Diaz et al. 2006) and might play a role. However, accurate information on FAD location was not readily available for the FADs of the South and Grande Anse departments at the time of this study. It is also important to note that during the same trip fishers can alternate fishing on FADs with fishing under *Sargassum* patches which aggregate dolphinfish and other relatively small-bodied species. Thus, the difference here observed might partly reflect a higher contribution of *Sargasum*-associated landings in the Southeast, due perhaps to a higher occurrence of *Sargassum* patches. Alternatively, this difference might be due to a better knowledge on how to fish billfishes in the South and Grande Anse departments, since fishers from these departments have been historically exploiting FAD resources for a longer time period than those in the Southeast.

The monitoring of the fishing trips also provided rigorously collected catch composition data and in doing so showed that the catch composition in south Haiti is consistent with that of FADs elsewhere in the Caribbean (Diaz et al. 2006, CRFM 2013, Mathieu et al. 2014), with a significant portion of the FAD landings made up of stocks currently considered to be regionally over-exploited such as blue marlin and yellowfin tuna (CRFM 2015). The short duration of the study precludes any solid conclusion about the biological status of the individuals typically caught on FAD across the three departments. Nevertheless, the current over-exploited status of these two species highlights the urgent need to improve biological monitoring of FAD landings in Haiti.

Notwithstanding the fact that artisanal FADs are a formal component of Haiti's National Plan to improve fisher's livelihoods and food security in coastal communities, it was also evident from the field visits that some fisher communities in the south were capable of organizing themselves to deploy FADs (with varying degrees of success) with little support from aid agencies and that privately owned FADs were being actively used (as they had been for decades). This strongly suggests that the FAD fishery in south Haiti is securing a permanent place into the Haitian fishery. In that respect, it is pertinent to note that the number of active FADs present at the time of the study was low relative the amount of coastline covered, compared to other islands in the region (Vallès 2015). This finding is important because it underscores the current opportunity to establish national fisheries management plans, monitoring systems, and regulatory frameworks in the early stages of the development of the FAD fishery, so as to ensure a profitable, socially equitable, and biologically sustainable activity (CRFM 2015) as well as to facilitate Haiti's integration into key regional fisheries management organizations such as the International Commission for the Conservation of Atlantic Tunas (ICCAT).

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