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WESTERN CENTRAL ATLANTIC FISHERY COMMISSION (WECAFC)
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The Caribbean Regional Management Plan for the Anchored Fish Aggregating Device (a FAD) Fishery – Working Document

Abbreviations and acronyms

CARIFICO	Caribbean Fisheries Co-management Project
CFMC	Caribbean Fisheries Management Council
CLME	Caribbean Large Marine Ecosystem project
CRFM	Caribbean Regional Fisheries Mechanism
EAF	Ecosystem Approach to Fisheries
ERA	Ecological Risk Analysis
FAO	Food and Agriculture Organization
ICCAT	The International Commission for the Conservation of Atlantic Tunas
IFREMER	French Research Institute for Exploration of the Sea
JICA	Japan International Cooperation Agency
MAGDELESA	Moored fish Aggregating Devices in the Lesser Antilles project
aFAD	Anchored (or Moored) Fish Aggregating Device
OSPESCA	Central America Fisheries and Aquaculture Organization
SAP	Strategic Action Plan
WECAFC	Western Central Atlantic Fishery Commission

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Executive summary

This document presents the Caribbean Regional Management Plan for the Anchored Fish Aggregating Device (aFAD) Fishery, which stems from the Terms of Reference and Work Plan of the of the WECAFC ad hoc Joint Working Group on Development of Sustainable Anchored Fish Aggregating Device (aFAD) Fishing in the Lesser Antilles for the 2019-2021 period. These Terms of Reference were formalized during the 3rd meeting of the Working Group held on April 30th - May 2nd 2019 and endorsed during Seventeenth Session of the Commission held on July 15-18th 2019 in Miami (USA). The Terms of Reference included the review of the CRFM Sub-Regional Management Plan for FAD Fisheries in the Eastern Caribbean¹ to adapt it to a broader a WECAFC regional FAD management plan.

The number of countries and overseas territories in the Caribbean adopting the use of aFADs has gradually increased since aFADs were first experimented with in the region during the 1960s. aFADs have facilitated the targeting of large oceanic and coastal pelagic resources by small-scale fishers, thus opening new revenue opportunities but also raising important challenges in governance and concerns about the impacts of aFADs on fish stocks shared across the region and on marine ecosystems.

A recent desk review and an online aFAD survey to assess the current state of the aFAD fishery have outlined that there are 6,200+ fishers and 2,700+ fishing vessels currently engaged in aFAD fishing across the region for mainly commercial and/or subsistence purposes. Nearly all aFAD fishing takes place in the insular states and overseas territories of the Caribbean, where aFAD vessel numbers have remained stable or increased across most locations over the last five years. It is also estimated that 3,600+ aFAD units are currently deployed across the insular Caribbean, with the Dominican Republic and Guadeloupe jointly accounting for the vast majority of all aFADs. Nearly all aFADs are privately owned by individual fishers or small groups of fishers, even though in many locations public aFADs can also be found.

Fishing on aFADs generally takes place using small-sized multipurpose vessels engaged in one-day fishing trips, carrying 2-3 fishers, and equipped with outboard engines. The degree of professional training of aFAD fishers differs markedly across locations, as does the level of onboard processing of large fish, highlighting the need for more fisher training. Moreover, adequate facilities to handle large fish are still lacking in many locations across the region and most of the catch is directly destined to local markets with generally little value added to the landed product.

Fishing on aFADs is conducted using a small range of techniques and dominated by surface and sub-surface trolling and the use of deep drifting droplines with live bait. A relatively large number of species are targeted on aFADs, including major tuna species such as yellowfin tuna; small tuna species such as blackfin tuna; and tuna-like species such as blue marlin. However, there can be marked differences across islands and within islands as well as seasonally in the relative contribution of these different species to the catch. The factors that drive such spatiotemporal variability in catch composition across the region remain poorly understood and require more research.

Several species targeted on aFADs are currently considered overexploited by ICCAT's most recent stock assessments and some of these species, namely blue marlin, are disproportionately caught on aFADs relative to the other pelagic fisheries. Moreover, the few existing biological data support that catches of large tunas and dolphinfish on aFADs are disproportionately represented by juvenile individuals. Finally, although incidental by-catch of marine mammals, sea turtles, and sea birds on aFADs appears to be infrequent across the region, rigorous data to support this assertion are lacking. All the above highlight the urgent need for improved monitoring of catches on aFADs across the region to ensure the long-term sustainable exploitation of target fish stocks while minimizing impacts on non-target species. However, considerable differences still exist among locations in the implementation of fishery statistical systems and

¹ CRFM, 2015. 2015 Draft Sub-Regional Management Plan for FAD Fisheries in the Eastern Caribbean (Stakeholder Working Document). CRFM Technical & Advisory Document 2015/ 05 p. 94.

in their data collection requirements. Moreover, because the stocks of many of species targeted on aFADs are shared regionally, efforts to improve monitoring of aFAD catches should also seek to standardize data requirements across locations to facilitate region-wide data integration for reliable stock assessments. Moreover, it is necessary to supplement fishery-dependent data from aFADs with fishery-independent data to accurately assess the impacts of aFAD fishing on stocks. The latter would benefit from regional research programs and monitoring networks where aFADs are being used as observatories.

It is generally expected that aFADs will improve fisher livelihoods and support food security. However, more rigorous data on aFAD economic performance are needed across the region to adequately substantiate such expectations and to guide aFAD programs. It is also generally expected that aFADs will lead to decreases fishing pressure in coastal systems. However, the very few studies that have assessed this expectation have found no support for it, highlighting the need for more research.

aFADs are generally largely made of synthetic non-biodegradable materials, although they differ markedly in design, materials, and cost across the region. Private aFADs are less likely to align with best practices in aFAD design than public aFADs. Consequently, they tend to get lost more often and are less likely to be recovered when lost. Private aFADs thus likely represent a significant source of marine litter in the region, underscoring an important challenge of the fishery and the need for affordable aFAD designs and aFAD funding systems that ultimately minimize marine litter.

There is a pervasive lack of comprehensive aFAD regulation and local aFAD fishery management plans across the region. Furthermore, in those locations where specific pieces of aFAD legislation exist, they are seldom enforced. Such inadequate regulatory environment can only lead to increases in conflicts among aFAD users. Many locations also report foreign aFAD fishers illegally operating in their local waters, although actual data on the extent of this problem are lacking, highlighting the need for more regional collaboration in monitoring, control, and surveillance.

It is widely accepted that an effective management of the aFAD fishery across the region will require more sharing of responsibilities between government and fishers. Although the actual nature of such arrangements remains to be resolved and will likely depend on local context, it is likely that it will require going beyond simply consulting fishers towards a model where fishers and other stakeholders are more actively engaged in decision making from early in the process. Considerable experience in participatory approaches in the aFAD fishery has been gained in the region over the last 10 years from which valuable lessons should be drawn. Successfully implementing such approaches will require strengthening fisher organizations and improving governance frameworks under which the aFAD fishery currently operates.

Without effective dialogue between fishers and Fishery authorities, and in the presence of a system that remains unregulated in practice, what emerges is an aFAD fishery based on informally established territorial-use rights that exclude some fishers from access to pelagic resources and leads to conflicts with those that challenge the informal system. This also results in the deployment of large numbers of low-cost private aFADs that, in the race for fish, might lead to a dilution of fishing yields and increases in fuel costs, potentially undermining the ultimate socio-economic objectives that aFAD were supposed to facilitate.

In light of all the above, the overall objective of the Plan is to guide the implementation of actions to ensure the sustainability of large oceanic and coastal pelagic fish stocks while fostering a healthy aFAD fishery and the improvement of the livelihoods of the people who rely on the fishery.

This Plan is anchored on an ecosystem-based approach to fisheries and seeks to improve partnerships and collaborations at local and regional scales throughout the Wider Caribbean region. It is meant to be implemented gradually and incrementally and recognizes that progress towards achieving the desired outcomes will differ across the region due to inherent differences in socio-economic and political context. In relation to the latter, the Plan is meant to be adaptive; it recognizes the need to continuously monitor the various components of the system (social, economic, biological, and ecosystem) to assess whether changes in actions and strategies are needed to achieve the desired specific objectives.

The Plan proposes the following specific objectives:

1. To improve national and regional governance frameworks for the aFAD fishery;
2. To support the development and adoption of robust and effective aFADs management measures across the region;
3. To improve local and regional systems for the collection, integration, sharing, and restitution of fishery-dependent data;
4. To improve the monitoring, control, and surveillance (MCS) of aFAD fisheries across the region to ensure effective implementation of applicable fishery regulations and help eradicate IUU fishing in the region;
5. To improve the environmental sustainability of aFAD fisheries;
6. To improve socio-economic performance and sustainability of aFAD fisheries;
7. To support a science-based approach to aFAD fisheries management.

1. Background

This document presents the Caribbean Regional Management Plan for the Anchored Fish Aggregating Device (aFAD) Fishery following the Recommendation of the 3rd meeting of the WECAFC ad hoc Joint Working Group on Development of Sustainable Anchored Fish Aggregating Device (aFAD) Fishing in the Lesser Antilles held on April 30th- May 2nd 2019 - Recommendation WECAFC/17/2019/21 (Amendment to Recommendation WECAFC/15/2014/2) - which was endorsed during Seventeenth Session of the Commission held on July 15-18 2019 in Miami, US, and was the basis for the 2019-2020 Programme of Work adopted by the Commission. This Programme sought to increase the knowledge of, and experience with, anchored-FADs related fisheries, with the ultimate goal of strengthening regional fisheries management and good-practice approaches for fisheries and aquaculture development. In this context, the development of this document was funded by the European Union through the Food and Agriculture Organization of the United Nations (FAO) and its Western Central Atlantic Fishery Commission (WECAFC).

Since the first exploration of aFAD use in the region in the late 1960's, the number of countries and overseas territories making use of aFADs has gradually increased, particularly in the insular Caribbean (Wilson et al. 2020), opening new revenue opportunities for small-scale fishers but also raising challenges in governance and concerns about the impacts of aFAD fishing on fish stocks shared across the region.

In that regard, considerable effort has been allocated over the last two decades towards describing the aFAD fishery and sharing information on aFADs across the region. Most of the existing detailed information comes from the European Union (France-Guadeloupe and France-Martinique), where aFAD fishing was adopted earlier than in other locations, and through research efforts of IFREMER that started in the 1990's (Reynal et al. 1999). In 2001, recognizing the need to exchange information, practices and experiences in the management and exploitation of large pelagic using aFADs, the WECAFC ad hoc Working Group on the Development of Sustainable Development of aFAD fishing in the Lesser Antilles was established and its first meeting held in Martinique (FAO 2002). Following this meeting, IFREMER conducted the DOLPHIN research project aimed at characterizing fish aggregations around aFADs and describing in considerable detail the aFAD fishery in the French Antilles. The results of this project were shared during the second Working Group meeting that took place in Guadeloupe in 2004 (FAO 2007). This later meeting led to the conception and subsequent development and execution of the MAGDELESA (Moored fish AGgregating DEvices in the LESser Antilles) project by IFREMER between 2011 and 2014, which generated considerable new knowledge on the aFAD fishery (Reynal et al. 2015).

Between 2010 and 2012, JICA and CRFM collaborated to conduct a pilot project in St Lucia and Dominica seeking to improve the capacity of fisheries officers and fishers' organizations to manage pelagic resources exploited using aFADs and increase aFAD productivity by developing skills and capacity to utilize pelagic resources (CRFM/JICA 2012). This project focused on technical aspects of aFAD design, construction, deployment, and maintenance but also sought to set the grounds for a co-management approach to such fisheries in which fishers were expected to increase their participation in decision making but also share a greater responsibility in the provision of fisheries data (CRFM/JICA 2012; CRFM 2013b). These efforts were followed up in 2013 by the implementation of the 5-year Caribbean Fisheries Co-Management (CARIFICO) Project, which sought to further support the development a co-management approach to aFAD fisheries in Dominica and St Lucia and expand its geographic range by including four more countries with significant aFAD fisheries, namely Antigua and Barbuda, St Kitts and Nevis, St Vincent and the Grenadines, and Grenada (CRFM 2014a; CRFM 2014b; CRFM 2017).

Around this time, during the CRFM-JICA CARIFICO/WECAFC-IFREMER MAGDELESA Workshop on FAD Fishery Management in St Vincent in 2013, it was proposed that the Working Group expand to a Joint Working Group with possible participation of JICA, IFREMER, CRFM and WECAFC (CRFM 2013a).

In this very dynamic context, and recognizing the increasing need for coordination, harmonization, and cooperation across the region on issues pertaining to aFAD use, the CRFM facilitated the development of

a draft Sub-regional Management Plan for the aFAD fishery for the Eastern Caribbean in 2015 (CRFM 2015a). In 2019, the Joint Working Group met for the third time and its Terms of Reference (ToR) were formalized during the Seventeenth Session of WECAFC that same year. These ToR included the review of the CRFM Sub-Regional Management Plan to adapt it to the broader WECAFC regional setting.

The Caribbean Regional Management Plan for the anchored Fish Aggregating Device (aFAD) Fishery thus seeks to build on the CRFM sub-regional management plan by seeking to (1) expand the geographic scope to include the wider Caribbean (Fig 1), (2) integrate the most recent developments in aFAD fisheries, and (3) provide an update on the current state of the aFAD fishery across the region. The latter was facilitated by a regional online survey on aFAD use across the region that took place between August and October 2021. Respondents from twenty countries/overseas territories with significant aFAD fisheries took part in the survey. These countries/overseas territories were St. Eustatius, Dominica, Bonaire, Haiti, Antigua and Barbuda, European Union (France-Guadeloupe, France-Martinique), St Lucia, Puerto Rico, Bermuda, Montserrat, St. Vincent and the Grenadines, Florida (USA), Saba, Anguilla, Tobago (Trinidad and Tobago), the Dominican Republic, Curaçao, Cayman Islands, and Grenada. Seventy percent of the respondents were affiliated with national/local fishery and/or coastal management authorities. A detailed review of the state and challenges of the aFAD fishery is given in Appendix I. Details and in-depth findings of the regional survey are given in Appendix II. A summary of the biology, distribution, and exploitation status of fish stocks of species typically caught on aFADs is given in Appendix III. Appendix IV is a stand-alone document that provides guidelines for the development and implementation of local aFAD management plans.

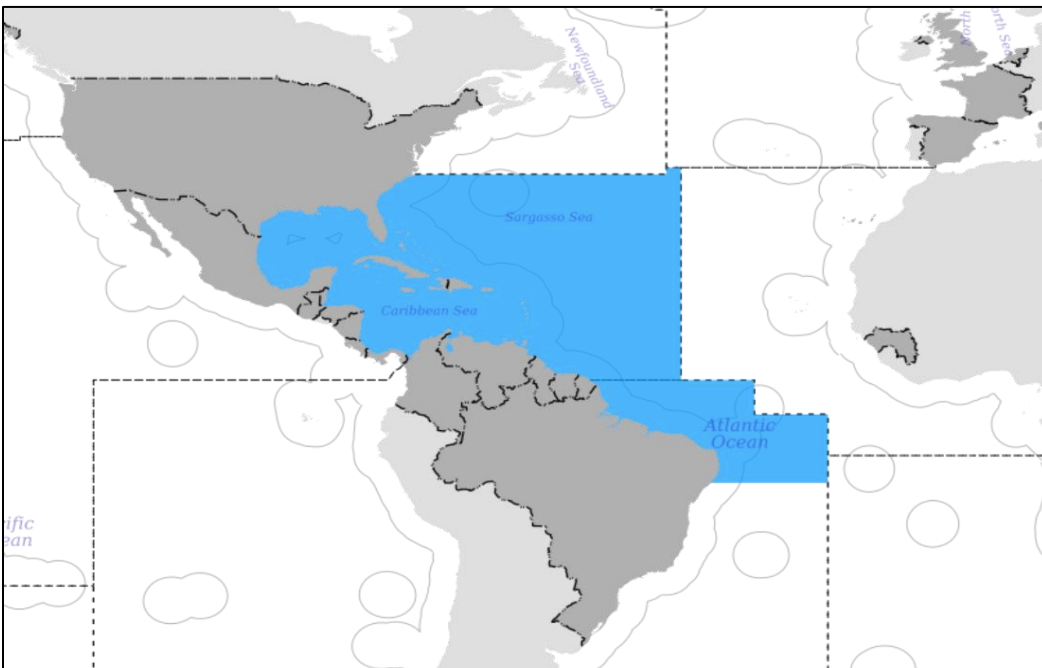


Figure 1. Area of competence of the Western Central Atlantic Fishery Commission (WECAFC)

2. Summary of the state and challenges of the aFAD fishery

An anchored Fish Aggregating Device (aFAD) is any man-assembled structure composed of surface (or subsurface) buoyant components attached to an anchoring system resting on the sea bottom, which is primarily designed and deployed to attract pelagic fish to facilitate their capture.

Nearly all aFAD fishing within the WECAFC region takes place in the insular states and overseas territories of the Caribbean (Table 1). There is also currently an estimated total number of 3,600+ aFAD units deployed across the insular Caribbean region, with two locations, the Dominican Republic and Guadeloupe (EU-FR), jointly accounting for 86% of all aFADs in the region (Table 1). Nearly all (97%) aFADs deployed across the Caribbean are privately owned by fishers, even though many locations also support publicly owned aFADs (Table 1).

Table 1 – Estimates in 2022 of numbers of public and private aFADs and aFAD fishers and vessels (full- and part-time) across WECAFC country members (and/or their overseas territories). Only those locations with confirmed significant aFAD fisheries are listed. NA- No data available. OT- Overseas territory. Data from Appendix I.

WECAFC Member /Territory	Public aFADs	Private aFADs	aFAD boats	aFAD fishers
Anguilla (British OT)	0	25	15	15
Antigua and Barbuda	8	20	15	35
Barbados	1	0	NA	NA
Bermuda (British OT)	1	0	5-25	5-75
Bonaire (Dutch Caribbean)	6	1	20	20
Cayman Islands (British OT)	0	2	-	-
Curacao (Dutch Caribbean)	0	20	10-15	10-15
Dominica	2	20	300	600
Dominican Republic (south coast)	0	2500	1250	2500
Grenada	0	3	70	140
Guadeloupe (EU-France)	<30	600	218	387
Haïti (southeast department)	6	3	250	1500
Martinique (EU-France)	4	20-25	220	377
Montserrat (British OT)	4	0	8	25
Puerto Rico (USA OT)	11	10	-	-
Saba (Dutch Caribbean)	0	15-20	12	22
Saint Kitts and Nevis	0	100	75	100
Saint Lucia	8-10	0	200-250	450-500
Saint Vincent and the Grenadines	6	0	50	100
Sint Eustatius (Dutch Caribbean)	1	5	6	6
Sint Marteen (Dutch Caribbean)	0	2	20	NA
St Barthelemy (French OT)	0	100	22	NA
Florida (USA)	8	0	500+	1000+
Trinidad and Tobago	0	100	-	60-80
US Virgin Islands (USA OT)	4	0	20	NA

About 6,200+ fishers and 2,700+ fishing vessels are engaged in (full- or part-time) aFAD fishing across the Caribbean (Table 1) for mainly commercial and/or subsistence purposes. aFAD vessel numbers have remained stable or increased across most locations over the last five years (Appendix I). Fishing on aFADs generally takes place using small-sized (<9 m long) multipurpose vessels (made of wood, fiberglass, or fiberglass and wood) engaged in one-day fishing trips, carrying 2-3 fishers, and equipped with outboard engines (Appendix I).

In the Caribbean, aFADs continue to be used with the expectations that they will increase economic returns of fishers, reduce fishing pressure on coastal and demersal resources, and increase food security (Fig 2).

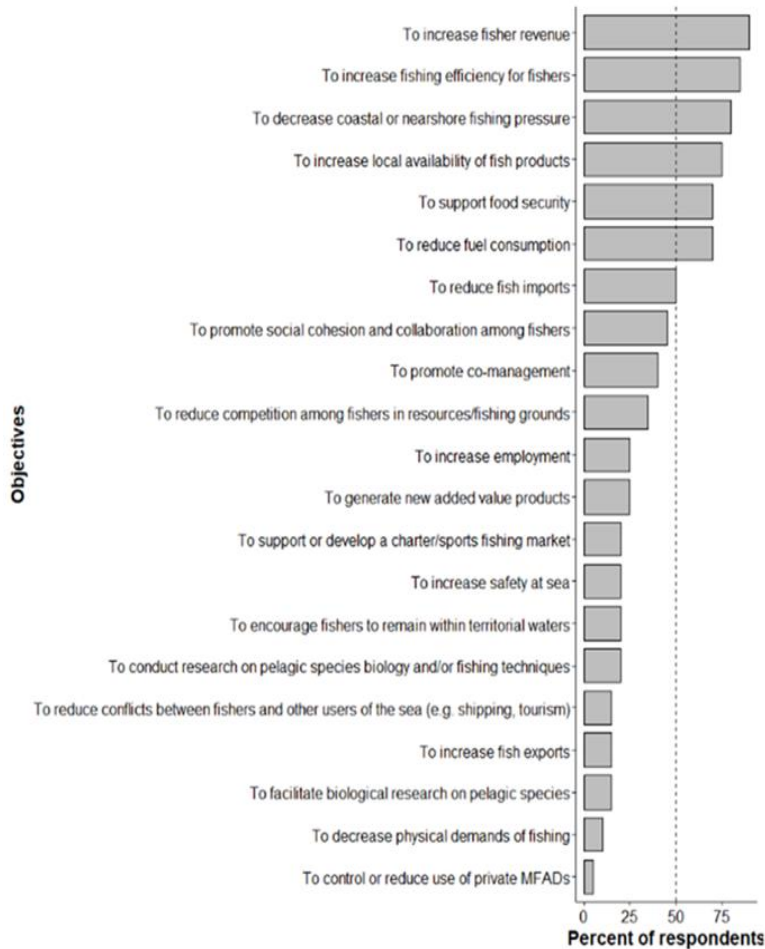


Figure 2. Frequency of citation of high-level objectives to support an aFAD fishery by key informants from 20 WECAFC territories/countries with aFAD fisheries surveyed in 2021. All but one were based on Caribbean island countries or territories. The list of objectives was based on CRFM (2015). Adapted from Vallès (2023), based on data from Appendix II

Both public and private aFADs are typically made of synthetic non-biodegradable materials, but private aFADs are generally considerably less expensive than public ones even though across locations they vary markedly in cost and design (Fig 3). Public aFADs designs generally align with best practices, including the provision of surface markers and features allowing the identification of their origin, whereas such best practice considerations are rarely implemented on private aFADs (Appendix I). Overall, private aFADs get lost more often than public aFADs and are also less likely to be recovered once they are lost (Appendix I), representing a significant source of marine litter in the region and underscoring the need for affordable aFAD designs that minimize marine litter.

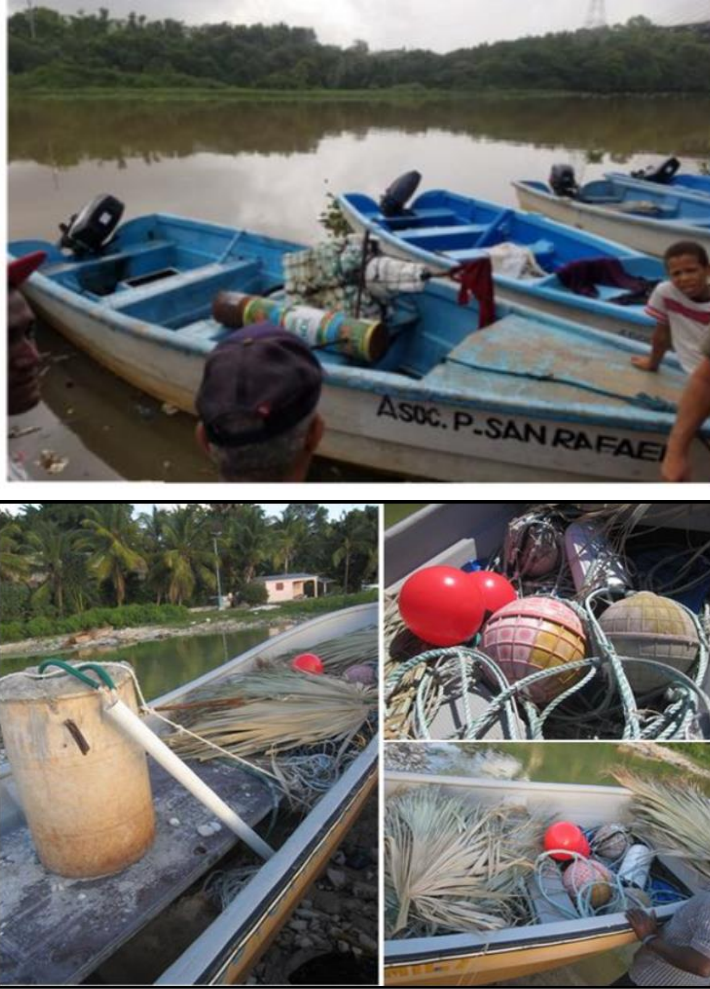


Figure 3. Anchor and floating components for light aFADs ready for deployment in the Dominican Republic (top panel) and Haiti (bottom panels); pictures are from Gertner et al. (2018) and Vallès (2015), respectively. Taken from Appendix I.

Fishing techniques on aFADs are largely dominated by the surface (<2 m deep) and sub-surface (2-10 m deep) trolling using baited hooks and artificial lures and deeper drifting droplines using live fish bait such as small tunas (Appendix I). A relatively large number of species are targeted on aFADs, including major tuna species such as yellowfin tuna, bigeye tuna, and skipjack; small tuna species such as blackfin tuna and little tunny; and tuna-like species such as blue marlin, wahoo, and dolphinfish (Fig 4). However, catch composition also differs markedly across locations and seasonally within a given location (Appendix I), underscoring an area for further research.

The extent to which large fish typically caught on aFADs are processed onboard to maintain high quality of the landed product (spiked; bled out; gutted; preserved on ice) differs across the region as does the degree of professional training available to aFAD fishers (Appendix I), highlighting an area where tangible increases in socio-economic benefits could be obtained with minimum investment. Moreover, adequate facilities to handle large fish are still lacking in many locations and most of the catch is often directly destined to local markets with generally little value added to the landed product (Appendix I).

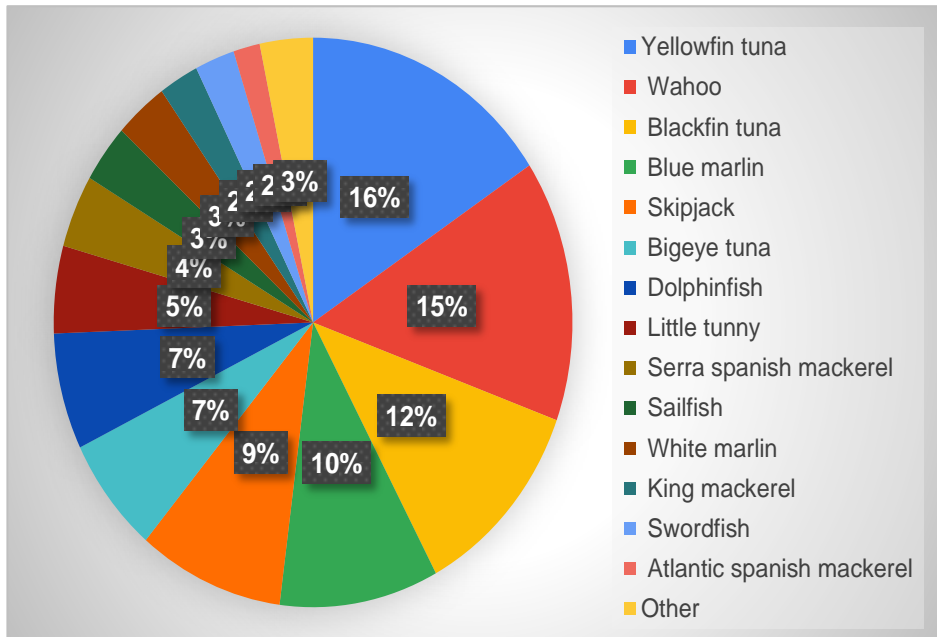


Figure 4. The most frequently cited target species on aFADs by experts from 20 locations across the Caribbean. Taken from Appendix I.

Several species targeted on aFADs are currently considered overexploited by ICCAT’s most recent stock assessments and some of these species, namely blue marlin, are disproportionately caught on aFADs relative to the other pelagic fisheries (Appendix I). This raises the urgent need to carefully monitor landings of species caught on aFADs and to do so in a way that can effectively provide a regionwide view of the state of shared stocks. However, considerable differences still exist among locations in the implementation of fishery statistical systems. Although several locations do not systematically collect fishery data, most do have active fishery data collection systems involving the use of standardized data collection forms; nearly all these locations distinguish landings from aFAD fishing from non-aFAD fishing (Appendix I). However, there is still great need to standardize minimum data requirements across these locations to help feed regional databases that can inform management more effectively (Table 2).

Table 2. Percentage of insular Caribbean territories/countries with aFAD fisheries that monitor fishing trips to aFADs to collect data on the variables listed below. Taken from Appendix I.

Variable	Yes	Some times	No
aFAD ID or location	38%	23%	38%
Time spent fishing	87%	13%	0%
Time spent travelling	43%	14%	43%
Number of fishers on boat	87%	7%	7%
Fishing techniques used	93%	7%	0%
Number of fishing lines in the water	50%	17%	33%
Total weight landed	93%	7%	0%
Weight landed by species	86%	14%	0%
Fuel consumption and other expenses	36%	29%	36%
Estimate of revenue from sale	64%	7%	29%
Number of fish landed	47%	27%	27%
Number of fish landed by species	47%	33%	20%

Published reports of aFAD landings are rare because separating aFAD catch data from other types of fishing has only begun recently in most of the locations that monitor fishing trips. The existing data show that variability in aFAD landings across the region spans one to two orders of magnitude (Fig 5); Guadeloupe (EU-FR) and the Dominican Republic largely dominate reported landings, with values exceeding 1,000 metric tons per year, in line with the large number of aFADs present in their territories (Fig 5; Table 1).

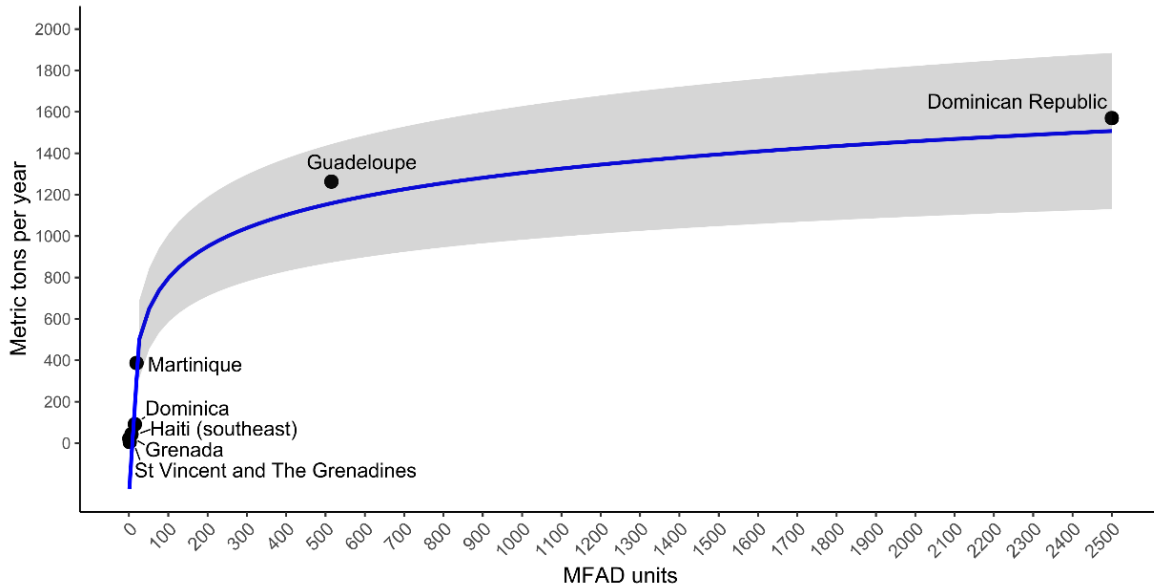


Figure 5. Yearly landings derived mostly from aFAD fisheries in countries or overseas territories across the Caribbean region as a function of numbers of aFADs. The grey band represents 95% confidence intervals. Adapted from Vallès (2023) based on data from Appendix I.

In terms of incidental catch, the capture of marine mammals, sea turtles, and sea birds on aFADs appears to be infrequent across the region, possibly because the use of entangling materials such as old nets as aFAD aggregators also seems to be infrequent (Appendix I). In contrast, sharks appear to be comparatively more frequently caught on aFADs (Appendix I), which is expected given the range of hook and line fishing techniques used. That said, actual data on incidental catches on aFADs, and the extent to which this is due to entanglement versus fishing, are notoriously lacking for any of these groups, highlighting the need for improved monitoring.

Moreover, because aFADs tend to aggregate juvenile fish of several tuna species and dolphinfish, catches of these species on aFADs can be numerically dominated by immature fish (Fig 6). Targeting juvenile tuna on aFADs for commercial purposes raises legitimate concerns about potential negative impacts on stocks. Further development of the aFAD fisheries in the region should give this issue due consideration and, to the extent that it is possible, seek to minimize such effects under the precautionary approach. In the meantime, it further underscores the need for improved monitoring of catches on aFADs and for urgent research on natural rates of juvenile mortality for target species in the region. Finally, it will be necessary to supplement fishery-dependent data from aFADs with fishery-independent data to accurately assess the impacts of aFAD fishing on stocks. The latter would benefit from regional research programs and monitoring networks where aFADs are being used as observatories.

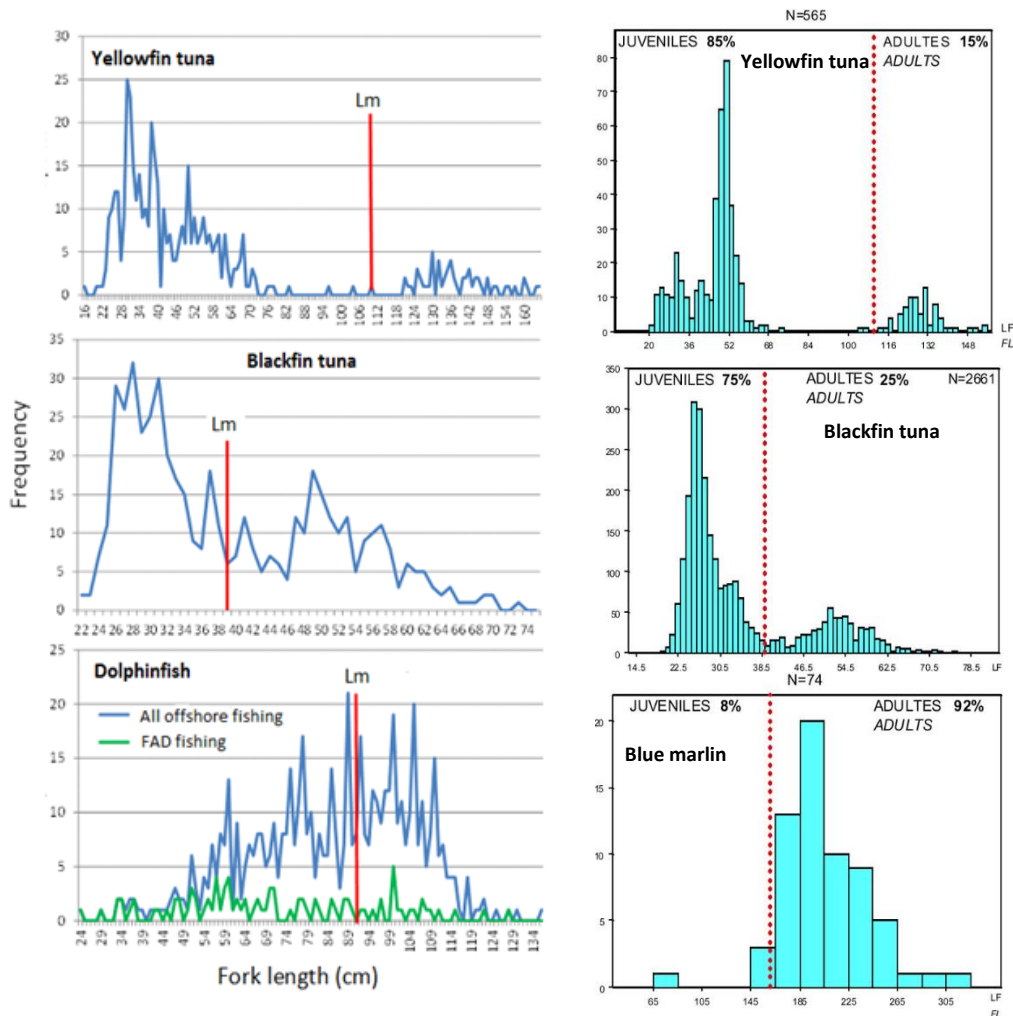


Figure 6 - Size-frequency distributions of fish caught around aFADs in Martinique between 2008 and 2013 (left panels) and between 1998 and 2001 (right panels). Vertical red lines indicate length at maturity (Lm). Adapted from Appendix I; taken from CRFM (2015a) and Doray et al. (2002).

The introduction of aFADs at a given location usually is done via the implementation of short-term projects funded by government or non-governmental agencies and typically involve the deployment of public aFADs that tend to align with best practices in aFAD design and are consequently relatively expensive to maintain and replace. The general expectation is therefore that the revenues generated by the aFAD fishery will ultimately contribute to support these public aFAD programs in the long run. However, it has been very difficult to create a sustainable funding scheme relying on fisher contributions to maintain public aFADs across the region (Appendix I). Instead, once the fishery is locally adopted, fishers will often prefer to invest in their own low-cost private aFADs, either individually or in groups. Private aFADs are lighter and cheaper and so easier to replace and deploy than public aFADs, which gives fishers greater ability to track the abundance of pelagic resources. They are also more likely to be deployed in locations that minimize their use by other fishers, which leads to higher revenue for the owners, but also to more frequent conflicts with non-owner users of the aFADs in the absence of regulation.

In that regard, there is a pervasive lack of comprehensive aFAD regulation (including aFAD registry and licensing systems) and local aFAD fishery management plans across the region (Appendix I). Furthermore, in those locations where specific pieces of aFAD legislation exist, they are seldom enforced (Appendix I).

Finally, there is also evidence that many fishers might be simply unaware of (formal or informal) rules governing public and private aFAD use when such rules exist (Appendix I), pointing also to a problem of ineffective communication and sensitization within and among stakeholders. Such inadequate or inexistent regulatory environment can only lead to increases in the frequency of conflicts among aFAD users. On the other hand, there is evidence that fishers might set or use aFADs in foreign waters of nearby islands (Appendix I), engaging in conflicts with local fishers, and suggesting that IUU fishing involving aFADs might be widespread across the region. The latter further highlights the urgent need for improved monitoring, control, and surveillance mechanisms and for more regional collaboration and sharing of information.

Importantly, in the absence of effective regulation, the evidence currently available does not support that the introduction of aFADs necessarily leads to decreases in fishing pressure on coastal and demersal resources (Appendix I), countering one of the key expected benefits of aFADs (Fig 2).

Finally, it is widely accepted that effective management of aFAD fisheries across the region will require more sharing of responsibilities between government and fishers. Although the actual nature of such arrangements remains to be resolved, it is likely that it will require going beyond simply consulting fishers towards a model where fishers and other fishery stakeholders are more actively engaged in decision making from early in the process. Considerable experience in participatory approaches in the aFAD fishery has been gained in the region over the last 10 years (e.g. CARIFICO project) from which valuable lessons should be drawn. Successfully implementing such approaches is, however, challenging and will require strengthening fisher organizations and improving formal and informal governance frameworks under which the aFAD fishery currently operates. Without effective dialogue between fishers and Fishery authorities, and in the presence of a system that remains unregulated in practice, the scenario that seems to emerge is that of a aFAD fishery based on the establishment of informal individual exclusive territorial-use rights around historical use of aFADs (Fig 6).

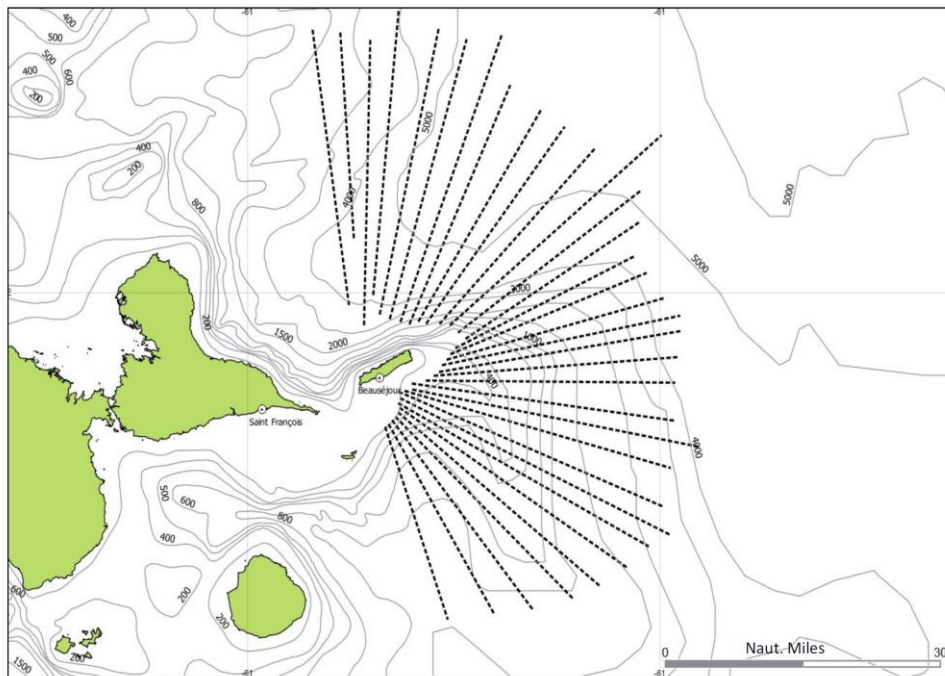


Figure 6. Informal territories of aFAD fishers in the Island of La Désirade (Guadeloupe) in 2014. Each line represents an exclusive non-formal fishing territory belonging to a aFAD fisher, with multiple MDAs deployed along the line. Taken from Guyader et al. (2018).

This scenario seems effective in limiting fishing access to other fishers, but raises serious issues about fairness and equity, and leads to conflicts with those that challenge the informal system. Moreover, in the race for fish, it ultimately results in the deployment of large numbers of low-cost aFADs, which will generally end up as marine litter, and to increases in fuel expenses that might outweigh the benefits of any increase in catches due to increases in aFADs deployed. For example, currently available data on aFAD landings versus number of aFADs deployed across the region suggest diminishing returns in landings as the number of aFADs deployed increases at a given location (Fig 5), highlighting the urgent need for better socio-economic data to ensure the long-term profitability of the fishery as well as fair and equitable social outcomes.

Such concerns about the long-term profitability of aFAD fisheries were reiterated by key informants across the region in a recent (2021) survey on aFAD fisheries (Appendices I and II), where high fuel consumption and costs associated with aFAD fishing scored highest among the issues that require the attention of managers (Fig 7). The lack of adequate regulation and enforcement capacity as well as the lack of management plans within which these fisheries typically operate also scored highest during the same regional survey (Fig 7), emphasizing again the urgent need to improve the governance and management of aFAD fisheries across the region to ensure their long-term biological and socio-economic sustainability.

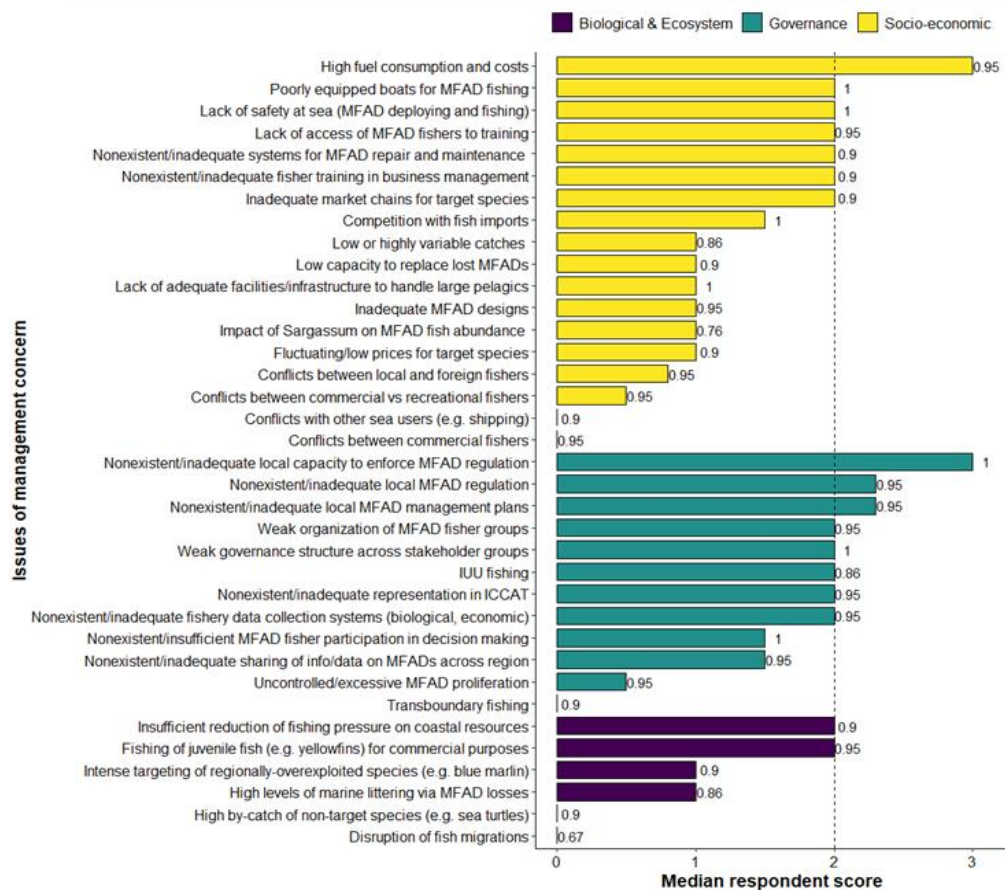


Figure 7. Results of a 2021 regional survey of key informants on aFADs showing the median priority scores across locations (n=21) for socio-economic, governance, biological, and ecosystem issues of management concern for aFAD fisheries. Scores varied between 0 (not important) to 3 (highest importance), the dashed vertical line delineates the issues that were here considered as most pressing across the region (median score ≥ 2) and the number labels on right of the bars represent the proportion of respondents (out of 21) that assigned a score (0-3) to a specific issue. Adapted from Vallès (2023), based on data from Appendices I and II.

3. Overall goal and specific objectives of the Plan

The overall objective of this Regional aFAD Fishery Management Plan is to guide the implementation of a set of identified management measures that can be applied at the regional, subregional, national and local levels for the sustainability of large oceanic and coastal pelagic fish stocks while ensuring a healthy aFAD fishery and the improvement of the livelihoods of the people that rely on the fishery.

This Plan is anchored on an ecosystem-based approach to fisheries, seeking to enhance partnerships and collaboration throughout the Wider Caribbean region to improve the long-term governance of aFAD fisheries across the Caribbean. It is meant to be implemented gradually and incrementally and recognizes that progress towards achieving the desired outcomes will differ across the region due to inherent differences in socio-economic and political context. In relation to the latter, the Plan is meant to be adaptive; it recognizes the need to continuously monitor the various components of the system (social, economic, biological, and ecosystem) to assess whether changes in actions and strategies are needed to achieve the desired specific objectives.

This section presents the specific objectives of the Plan, along with the corresponding expected outputs and the activities that will be necessary to reach those outputs. The activities themselves are also accompanied by their relevant indicators, means of verification, the key implementing actors, and a proposed timeline for execution. The objectives and activities were identified by integrating those proposed by the sub-regional aFAD fishery management (CRFM 2015a) with the findings of the review of the state and challenges of the fishery (Appendix I). All the elements are presented in Table 3.

This Regional aFAD Fishery Management Plan was formulated with the following specific objectives:

- O1 -To improve national and regional governance frameworks for the aFAD fishery;
- O2 -To support the development and adoption of robust and effective aFADs management measures across the region;
- O3 - To improve local and regional systems for the collection, integration, sharing, and restitution of fishery-dependent data;
- O4 - To improve the monitoring, control, and surveillance (MCS) of aFAD fisheries across the region to ensure effective implementation of applicable fishery regulations and help eradicate IUU fishing in the region;
- O5 - To improve the environmental sustainability of aFAD fisheries;
- O6 - To improve socio-economic performance and sustainability of aFAD fisheries;
- O7 - To support a science-based approach to aFAD fisheries management.

Table 3 – Matrix of expected outputs and associated activities, indicators, means of verification, implementing actors, and timelines for execution under each specific objective of the Regional aFAD fishery Management Plan

OBJECTIVE / OUTCOME	Outputs	Activities	Indicators	Means of verification	Actors	Time
O1 - To improve national and regional governance frameworks for the aFAD fishery	Legal national/local regulatory frameworks and policies to support co-management and aFAD management plans are adopted	Adopt/Update legal instruments to support effective (co-)management arrangements and align with best practices	Relevant legislation is drafted and adopted	Relevant legal documentation (e.g. publication in Gazette)	National / local governments	1-5 years
		Establish a national/local policy on public versus private (individual vs collective) aFAD use	Policy on private versus public aFAD use is established	Meeting and workshop minutes	National / local governments& fisher and other stakeholder local organizations	1-3 years
		Explore use of formal Territorial User Rights for Fishing (TURFs) arrangements on aFADs	Multi-stakeholder position on TURFs use is clarified	Meeting and workshop minutes	National / local governments& fisher and other stakeholder local organizations	1-3 years
	Capacity of all key aFAD fishery stakeholders to participate in co-management is strengthened	Conduct local/national level consultations and public awareness campaigns on the importance of management of the aFAD fishery	Consultations and outreach campaigns are conducted	Meeting minutes; media outputs	National / local governments	1-3 years
		Strengthen national/local fishery authorities and other key governmental authorities	Staff, funding, and logistic resources are increased	Allocated budgets	National / local governments	1-3 years
		Strengthen aFAD fisher groups and other (non-governmental) aFAD fishery stakeholders to facilitate effective collective representation	Membership and number of fisherfolk organizations are increased	Meeting minutes and workshop/training sessions with list of participants; legal status documents of organization	National / local governments& fisher and other stakeholder local organizations	1-3 years
		Strengthen multi-stakeholder organizational structures to support effective dialogue among stakeholders	Multi-stakeholder dialogue mechanism is formally established	Meeting minutes and workshop/training sessions with list of participants; legal status documents of organization	National / local governments& fisher and other stakeholder local organizations	1-3 years
	Cooperation between different regional and sub-regional	Increase scientific contributions from the aFAD Working Group to relevant ICCAT Working Groups	aFAD technical outputs are increased	Technical documents	Working Group members	1-3 years

	organizations dealing with aFAD fisheries in the region is increased	Establish bi-lateral and multilateral MOUs with reference to aFAD management	The number of MOUs is increased	Signed MOUs	National / local governments & RFBs (CRFM, OSPESCA and WECAFC)	1-3 years
		Share best practices and experiences across the region	Workshops and exchange activities involving key stakeholders are increased	Workshops and exchange program reports	National / local governments & RFBs (CRFM, OSPESCA and WECAFC)	1-3 years
	Participation of countries with aFAD fisheries in regional decision-making mechanisms and processes is increased	Increase collaboration of Caribbean-island nations with ICCAT and relevant fisheries bodies	Caribbean SIDS membership in ICCAT is increased	ICCAT membership certification	National / local governments & RFBs (CRFM, OSPESCA and WECAFC))	1-10 years
	Regional Management Plan fit for purpose and adaptive to evolving environmental and socioeconomic conditions	Reports to WECAFC every 5 years and review of the ROP as needed	Revised management plan is formally adopted	Revised regional management plan document	National / local governments & RFBs (CRFM and WECAFC)	5 years

Table 3 – Matrix of expected outputs and associated activities, indicators, means of verification, implementing actors, and timelines for execution under each specific objective of the Regional aFAD fishery Management Plan continued

OBJECTIVE / OUTCOME	Outputs	Activities	Indicators	Means of verification	Actors	Time
O2- To support the development and adoption of robust and effective aFADs management measures across the region	The conditions for developing effective adaptive local aFAD fishery management plans are met	Ensure adequate dissemination and sharing of information across stakeholder groups on the status of the local aFAD fishery and target species	Consultations and outreach campaigns are conducted	Meeting and workshop minutes; media outputs	National / local governments& fisher and other stakeholder local organizations	1-3 years
		Facilitate multi-stakeholder establishment of broad objectives of aFAD management plan	Objectives are agreed upon	Meeting and workshop minutes	National / local governments& fisher and other stakeholder local organizations	1-3 years
		Facilitate multi-stakeholder agreement on the rights and duties of all stakeholders during plan implementation	Rights and duties of specific stakeholder groups are agreed upon	Meeting and workshop minutes	National / local governments& fisher and other stakeholder local organizations	1-3 years
		Facilitate multi-stakeholder agreement on who has a right to fish on aFADs under the management plan	Who has right to fish is defined	Meeting and workshop minutes	National / local governments& fisher and other stakeholder local organizations	1-3 years
		Ensure that management plan is aligned with and supported by local legislation	Management plan is anchored on local legal framework	Proposed management plan document; relevant legal documentation	National / local governments& fisher and other stakeholder local organizations	1-3 years

		Facilitate multi-stakeholder approval of management plan	Management plan is formally adopted	Meeting and workshop minutes; management plan document	National / local governments & fisher and other stakeholder local organizations	1-3 years
A comprehensive set of local aFAD fishery regulations is agreed upon and adopted through local fishery management plans		Adopt measures to increase in owner identification markings on aFADs	Measures are formally adopted	Management plan document	National / local governments & fisher local organizations	1-3 years
		Adopt measures to increase recording of aFAD catch and effort data	Measures are formally adopted	Management plan document	National / local governments & fisher local organizations	1-3 years
		Adopt measures to reduce use of animal entangling materials on aFAD designs	Measures are formally adopted	Management plan document	National / local governments & fisher local organizations	1-3 years
		Adopt measures to promote aFAD designs that minimize aFAD losses and/or maximize use of biodegradable materials	Measures are formally adopted	Management plan document	National / local governments & fisher local organizations	1-3 years
		If appropriate, adopt measures to limit aFAD numbers and distribution	Measures are formally adopted	Management plan document	National / local governments & fisher local organizations	1-3 years
		If appropriate, adopt seasonal and/or spatial fishing closures on aFADS	Measures are formally adopted	Management plan document	National / local governments & fisher local organizations	1-3 years
		If appropriate, prohibit specific fishing techniques and/or strategies	Measures are formally adopted	Management plan document	National / local governments & fisher local organizations	1-3 years
		If appropriate, adopt limits to catches and/or fishing effort on aFADs	Measures are formally adopted	Management plan document	National / local governments & fisher local organizations	1-3 years
Adaptive local aFAD fishery management plans anchored on EAF approach are harmonized across the region		Gradually update and harmonize local/national management plans (and associated regulations) across the region as appropriate to increasingly align with EAF best practices and the recommendations of current fishery management bodies and instruments (e.g. ICCAT)	Plan measures are revised and amended	Revised management plan document	RFBs (CRFM, OSPESCA and WECAFC) & National / local governments & fisher and other stakeholder local organizations	1-5 years
		Critically evaluate adaptive local/national aFAD management plans across the region within five-year cycles	Local management plans are reviewed and evaluated	Evaluation recommendations and plan amendment documents	National / local governments & RFBs (CRFM, OSPESCA and WECAFC)	1-10 years

Table 3 – Matrix of expected outputs and associated activities, indicators, means of verification, implementing actors, and timelines for execution under each specific objective of the Regional aFAD fishery Management Plan continued

OBJECTIVE / OUTCOME	Outputs	Activities	Indicators	Means of verification	Actors	Time
O3 - To improve local and regional systems for the collection, integration, sharing, and restitution of fishery-dependent data	Minimum fishery-dependent data requirements (catch and effort, bycatch, fishing trip expenses and revenue) for aFAD monitoring are increasingly harmonized across the region	To the extent that it is possible, align (local/national) data requirements for catch and effort and biological data (for target and by-catch species caught on aFADs) with those of CRFM aFAD logbook or WECAFC logbook datasheets	Data collection forms and protocols are revised and updated	Data collection forms and/or fisher logbooks and protocol descriptions;	National / local fisheries authorities & fisher local organizations	1-3 years
		Establish and/or update local/national centralized electronic databases for fishery-dependent data storage and processing	Updated database is operational	Database outputs	National / local fisheries authorities	1-3 years
		To the extent that it is possible, align local/national centralized electronic databases for fishery-dependent data storage with WECAFC DCRF data requirements	Updated database is operational	Database outputs	National / local fisheries authorities	1-3 years
	Fishery-dependent data collection is more efficiently conducted, and such data are more quickly processed and returned to relevant stakeholders	Develop data sharing agreements between local/national fishery authorities and fishers	Data sharing agreements are developed	Signed sharing agreements	National / local fisheries authorities & fisher local organizations	1-3 years
		Test and gradually integrate the use of low-cost ICT tools into the fishery data collection process	Fishery data collection apps for mobile devices linked to electronic databases are developed	Field data collection apps on mobile devices are functional; sample data	National / local fisheries authorities & fisher local organizations	1-3 years
		Increase use ICT tools to return personalized summaries of catch and effort to fishers in shorter timeframes	Personalized summary reports print outs are increased	Number of personalized summary reports print outs	National / local fisheries authorities & fisher local organizations	1-3 years
	The size, number, and other characteristics of aFAD fishing vessels are adequately documented and updated at relevant time intervals	Conduct frame surveys at appropriate time intervals	Frame surveys are conducted as appropriate	Frame survey results	National / local fisheries authorities & fisher local organizations	1-5 years
	Fishery-dependent data collection is gradually refined and improved	Regularly revise and update protocols for collection of catch and effort and biological data	Data collection protocols are revised and updated	Revised protocols; sample data	National / local fisheries authorities & fisher local organizations	1-3 years

		Regularly train data collectors and voluntary fishers on catch and effort and biological data collection	Training sessions are conducted	Training session documents and certificates of participation	National / local fisheries authorities & fisher local organizations	1-3 years
		Regularly train data collectors and voluntary fishers on species identification	Training sessions are conducted	Training session documents and certificates of participation	National / local fisheries authorities & fisher local organizations	1-3 years
		Generate data from other fishery-related sources (e.g. random telephone fisher surveys; market surveys; recreational fishing surveys) to cross-validate catch and effort data to identify and reduce potential sampling biases	Data from other types of surveys are available	Alternative sample data	National / local fisheries authorities & fisher local organizations	1-5 years
	Fishery-dependent data collection coverage is gradually expanded in space and time	Increase human capacity (data collectors; voluntary fishers) and/or availability of ICT tools for data collection process	Frequency of fishing trip surveys and number of landing sites monitored are increased	Sample data	National / local fisheries authorities & fisher local organizations	1-5 years
	Regional integration of aFAD fishery-dependent data is improved	Develop data sharing agreements between national fishery authorities and regional fishery bodies	Data sharing agreements are developed	Signed sharing agreements	National / local governments & RFBs (CRFM, OSPESCA and WECAFC)	1-5 years
		To the extent that it is possible, integrate of local/national fishery databases with regional WECSFC DCRF database	Data transfer mechanisms between local and regional databases are operational	Sample data are effectively transferred across databases	National / local governments & RFBs (CRFM, OSPESCA and WECAFC)	1-5 years

Table 3 – Matrix of expected outputs and associated activities, indicators, means of verification, implementing actors, and timelines for execution under each specific objective of the Regional aFAD fishery Management Plan continued

OBJECTIVE / OUTCOME	Outputs	Activities	Indicators	Means of verification	Actors	Time
O4 - To improve the monitoring, control, and surveillance (MCS) of aFAD fisheries across the region to ensure effective	Fishing effort on aFADs and aFAD location are increasingly mapped	Test and gradually implement the use of Vessel Tracking Systems (VTS) for aFAD motorized vessels	VTS are operational	Vessel track map reports	National / local fisheries authorities & fisher local organizations	1-3 years
		Develop VTS data sharing agreements between local/national fishery authorities and fishers	VTS data sharing agreements are in place	Data sharing agreement documents	National / local fisheries authorities & fisher local organizations	1-5 years
		Establish and/or update local/national centralized electronic databases for VTS data storage and processing	VTS electronic database is operational	Vessel track map reports	National / local fisheries authorities	1-5 years

implementation of applicable fishery regulations and help eradicate IUU fishing in the region		Increase use ICT tools to return personalized summaries of VTS data to fishers	The number of personalized electronic vessel track map reports is increased	Fisher surveys; vessel track map reports	National / local fisheries authorities	1-5 years
	aFAD registry, aFAD fisher licensing, and aFAD vessel registry systems are in place	Develop protocols for aFAD registry, aFAD marking, aFAD vessel registry, and aFAD fishery licensing systems	Protocol formally established and disseminated	Protocol documents	National / local fisheries authorities	1-3 years
		Establish and/or update local/national centralized electronic databases for aFAD registry and aFAD licensing data storage and processing	Registry and licensing systems are operational	Registry and licensing records; license cards available	National / local fisheries authorities aFAD	1-5 years
		Test and gradually implement the use of low-cost electronic data collection tools to facilitate time efficient aFAD registry, aFAD vessel registry, and aFAD licensing	Electronic registry and licensing systems are operational	Registry and licensing records; license cards available	National / local fisheries authorities & fisher local organizations aFAD	1-5 years
		Integrate local/national electronic databases for (1) catch and effort data, (2) frame survey data, (3) VTS data, and (4) aFAD unit and aFAD vessel registry data	Summary reporting that integrates data across databases is operational	Report documents; database integration design document	National / local fisheries authorities	1-5 years
	MCS measures increasingly coordinated and enforced across the region	Establish aFAD activity data sharing agreements among neighboring local/national fishery authorities	Data sharing agreements are established	Signed data sharing agreements	National / local governments & RFBs (CRFM, OSPESCA and WECAFC)	1-5 years
		Establish bi-lateral/multi-lateral agreements for coordination and cooperation in monitoring and enforcement of aFAD activity	Coordination and cooperation agreements are established	Signed agreements	National / local governments & RFBs (CRFM, OSPESCA and WECAFC)	1-5 years

Table 3 – Matrix of expected outputs and associated activities, indicators, means of verification, implementing actors, and timelines for execution under each specific objective of the Regional aFAD fishery Management Plan continued

OBJECTIVE / OUTCOME	Outputs	Activities	Indicators	Means of verification	Actors	Time
O5 - To improve the environmental sustainability of aFAD fisheries	Key stakeholders are more informed and aware of the potential negative effects of aFADs	Conduct public awareness campaign on exploitation status of key target species and on links of aFADs to abandoned, lost, and discarded fishing gear	Public awareness and education campaigns are conducted	Meeting minutes; education and media outputs	National / local governments & fisher and other stakeholder local organizations	1-3 years
	Incidental by-catch on aFADs is reduced	Train fishers in improved fishing techniques and strategies, and the biology and behavior of target species	Training sessions are conducted	Training session documents and certificates of participation	National / local fisheries authorities & fisher local organizations	1-3 years
	Animal entanglement on aFADs is reduced	Incentivize use of non-entangling materials for aFAD designs	Number of aFADs incorporating non-entangling materials is increased	Fisher surveys; aFAD registry records; field surveys	National / local fisheries authorities & fisher local organizations	1-3 years
	aFAD marine debris is reduced	Train fishers in improved aFAD designs	Training sessions are conducted	Training session documents and certificates of participation	National / local fisheries authorities & fisher local organizations	1-3 years
		Incentivize use GPS unit locators on aFADs to facilitate tracking and recovery in the case of loss	Number of aFADs with GPS units is increased	Fisher surveys; aFAD registry records; field surveys	National / local fisheries authorities & fisher local organizations	1-3 years
		Facilitate use of locally-available biodegradable materials for aFAD designs	Number of aFADs incorporating bio-degradable materials is increased	Fisher surveys; aFAD registry records; field surveys	National / local fisheries authorities & fisher local organizations	1-3 years
	Catches of juvenile fish on aFADs are reduced	Train fishers in improved fishing techniques and strategies, and the biology and behavior of target species	Training sessions are conducted	Training session documents and certificates of participation	National / local fisheries authorities & fisher local organizations	1-3 years
		To the extent that it is possible, disincentivize sales of juvenile fish	Catches in juvenile fish are reduced	Catch and effort and biological data; market surveys	National / local fisheries authorities & fisher local organizations	1-3 years

Table 3 – Matrix of expected outputs and associated activities, indicators, means of verification, implementing actors, and timelines for execution under each specific objective of the Regional aFAD fishery Management Plan continued

OBJECTIVE / OUTCOME	Outputs	Activities	Indicators	Means of verification	Actors	Time
O6 - To improve the socio-economic performance and sustainability of aFAD fisheries	Local knowledge of the contribution of aFADs to livelihoods and national economies is improved	Increase integration of summaries of aFAD fishing trip economic data (expenses and revenue) into national economic databases	The frequency and quality of reports of contribution of aFADs to national economic activity is increased	Report documents	National / local fisheries authorities	1-5 years
		Conduct household surveys to establish socio-economic baselines for aFAD fishers and assess trends over time	Household surveys are conducted	Sample data; report documents; data collection forms and protocol; operational database	National / local fisheries authorities & fisher local organizations	1-5 years
		Conduct market surveys at appropriate intervals to quantify aFAD-associated economic activity and assess trends over time	Market surveys are conducted	Sample data; report documents; data collection forms and protocol; operational database	National / local fisheries authorities	1-5 years
	Economic returns and working conditions of aFAD fishers are improved	Train aFAD fishers on (1) safety at sea, (2) navigation, (3) large fish handling and conservation, (4) aFAD business management, and (5) use of ICT systems	Training sessions are conducted	Training session documents and certificates of participation	National / local fisheries authorities & fisher local organizations	1-3 years
		Increase use ICT tools to return personalized summaries of fishing trip economic data (expenses and revenue) to fishers in shorter timeframes	Production of personalized summaries of fishing trip economic data for fishers increased	Personalized summary reports print outs; fisher surveys	National / local fisheries authorities & fisher local organizations	1-5 years
		Develop ICT systems with, and for, fishers to increase fishing efficiency and safety at sea	ICT tools are developed and used by fishers	Relevant apps; fisher surveys	National / local fisheries authorities & fisher local organizations	1-5 years
		Set guidelines for aFAD vessel minimum requirements and personal protection equipment	Scope and content of guidelines is available	Guideline documents	National / local fisheries authorities & fisher local organizations	1-3 years
		Improve landing facilities and infrastructure to facilitate handling and post-harvest processing of large fish	Landing facilities and infra-structure are improved	Documentation of the works conducted; user surveys	National / local fisheries authorities	1-5 years
		Incentivize establishment of public-private partnerships along the market value chain involving aFAD fisher groups	Public-private partnerships are established	Relevant documents outlining the structure and functioning of	National / local fisheries authorities & fisher local organizations & Private sector	1-5 years

			existing partnerships; stakeholder surveys		
	If appropriate, explore export markets and value-added processing for pelagic fish to avoid market gluts	Recommendations of market studies are available	Market study reports	National / local fisheries authorities & fisher local organizations & Private sector	1-5 years
	If possible and appropriate, explore feasibility of controls on fish imports to support local fish production	Data on fish imports and their impact on local prices are available	Feasibility study	National / local governments	1-5 years
	Test and implement use of satellite-linked echosounder buoys and other electronic equipment on strategically selected aFADs locally to inform fishers on local abundance of target species	Number and location of echosounder buoys	Fisher surveys; echosounder data	National / local fisheries authorities & fisher local organizations	1-5 years
Where they exist, the long-term financial viability of public aFAD programs is improved	Develop and/or update national public aFAD programs following best practices	A national aFAD program proposal is available	Cost-benefit study	National / local fisheries authorities & fisher and other stakeholder local organizations	1-10 years
	Secure local funding to support public aFAD programs, including license fees, public-private partnerships, support from national budget, donors, tax-free concessions, research programs, and/or stakeholder contributions	Funding and funding scheme are available	aFAD program financial/banking statements; funding plan document;	National / local fisheries authorities & fisher and other stakeholder local organizations	1-10 years
	Include a contingency plan to address aFAD losses due to extreme weather events	Contingency plan is available	Contingency plan document	National / local fisheries authorities & fisher and other stakeholder local organizations	1-10 years
	Integrate local/national public aFAD programs with local aFAD management plan	Document guiding the integration is available	Meetings and workshop minutes; relevant documentation	National / local fisheries authorities & fisher and other stakeholder local organizations	1-10 years
	Implement national aFAD program	Number and lifespan of deployed aFADs	Fisher surveys; program accounting reports ; field surveys	National / local fisheries authorities & fisher and other stakeholder local organizations	1-10 years

Table 3 – Matrix of expected outputs and associated activities, indicators, means of verification, implementing actors, and timelines for execution under each specific objective of the Regional aFAD fishery Management Plan continued

OBJECTIVE / OUTCOME	Outputs	Activities	Indicators	Means of verification	Actors	Time
O7 - To support a science-based approach to aFAD fisheries management	Local and regional technical capacity to participate in research is improved	Increase funding for training of local research staff (undergraduate and graduate tertiary education level)	New funding is available	Calls for scholarships	National / local governments & RFBs (CRFM, OSPESCA and WECAFC) & local and regional research groups	1-5 years
		Increase numbers of dedicated local research staff	New local research posts are filled	Terms of reference and contracts of new posts	National / local governmental and non-governmental organizations	1-5 years
		Increase local and regional funding for multi-disciplinary and multi-institutional research collaborations (universities, local fishery authorities, Working Groups, Fishery bodies, ICCAT, research teams) across the region	New funding is available	Calls for research applications	National / local fishery authorities & RFBs (CRFM, OSPESCA and WECAFC) & local and regional research groups	1-5 years
	Understanding of how aFAD fishing interacts with coastal/demersal fishing is improved	Participate in research programs assessing links between aFAD fishing and demersal/coastal fishing	Research projects are implemented	Project technical reports	National / local fishery authorities & RFBs (CRFM, OSPESCA and WECAFC) & local and regional research groups & fisher local and regional organizations	1-5 years
	Generation of fishery-independent data on the abundance, movement, mortality and growth of target and non-target species on aFADs is improved	Participate in regional research programs and surveys at sea to generate fishery-independent data on abundance, growth, survivorship and/or movement of selected species.	Research projects are implemented	Project technical reports	National / local fishery authorities & RFBs (CRFM, OSPESCA and WECAFC) & local and regional research groups & fisher local and regional organizations	1-5 years
	Understanding of factors that affect catch composition and fishing yields on aFAD is improved	Participate in research to identify fishing techniques and practices that minimize catches of vulnerable fish groups and maximize catches of sustainably exploited fish groups	Research projects are implemented	Project technical reports	National / local fishery authorities & RFBs (CRFM, OSPESCA and WECAFC) & local and regional research groups & fisher local and regional organizations	1-5 years
	Understanding of how local aFAD designs affect aFAD losses and marine litter is improved	Participate in research to identify suitable local biodegradable and non-entangling materials for aFAD construction	Research projects are implemented	Project technical reports	National / local fishery authorities & RFBs (CRFM, OSPESCA and WECAFC) & local and regional research groups & fisher local and regional organizations	1-5 years
		Participate in research to optimize aFAD designs to minimize both aFAD losses and aFAD costs	Research projects are implemented	Project technical reports	National / local fishery authorities & RFBs (CRFM, OSPESCA and WECAFC) & local and regional research groups & fisher local and regional organizations	1-5 years

4. Implementation advice for selected activities promoting a sustainable aFAD fishery across the region

Some of the recommended activities under each specific objective of the Plan are expanded below to illustrate their rationale and facilitate their implementation.

4.1 Improving the national and regional governance frameworks for the aFAD fishery (O1)

4.1.1 Adopt/update legal instruments to support effective (co-)management arrangements and align with best practices

Justification: A recent report of the legal and institutional framework of Caribbean countries, including some with significant aFAD fisheries, highlighted that the objectives and scope of fisheries legislation in these countries were generally consistent with the principles of sustainable management (FAO 2016a). It also highlighted that many laws reflected a multi-stakeholder and participatory vision of fisheries governance, aligning with best practices and that most countries in the region had an adequate legal basis for the elaboration of management plans (FAO 2016a). However, the report also outlined that the legal basis for co-management was generally under-developed across the region and that countries differed considerably in their treatment of rights-based approaches such as Territorial User Rights for Fishing (TURF) as well as in their integration of aFAD use in their legislation (FAO 2016a). The latter highlights that more efforts are needed to create an adequate legal and institutional framework to effectively support aFAD fishery management plans, particularly if co-management is the final goal, although the extent to which such efforts are necessary will depend on the country.

Implementation advice: Use existing legal frameworks to identify areas of weakness and address these areas so that the revised frameworks align with the guiding principles of Ecosystem Approach to Fisheries, the precautionary approach, and good governance (transparency, participation, accountability, and nondiscrimination) (Tietze and Singh-Renton 2012b; FAO 2016a) as well as marine spatial planning. In so doing, create the necessary space to integrate co-management principles and provisions governing aFAD use. In the meantime, countries that already have legal provisions for engagement of fisherfolk organizations in fisheries governance should make use of them. Such mechanisms may include designation of local fisheries management areas and Local Fisheries Management Authorities with capacity to make fishing regulations in the local fishery management areas (e.g. Section 18 and 19 of the 1987 Fisheries Act of Dominica).

4.1.2 Strengthen aFAD fisher participation in the management process.

Justification: It is increasingly recognized that effective management of the aFAD fishery will require active engagement and participation of fishers in the decision-making process and the sharing of responsibility within the management system. This will be particularly so if the ultimate goal is to establish durable co-management arrangements. The collective representation of (commercial, recreational, subsistence) fishers' interests will be best achieved via the voice of legally registered fisherfolk groups such as associations or cooperatives. These formal groups are expected to play a fundamental role in defining stakeholder rights and duties within the aFAD fishery, in developing aFAD programs with government, and in identifying and implementing best management practices, including the collection and/or reporting of fishery catches, the elaboration of code of conducts, and the drafting of national aFAD fishery management plans (CRFM/JICA 2011). Building fisher collective capacity for decision-making might require substantial time, commitment, and continued support from national fisheries authorities and other actors wishing to engage fishers.

Implementation advice: Empowering fisherfolk organizations will require identifying leaders, providing technical assistance, building capacity in governance, administration and leadership skills, and fostering fisher engagement and participation in the organizations by providing tangible benefits (Tamura et al. 2018). This process will require time and resources and is unlikely to be achieved via short-term projects; rather, it should be recognized as an integral part of national/local development and food security policies. Moreover, the extent to which these fisher organizations are asked to assume responsibilities in management should be commensurate with their ability and means to effectively to do so (CRFM 2017), which could gradually increase as the organizations strengthen.

4.1.3 Strengthen Fisher Advisory Committees or similar intersectoral coordinating mechanisms.

Justification: Interactive governance of aFAD fisheries is likely to be best operationalized through National Intersectoral Coordinating Mechanisms such as Fishery Advisory Committees (FAC) (Compton et al. 2017). These Fishery Advisory Committees could help integrate and connect sectors and stakeholders with interest in marine ecosystem-based approaches at the national level, including representatives of civil society, NGOs, and the private sector. They could also serve to link governance processes at national and regional scales. These FAC could operationalize all stages of the policy cycle (i.e. data and information, analysis and advice, decision-making, implementation, review and evaluation) of the aFAD fishery management system and process (Tietze and Singh-Renton 2012b; Compton et al. 2017).

Implementation advice: As stated in CRFM (2015a), the current functioning and structure of national Fisheries Advisory Committees (FAC) needs to be revised to assure participation of all fisheries sub-sectors and of stakeholders beyond fisheries that have interest in the marine ecosystem. This revision should ensure that FACs are formally institutionalized and have a clear structure, functioning and mandate, which might require bringing legislation up to date (FAO 2016a). The selection process for FAC members should be made transparent and carried out in close consultation with the groups which are to be represented, strong leaders should be identified, and resources should be allocated to support the adequate functioning of FACs.

4.1.4 Explore the use of Territorial Use Rights for Fishing (TURFs) arrangements on aFADs.

Justification: In locations where a public aFAD program is unlikely to be financially sustainable and/or yield the desired socio-economic benefits in the long run, countries should explore the use of formalized Territorial Use Rights for Fishing (TURF) as part of the management system. Informal TURF use of private aFADs already exist in the region and are largely recognized within fishing communities (FAO 2016b; Gentner et al. 2018; Guyader et al. 2018). Conflicts do arise when those who are excluded from fishing question the legitimacy of these informal systems (Bugeja Said et al. 2021). There thus seems to be an opportunity to build on these informal governance arrangements so as to formalize them in way that could help improve equity in access to aFAD fishing opportunities while controlling fishing effort on aFADs (Sadusky et al. 2018). This potential remains largely unexplored in the region (FAO 2016b).

Implementation advice: Bugeja Said et al. (2021) outline insightful differences and similarities between the aFAD fishery of Malta and Guadeloupe. Both fisheries are similar in that both are characterized by the existence of spatially explicit territorial course-lines within which individual fishers deployed multiple aFADs. A fundamental difference is that in the Malta fishery, the course-lines are transparently and fairly assigned by government to individual fishers on an annual lottery basis within which fishers have exclusive fishing rights. Fishers can swamp territories, but they cannot transfer them through a market nor divide them into subparts. In contrast, in Guadeloupe, most territories are informally created by individual fishers even though provisions exist to secure temporary use of space for aFAD deployment; these provisions are rarely followed or enforced. These informal territories are created on a first come first serve basis and then subsequently indefinitely maintained by the individual fishers themselves, precluding access to fishing grounds to other fishers, particularly younger ones. These informal territories are sold and transferred among fishers, even though there is no legal basis to do so. Neither fishery seeks to control the number of aFADs deployed within these formal or informal territories and neither have clear spatial planning and management policies, which reduce fishing yields and increase interferences with other users, respectively.

The examples by Bugeja Said et al. (2021) provide valuable lessons, particularly for those locations in the Caribbean where the aFAD fishery is still at a relatively early development stage, where it might still be practical and politically sensible to introduce the necessary regulatory changes. These examples highlight that the use of a system of territorial use rights to individual fishers or, preferably, groups of fishers is likely to provide the necessary incentive structure to help maintain the system in the long run with minimum financial investment from government. However, and importantly, such system should be based on assigning access rights for territories in a way that is equitable, inclusive, transparent, and temporary. It should also be carefully informed by spatial planning and set

clear limits to aFAD numbers within each territory. Moreover, eligibility to enter the system should be conditioned to the use of aFADs that follow minimum quality standards. The monitoring, control, and surveillance component of these TURF systems, which is always the weakest link, could be facilitated by the integration of low-cost ICT systems into the monitoring system from early on (see Measure 4.4.2).

4.2 Supporting the development and adoption of robust and effective aFADs management measures across the region (O2)

4.2.1 Develop, implement, and harmonize local/national adaptive aFAD fishery management plans

Justification: The management of aFADs in accordance with the principles and best practices identified in this document can be achieved in a number of different ways, including through national or local management plans that address relevant fish stocks and ecosystems. However, very few countries and overseas territories currently have management plans in place for the aFAD fishery. This makes it difficult to rigorously assess whether the policy objectives that aFADs were supposed to facilitate have been objectively achieved and can be supported with data. It also precludes addressing legitimate concerns about the impacts that aFADs can have on shared regional stocks in the current context of open access, undermining the long-term sustainability of the fishery and threatening the livelihoods of fishers, particularly in light of the evidence that some of these stocks are already under heavy regional pressure and some are overexploited (Bealey et al. 2019). Finally, it creates an environment conducive to conflicts among stakeholders. As indicated in CRFM (2015a), it is thus critical and urgent that countries initiate as soon as possible the process of aFAD fishery management plan development and implementation .

Implementation advice: Countries should, as far as practically possible, use existing current legislation to the fullest extent towards implementation of adaptive management plans while in the process of amending current legislation. The plans should be grounded on the principles of EAF and so integrate all fishery stakeholders from the onset. In some locations, national consultations and public awareness campaigns are likely to be needed to increase the engagement and participation of stakeholders. The strengthening fisherfolk organizations and Fisheries Advisory Committees might have to be integrated within the plan development and implementation process itself. In accordance to EAF principles, these plans should be comprehensive and adaptive and go well beyond the establishment codes of conduct aimed at minimizing user conflicts to also help generate local knowledge on the exploitation status of the fish stocks and use current regional knowledge to guide the establishment of local management measures (Box 1). These plans should thus, to the extent that is practically possible, and being mindful of context, align with current recommendations of ICCAT for tuna (See Annexe 1 of ICCAT 2020a) and billfishes (ICCAT 2019; ICCAT 2020b) and of other relevant regional (WECAFC) and sub-regional (CRFM, OSPESCA) fishery bodies and relevant instruments such as The Caribbean Billfish Management and Conservation Plan (Bealey et al. 2019), the draft Subregional Fisheries Management Plan for Blackfin Tuna Fisheries in the Eastern Caribbean (Tietze and Singh-Renton 2012a) and FAO’s Voluntary Guidelines on the Marking of Fishing Gear (FAO 2019). Such alignment with best practices and sub-regional and regional recommendations - even though some do not directly apply to the small (<9m long) vessels that characterize the aFAD fishery (e.g. ICCAT 2020a) - will contribute to ensure some degree of harmonization across the region, which will be necessary for any management measure to be effective in the long-term. In that regard, WECAFC, in collaboration with CRFM and OSPESCA, through the Interim Coordination Arrangement, could play an important role in reviewing and evaluating local/national management plans across the region and make recommendations towards their gradual harmonization, as appropriate. Ultimately, this iterative process could encourage more countries within the region to join ICCAT as members or cooperating parties.

Box 1. Aspects of aFAD use to consider when developing provisions for legal frameworks and/or management plans for the aFAD fishery. Taken and adapted from CRFM (2015a). See also Annex 1 of ICCAT (2020a) and the Voluntary Guidelines on the Marking of Fishing Gear (FAO 2019).

- aFAD design, including:
 - Minimum standards ensuring a sufficient mooring weight and an adapted buoy volume to resist currents;
 - Minimum standards for identification and marking of aFADs (e.g. lighting requirements; radar reflectors; visible distance during the night and day) so as to prevent navigational hazards;
 - Prohibition of use of certain materials in aFAD construction, including entangling materials (e.g. old nets).
- Authorization for deployment of aFADs;
- Registration of aFADs;

- aFAD fisher license and license fees;
- Required provision of catch and effort data by aFAD fishers;
- Fishing techniques allowed and/or prohibited on aFADs;
- Rules governing fishing operations near aFADs, including distance from aFAD to which rules apply;
- Responsibilities of (national and community level) organizations in the aFAD fishery, including:
 - Constructing, deploying, maintaining, monitoring and replacing aFADs.
- In addition to the above, additional provisions could be considered in relation to the following:
 - Reporting and disposal of unauthorized aFADs;
 - Reporting of aFAD losses and replacement;
 - Designating areas closed to aFADs (e.g. shipping lanes) and/or where only aFAD fishing is allowed;
 - Designating the maximum total number of aFADs within the authorized areas;
 - Establishing arbitration mechanisms to address cases of conflict;
 - Designating the minimum distance separating aFADs;
 - Establishing rules governing commercial versus recreational fishing on aFADs;
 - Specifying the vessel characteristics for aFAD transport and deployment;
 - Prohibiting the transshipment at sea of fish caught on aFADs;
 - Regulating the composition of the catch on aFADs, including minimizing the capture of juveniles and endangered and threatened species including sea turtles;
 - Controlling fishing pressure on nearshore/reef resources by aFAD fishers;
 - Establishing spatiotemporal closures as relevant to avoid by-catch;
 - If applicable, establishing rules governing user access to private and public aFADs;
 - If applicable, designating the maximum number of private aFADs per fisher.

4.3 Improving local and regional systems for the collection, integration, sharing, and restitution of fishery-dependent data (O3)

4.3.1 Harmonize minimum catch and effort and biological data requirements across the region and integrate national data sets into a regional database

Justification: The fish stocks exploited on aFADs are shared regionally (in some cases, the stocks are shared oceanwide) and thus any effective attempt to assess the impact of the aFAD fishery will require the integration of catch and effort and biological data at the regional scale. The latter would be greatly facilitated by standardizing minimum data requirements across countries; failing to do so will add another potentially large source of uncertainty to the assessments or might simply preclude an assessment at the right spatial scale. Data standardization would also allow integration of national/local datasets into a regional shared WECAFC-OSPESCA-CRFM database, which should be used to inform ICCAT.

Implementation advice: Countries and overseas territories that have not yet implemented fishery-dependent data collection systems for aFAD fisheries, or who are in the process of revising data requirements for such systems, are encouraged to align, to the extent that it is possible, minimum fishery data requirements with those of the CRFM FAD fishery logbook (CRFM 2015b), which was originally developed in consultation with several Fisheries Departments across the region. The logbook was designed to allow for the collection of refined catch and effort data, cost-benefit data, crude environmental data, and by-catch information, and to align as much as possible with ICCAT requirements. It also considered the level of fish processing onboard, further facilitating harmonization and integration of data across the region. Alternatively, the data requirements of the WECAFC modular logbook could also be used as reference (WECAFC 2018). Finally, to the extent that it is possible, national, sub-regional, and regional databases should align with the WECAFC Data Collection Reference Framework (WECAFC 2022).

4.3.2 Use low-cost Information and Communication Technology (ICT) tools to improve collection and processing of catch and effort data

Justification: The cost of ICT systems is rapidly going down and will likely continue to do so over the next decade. Among these, the use of electronic survey forms on fixed and mobile devices (computers, tablets, smartphones) connected to cellular and/or satellite networks that automatically store the data in electronic databases can dramatically speed up the fishery data collection, data handling, data quality assessment and data analysis, with near-real time capabilities in some contexts. This means that the time gap between the provision of raw data by fishers and the return of processed activity summary outputs (e.g. catch and effort data, cost-revenue data) to them could be minimized to the point where such summaries could become operationally useful to them. This also raises

the potential for such summary outputs to be personalized and confidential for each individual fisher, which should increase the incentive to collaborate with data provision.

Implementation advice: There are countries within the region such as Dominica that are already effectively using ICT systems for fishery monitoring with little external support – Their experience should be shared across the region. It will also be critical to establish monitoring systems where the data generated by fishers are co-owned by them to foster transparency and accountability and to empower fishers in the decision-making process. This implies that the implementation of ICT systems should integrate from the beginning mechanisms and data sharing agreements that allow fishers to co-own and access their data and protect them against data misuse or manipulation. This might imply in some cases establishing confidentiality agreements that protect the identity of individual fishers.

4.4 Improving the monitoring, control, and surveillance (MCS) of aFAD fisheries across the region to ensure effective implementation of applicable fishery regulations and help eradicate IUU fishing in the region (O4)

4.4.1 Implement aFAD fisher licensing, vessel registry, and aFAD registry systems

Justification: The aFAD fishery is in practice an open access fishery across most locations. It is widely recognized that the fishery should transition to a restricted-access system in due time to ensure the sustainable exploitation of stocks, to optimize fishing yields, to reduce potential for aFAD overcapacity, and to minimize user conflicts. This will require controlling the number of fishers, vessels and aFADs operating at any given time. As stated in CRFM (2015a), the national authorities should implement a licensing system for aFAD fisheries. Moreover, all vessels exploiting aFADs should be registered and have a registration number. This vessel registration system is needed to identify vessels fishing for large oceanic and coastal pelagics species, track change of ownership, base of operation and use of vessels, and provide information to sub-regional and regional databases. National authorities should also implement a registry and aFAD marking system for deployed aFADs that records data on aFAD location, design, marking, and other characteristics as well as reports of aFAD losses.

Implementation advice: Legislation on aFAD use will likely need to be revised and adopted to support compliance with these systems, as adequate legislation is still lacking in many locations (FAO 2016a). The marking and registration systems for aFADs should closely align with the directives of the Voluntary Guidelines on the Marking of Fishing Gear (FAO 2019) and be harmonized across the region. To minimize administration and bureaucratic delays and so increase likelihood of fisher participation and compliance, Information and Communication Technology (ICT) systems such as apps linked to electronic databases should be explored to facilitate and considerably reduce time frames associated with the granting of licenses and the registration process.

4.4.2 Use low-cost Information and Communication Technology (ICT) tools to map aFAD boat activity

Justification: The use of Vessel Tracking Systems for small boats (e.g. < 9 m length) can provide high-resolution tracking of effort and landings and increase safety at sea (if connected in real-time with satellite networks). This vessel tracking technology can also help reveal the location of individual aFADs used (e.g. Widyatmoko et al. 2021) and thus dramatically improve the monitoring, control, and surveillance (MCS) system of the aFAD network. Coupling VTS with electronic catch and effort data collection systems has been shown to be a powerful way of obtaining high-resolution catch documentation in a traditionally data-poor context (e.g. Tilley et al. 2020).

Implementation advice: There are countries and overseas territories within the region such as Barbados and Montserrat, respectively, that are already effectively using VTS for fishery monitoring with good buy-in from fishers and with minimum external support. Again, their experience and lessons learned should be widely shared across the region. These types of data should also be co-owned by fishers through data sharing agreements. Existing data on aFAD numbers and location could also be cross validated via aerial surveys of aFADs (Guyader et al. 2017).

4.5 Improving the environmental sustainability of aFAD fisheries (O5)

4.5.1 Increase stakeholder awareness of environmental challenges associated with the aFAD fishery

Justification: In a context of shared responsibility in the management of the aFAD fishery, adopting effective measures to minimize the impacts of aFADs on exploited species and on the wider marine ecosystem will require the buy-in of the key stakeholders (fishers; fishery authorities; vendors; consumers). This in turn will require greater awareness across the different stakeholder groups of the challenges associated with the aFAD fishery

Implementation advice: Develop and disseminate educational material (posters; booklets; brochures; manuals; TV and radio broadcasts) specifically designed to target fishers and other key stakeholders, including the general public, informing on key exploited species, with emphasis on their identification features, their biology, their stock exploitation status, and their vulnerability to aFAD fishing. If possible, condition granting of aFAD licenses and other formal government support for aFAD fishers to obtention of training certificates including modules on environmental challenges associated with aFAD fisheries, including species biology and best practices in aFAD designs. All educational and sensitization material should be regularly updated and based on the best available science.

4.6 Measures to improve the socio-economic performance and sustainability of aFAD fisheries (O6)

4.6.1 Increase aFAD fisher training

Justification: The data presented in the review of the state and challenges of the aFAD fishery (Appendix I) strongly support the need for more fisher training in all areas surrounding the use of aFADs, including safety at sea, navigation, aFAD use and fishing techniques, large fish handling and conservation (Eugène et al. 2015), business management, and use of ICT systems. In relation the latter, fisher-oriented mobile phone applications, WhatsApp messaging groups, and/or VHF handsets could tangibly enhance fisher safety at sea, enhance communications at sea and onshore, and improve cost and time efficiency as well as fishing efficiency for fishers (Babu 2020). Overall, fisher training should lead to greater working conditions, a higher quality of fish landings, and a better financial performance of aFAD fishers. It could also facilitate diversification of resource use on aFADs by introducing fishing techniques and practices that allow targeting species that are currently underexploited around aFADs.

Implementation advice: Develop a multi-lingual professional training course with modular packages addressing all key areas of aFAD fishing, supported with video footage (e.g. Youtube videos) to enhance the learning experience. It will also be important to promote fisher exchanges among locations within the region, but also between regions with a longer tradition of aFAD fishing such as the Pacific to share experiences, knowledge, and best practices in aFAD use and governance. Finally, to build ICT capacity in fishers in a way that can effectively improve their livelihoods and reduce their vulnerabilities, they need to be integrated from early in the development of the context-appropriate ICT solutions that are meant to help them to ensure that their needs are adequately satisfied (Mallalieu 2020).

4.6.2 Improve post-harvest and infrastructure support

Justification: Raising Sanitary and Phytosanitary (SPS) standards of fish caught on aFADs will be particularly important to overcome market gluts during periods of high fish abundance (Diaz et al. 2002) and/or the competition with fish imports (Mathieu et al. 2014) by opening opportunities to engage new markets, either as added-valued processed products, eco-labeled products, and/or as exports. In this case, improved fisher training in fish handling and conservation should be accompanied with the improvement of post-harvest infrastructure and facilities to adequately accommodate large fish, which remain deficient across many locations in the region.

Implementation advice: Conduct marketing studies and engage relevant actors within the private sector to assess potential to develop Public-Private Partnerships supporting post-harvest infrastructure improvements and added-value processing and product differentiation.

4.6.3 Incentivize establishment of public-private partnerships (PPP) along the market value chain involving aFAD fisher groups

Justification: As stated in CRFM (2015a), an aFAD fishery characterized by open access using very high densities of short-lived, non-biodegradable, and privately and individually funded aFADs threatens the long-term socio-ecological sustainability of the aFAD fishery and should be discouraged across the region. On the other hand, it has been challenging to maintain publicly funded aFAD programs in the region, although the implementation of comprehensive aFAD management plans might help alleviate this problem. In this context, establishing formal Public-Private Partnerships (PPP) in the aFAD fishery could help achieve the sought socio-economic objectives in the long run while promoting best practices in aFAD use, but these joint ventures remain largely unexplored in the region. Here, PPP are defined as “*a cooperative venture between the public and private sectors, built on the expertise of each partner that best meets clearly defined public needs for services or infrastructure through the transfer between partners of resources, risks and rewards*” (Weirowski and Hall 2008). PPPs can provide a range of opportunities that include improving access to national and international markets, improving food safety and quality, developing niche markets, improving infrastructure, improving financial services, facilitating technology development and research, and improving information and communication (Weirowski and Hall 2008). All these areas are highly relevant to the aFAD fishery.

Implementation advice: The exact nature and objective of any PPP will obviously depend on the socio-economic, political, and organizational context and specific partners involved from both the public sector (government, development banks, NGOs, research institutions) and the private sector (fisher associations or cooperatives, fish processors, microcredit institutions, traders, consultants), which will vary across locations. In the Caribbean, the financing of small-scale ventures in local processing and marketing is a big challenge in most fisheries (Khan et al. 2019). This is also the case in the aFAD fishery, which would benefit from added-value processing (e.g. filleting, smoking) and product differentiation (e.g. eco labeling) and marketing in those locations where the fishery is managed sustainably. This might require initial investment in infrastructure (e.g. expansion of cold facilities), financial support (e.g. micro-credits) and technical support (e.g. training; marketing studies) that could be facilitated by government or/and its associate donors. The aFAD fishery would also benefit from long-lived aFAD designs, which could be supported by government via the provision of technical support and tax-free concessions on high-quality materials and/or equipment (e.g. GPS buoys) for aFADs to fisher groups acting as partners. In any case, it is highly desirable that PPPs are designed so as to favor self-organization of stakeholder groups (e.g. fisher cooperatives or associations) and that their implementation is contingent on the use of best practices through the entire value chain of the aFAD fishery, including the pre-harvest (sustainably exploited species), harvest (fishing and aFAD designs), and post-harvest (processing and marketing) stages.

4.7 Supporting a science-based approach to aFAD fisheries management (O7)

4.7.1 Increase local technical capacity in fisheries research

Justification: Actively participating in both the development and implementation of local and regional research programs aimed at addressing key management concerns in the aFAD fishery will be more effectively conducted if the scientific capacity to fully partake in such research already exists within the region. Yet, such local capacity is currently very limited and patchily distributed within the insular Caribbean. Importantly, building such local research capacity will help ensure that research also seeks to address local and sub-regional priorities and interests, while aligning with regional ones.

Implementation advice: Engage tertiary institutions within and outside the region to develop post-graduate (MSc, PhD) programs in fisheries research tailored to the Caribbean region and support the establishment of post-graduate scholarships. Secure funding to support research positions in fisheries within tertiary institutions, research institutes, fishery authority departments, consultancy firms, and environmental NGOs within the region.

4.7.2 Participate in regional research programs and surveys at sea to generate fishery-independent data on abundance, growth, survivorship, and/or movement of selected species

Justification: Biological research is required on multiple topics to help assess and mitigate the impacts of aFADs on target and non-target species and ecosystems, such as the characterization of size and species composition of

aggregations and catches on aFADs, movements between aFADs and other habitats and areas, growth, and changes in abundance over time. Moreover, it is well known that Catch per Unit Effort (CPUE) on FADs is not a reliable measure of relative abundance of exploited fish stocks because fish can continue to aggregate on aFADs, and so result in stable CPUE on aFADs, even though their total population abundance might be rapidly declining (Ehrhardt et al. 2017). Detailed fishery-dependent data (catch and effort; biological) from aFADs are still needed to help assess how much biomass is removed by aFAD fishing and to better understand the range of spatiotemporal environmental factors that influence catch composition (species and fish sizes) on aFADs. However, these fishery-dependent data will need to be complemented with fishery-independent data from aFADs to provide a reliable picture of the impact of aFADs on fish stocks (Moreno et al. 2016a). Moreover, there are non-target species caught on aFADs that also need to be considered when assessing aFAD impacts, but for which there are little fishery-dependent data available (Moreno et al. 2016a).

Implementation advice: aFADs can be equipped with satellited-linked buoys integrating ICT systems such as echosounders, hydrophones, underwater and surface cameras, and acoustic receivers, which jointly provide an multisensory observatory of target and non-target animal communities associated with aFADs (Moreno et al. 2016a; Merten et al. 2018). By equipping strategically located aFADs with these ICT systems, the spatiotemporal coverage of fishery-independent data collection could be greatly expanded in the region. Importantly, coupled with tagging studies, these electronically equipped aFAD networks can be used to derive fishery-independent indices of population abundance of key target species, at least over some larger scales (Capello et al. 2016), and also improve knowledge about aFADs interactions at the local level. They could also facilitate research on mortality rates of selected species (e.g. juvenile tuna). Moreover, they could provide valuable data to assess the expected effects of climate change on the abundance and distribution of large pelagic fish stocks and associated fisheries in the region (Monnereau and Oxenford 2017; Oxenford and Monnereau 2017; Cheung et al. 2019a; Cheung et al. 2019b). With current estimates of 3,500+ aFADs in the WECAFC region there is great potential to expand the spatial coverage of electronic monitoring of target and non-target species using aFADs as observatories. This would dramatically improve our capacity to monitor the abundance of these species over a range of relevant spatiotemporal scales to supplement fishery-dependent data (e.g. Orúe et al. 2020) and help assess the impacts of aFADs on stocks and other components of the ecosystem. This type of research is already very active in the purse-seine tuna fishery of the Indo-Pacific making use of drifting FADs (Forget et al. 2015; Capello et al. 2016; Lopez et al. 2016; Moreno et al. 2016a; Lopez et al. 2017a; Lopez et al. 2017b; Boyra et al. 2019; Orúe et al. 2019; Orue et al. 2019; Baidai et al. 2020; Orúe et al. 2020; Santiago et al. 2020). Much of that technical experience, knowledge, and recent technology existing in the Indo-Pacific is likely to be directly transferable to aFADs in the Wider Caribbean region. It would thus be important to develop a long-term regional research program supported by a network of strategically located aFADs acting as observatories across the region in collaboration with relevant research groups (from within and outside the region) and WECAFC/CRFM/OSPESCA and ICCAT scientific divisions. Finally, these aFAD observatories could also be used to inform fishers about the local abundance of those target species that are being sustainably exploited so to increase fishing efficiency (Bell et al. 2018), which could foster strengthened partnerships between fishers and research programs.

4.7.3 Participate in research to develop cost-effective aFAD designs that minimize marine litter

Justification: Public aFADs are generally designed to minimize aFAD loss rates, which entails a relatively high cost per unit, whereas individual private aFADs are generally designed to minimize costs, which tends to lead to high aFAD losses. From the perspective of minimizing marine littering, it is highly desirable that when aFAD units are lost they are recovered quickly. Alternatively, if recovery is not possible or practical, then it is highly desirable that the units are made of biodegradable materials. The use of biodegradable materials is receiving increased research attention in the purse seine tuna fishery making use of drifting FADs (Moreno et al. 2016b; Lopez et al. 2019), where it has been integrated into policy recommendations (ICCAT 2020a). In the Caribbean, the use of light aFADs entirely made of biodegradable materials can be justified if aFAD fishing were to be highly seasonal, as in the Mediterranean dolphinfish fishery (Morales-Nin et al. 2000) and this appeared to be the case in some locations in the region (Appendix I). However, if aFADs are to be used all year long, as it is the case in many locations, then the emphasis might be on maximizing aFAD lifespan and on recovering the units when these get lost, which should position aFAD design towards the heavy and semi-heavy end of the range and involve the use of highly durable

synthetic materials. Best practices in aFAD construction and materials aimed at maximizing lifespan now exist for the region (Gervain et al. 2015) and descriptions of aFAD designs currently used in other regions are also publicly available (Sokimi et al. 2020 and references therein). The challenge remains to integrate such existing knowledge into designs that offer the longest lifespan (and chances of recovery when lost) at a cost that can be sustainably absorbed by aFAD programs, which often rely in short-term projects for funding to support the relatively high cost of public aFADs. The latter also needs to recognize that the physical environment in which aFADs are deployed (depth, currents, wave exposure, storm frequency, shipping traffic) will differ among locations so that the optimal design will depend on location. For example, due to high shipping traffic around Puerto Rico, subsurface aFADs are currently being deployed in greater frequency than surface aFADs due to past issues with surface aFAD shipstrikes. Finally, it is important to highlight that accurate data on aFAD lifespan are scarce because of the widespread lack of regular monitoring and/or loss reporting so that much more is known about the few aFADs that remain than about the many that were lost. The latter makes it very difficult to link aFAD design to prevailing (and extreme) local environmental conditions to inform aFAD design process.

Implementation advice: Countries/locations that experience similar prevailing physical conditions should consider joining efforts to support research collaborations into improving the cost-effectiveness of local aFAD designs and exploring that of new ones (e.g. subsurface aFADs: Schneider et al. 2021) in a carefully controlled monitoring setting so that drivers of aFAD losses are adequately identified. Moreover, establishing a regional database of deployed and lost aFADs that includes detailed info on aFAD design and prevailing physical conditions would provide important insights into what is a durable aFAD design. In addition to that, the use of satellite-linked GPS units is becoming increasingly affordable and might now represent only a small fraction of the aFAD total cost. Thus, systematically integrating solar-powered GPS buoys into the surface component of aFADs, as it is typically done for drifting FADs in the purse-seine tuna fishery, will help maximize recovery when they get lost, potentially also allowing the re-use of aFAD materials (Sinopoli et al. 2020). Furthermore, research should also take place on those locations where shorter lived light aFADs made of biodegradable materials might be preferred; such research should draw from the traditional knowledge in aFAD materials (Morales-Nin et al. 2000) and those currently being explored for drifting FADs (Moreno et al. 2018a; Moreno et al. 2018b; Lopez et al. 2019; Wang et al. 2021), while also being mindful that such materials need to be locally available and affordable. These alternative biodegradable materials should be actively promoted over non-biodegradable ones. For any of these efforts to be successful in the long run, it will be critical to involve fishers into aFAD design development from early on. Finally, irrespective of aFAD type, the use of animal entangling materials such as old nets in any part of the aFAD design should be explicitly prohibited across the region.

5. Adaptative management mechanisms for implementing and reviewing the Plan

National governments are responsible for implementing the Plan at the national level. Members will report yearly on the implementation progress of the different activities to WECAFC and their relevant sub-regional organizations (i.e. CRFM and OSPESCA). The latter can be done using a template to assign scores to their degree of implementation of each activity, as it is currently being done for the Regional Queen Conch Fisheries Management and Conservation Plan (Yvette Diei Ouadi, pers comm).

Amendments to the Plan are to be made at the level of WECAFC and then passed on to its Members, CRFM and OSPESCA for their implementation, as appropriate. WECAFC will also liaise with ICCAT under any relevant bilateral cooperation arrangement.

Moreover, development agencies, financial institutions, and government and non-governmental agencies investing in the implementation of activities under the Plan should also independently monitor and evaluate the impact of their financial contributions on the expected outcomes.

A review of progress should be conducted regularly by the WECAFC in conjunction with the Joint aFAD Working group. A first evaluation of activities and outcomes under each specific objective should be conducted after five years of the Plan being adopted before a major amendment to the Plan is to be conducted.

The financial resources to implement the Plan will be obtained mainly at the national level, with support from bilateral and multilateral donors and collaborators.

6. References

- Babu S (2020) Building technology enabled capacity for small-scale fishers in South India Information and communication technologies for small-scale fisheries (ICT4SSF). FAO/Worldfish, Bangkok, pp 24-31
- Baidai Y, Dagorn L, Amande MJ, Gaertner D, Capello M (2020) Machine learning for characterizing tropical tuna aggregations under Drifting Fish Aggregating Devices (DFADs) from commercial echosounder buoys data. *Fisheries Research* 229 doi 10.1016/j.fishres.2020.105613
- Bealey R, Pérez Moreno M, Van Anrooy R (2019) The Caribbean Billfish Management and Conservation Plan. FAO Fisheries and Aquaculture Technical Paper. No. 643. Rome, FAO. 106 pp. Licence: CC BY-NC-SA 3.0 IGO
- Bell JD, Albert J, Amos G, Arthur C, Blanc M, Bromhead D, Heron SF, Hobday AJ, Hunt A, Itano D, James PAS, Lehodey P, Liu G, Nicol S, Potemra J, Reygondeau G, Rubani J, Phillips JS, Senina I, Sokimi W (2018) Operationalising access to oceanic fisheries resources by small-scale fishers to improve food security in the Pacific Islands. *Mar Policy* 88: 315-322 doi 10.1016/j.marpol.2017.11.008
- Boyra G, Moreno G, Orue B, Sobradillo B, Sancristobal I, O'Driscoll R (2019) In situ target strength of bigeye tuna (*Thunnus obesus*) associated with fish aggregating devices. *ICES J Mar Sci* doi 10.1093/icesjms/fsz131
- Bugeja Said A, Guyader O, Frangoudes K (2021) Diagnosing 'access' matters in the governance of moored fishing aggregate devices (MFADs): A perspective for SDG14b from Malta and Guadeloupe. *Ocean Coast Manage* 214 doi 10.1016/j.ocecoaman.2021.105890
- Capello M, Deneubourg JL, Robert M, Holland KN, Schaefer KM, Dagorn L (2016) Population assessment of tropical tuna based on their associative behavior around floating objects. *Sci Rep* 6: 36415 doi 10.1038/srep36415
- Cheung WW, Reygondeau G, Wabnitz CCC, Tamburello N, Singh-Renton S (2019a) Climate change effects on Caribbean marine ecosystems and fisheries. Regional projections. In: CRFM (ed) CRFM Research paper Collection CRFM Secretariat, Belize and St Vincent and the Grenadines, pp 10-97
- Cheung WW, Reygondeau G, Wabnitz CCC, Tamburello N, Singh-Renton S, Joseph A (2019b) Climate change effects on Caribbean marine ecosystems and fisheries. National projections for six case study countries: Jamaica, Haiti, Dominica, St Lucia, St Vincent and the Grenadines, and Grenada. In: CRFM (ed) CRFM Research paper Collection CRFM Secretariat, Belize and St Vincent and the Grenadines, pp 98-172
- Compton S, McConney P, Monnereau I, Simmons B, Mahon R (2017) Good Practice Guidelines for Successful National Intersectoral Coordination Mechanisms (NICs). Report for the UNDP/GEF CLME+ Project (2015-2020). CERMES Technical Report No. 88. Centre for Resource Management and Environmental Studies, The University of the West Indies, Cave Hill Campus, Barbados.
- CRFM (2013a) Report of the CRFM - JICA CARIFICO / WECAFC - IFREMER MAGDELESA Workshop on FAD Fishery Management. CRFM Technical & Advisory Document Number 2013 / 9. CRFM Secretariat, Belize
- CRFM (2013b) Report of the CRFM / JICA Fish Aggregating Devices (FAD) Fishery Management Workshop for OECS Countries, 13 March 2013, Roseau, Dominica. CRFM Technical & Advisory Document Number 2013 / 5. CRFM Secretariat, Belize
- CRFM (2014a) Report of Tenth Annual CRFM Scientific Meeting – Kingstown, St. Vincent & the Grenadines, 10-17 June 2014 - National Reports. CRFM Fishery Report – 2014. Volume 1, Suppl. 1. 48p.
- CRFM (2014b) Report of the CRFM / CARIFICO Regional Workshop on FAD Management, 05 December 2014, Trinidad and Tobago. CRFM Technical & Advisory Document, No. 2014/ 7. CRFM Secretariat, Belize
- CRFM (2015a) 2015 Draft Sub-Regional Management Plan for FAD Fisheries in the Eastern Caribbean (Stakeholder Working Document). CRFM Technical & Advisory Document 2015/ 05
- CRFM (2015b) FAD Fishery Model Logbook. CRFM Special Publication No. 4. . CRFM Secretariat, Belize
- CRFM (2017) Report of CRFM / CARIFICO Seminar: Strengthening Fisheries Co-management in the Region. CRFM Technical & Advisory Document Number 2017 / 4. CRFM Secretariat, Belize
- CRFM/JICA (2012) Study on the formulation of a master plan on the sustainable use of fisheries resource for coastal community development in the Caribbean. Final report. Japan International Cooperation Agency & IC Net Limited

- Diaz N, Doray M, Gervain P, Reynal L, Carpentier A, Lagin A (2002) Pêche des poissons pélagiques hauturiers et développement des DCP ancrés en Guadeloupe National reports and technical papers presented at the First meeting of the WECAFC ad hoc Working Group on the development of sustainable moored fish aggregating device fishing in the Lesser Antilles, Le Robert, Martinique, 8-11 October 2001 FAO, Rome, pp 39-55
- Doray M, Reynal L, Carpentier A, Lagin A (2002) Le développement de la pêche associée au DCP ancrés en Martinique National reports and technical papers presented at the First meeting of the WECAFC ad hoc Working Group on the development of sustainable moored fish aggregating device fishing in the Lesser Antilles, Le Robert, Martinique, 8-11 October 2001 FAO, Rome, pp 69-88
- Ehrhardt N, Brown JE, Pohlot BG (2017) Desk Review of FADs fisheries development in the WECAFC region and the impact on stock assessments. Western Central Atlantic Fishery Commission (WECAF). Eight Session of the Scientific Advisory Group (SAG). Merida, Mexico, 3-4 November 2017. WECAF, Merida, Mexico
- Eugène S, Andrews C, Dromer C, Ishida M, Mohammed E (2015) Manual of Best Practices in Fisheries that use Moored Fish Aggregating Devices: Maintaining Good Quality of FAD-Caught Fish: From the point of capture to the point of sale. CRFM Special Publication No. 6, Vol. II. . CRFM Secretariat, Belize
- FAO (2002) Report of the first meeting of the WECAFC ad hoc Working Group on the development of sustainable moored fish aggregating device fishing in the Lesser Antilles. Le Robert, Martinique, 8-11 October 2001
- FAO (2007) Report of and papers presented at the Second meeting of the WECAFC ad hoc Working Group on the development of sustainable moored fish aggregating device fishing in the Lesser Antilles. Bouillante, Guadeloupe, 5-10 July 2004
- FAO (2016a) Caribbean Fisheries Legal and Institutional Study: Findings of the comparative assessment and country reports, by Cristina Leria. FAO Fisheries and Aquaculture Circular No. 1124. Bridgetown, Barbados .
- FAO (2016b) The Use and Design of Rights and Tenure Based Management Systems for Transboundary Stocks in the Caribbean, by Brad Gentner. FAO Fisheries and Aquaculture Circular No. 1126. Barbados, Bridgetown.
- FAO (2019) Voluntary Guidelines on the Marking of Fishing Gear FAO, Rome
- Forget FG, Capello M, Filmlalter JD, Govinden R, Soria M, Cowley PD, Dagorn L (2015) Behaviour and vulnerability of target and non-target species at drifting fish aggregating devices (FADs) in the tropical tuna purse seine fishery determined by acoustic telemetry. *Can J Fish Aquat Sci* 72: 1398-1405 doi 10.1139/cjfas-2014-0458
- Gentner B, Arocha F, Anderson C, Flett K, Obregon P, van Anrooy R (2018) Fishery performance indicator studies for the commercial and recreational pelagic fleets of the Dominican Republic and Grenada. FAO Fisheries and Aquaculture Circular No. 1162. . FAO, Rome, Italy
- Gervain P, Reynal L, Defoe J, Ishida M, Mohammed E (2015) Manual of Best Practices in Fisheries that use Moored Fish Aggregating Devices: FAD Design, Construction and Deployment. CRFM Special Publication No. 6. Vol. I. CRFM Secretariat, Belize
- Guyader O, Frangoudes K, Kleiber D (2018) Existing Territories and Formalization of Territorial Use Rights for Moored Fish Aggregating Devices: The Case of Small-Scale Fisheries in the La Desirade Island (France). *Soc Nat Resour* 31: 822-836 doi 10.1080/08941920.2018.1443235
- Guyader O, Robert B, Lionel R (2107) Assessing the number of moored fishing aggregating devices through aerial surveys: A case study from Guadeloupe. *Fish Res* 185:73-82.
- ICCAT (2019) 18-05 Recommendation by ICCAT on improvement of compliance review of conservation and management measures regarding billfish caught in the ICCAT convention area
- ICCAT (2020a) 19-02 Recommendation by ICCAT to replace recommendation 16-01 by ICCAT on a multi-annual conservation and management programme for tropical tunas
- ICCAT (2020b) 19-05 Recommendation by ICCAT to establish rebuilding programs for blue marlin and white marlin/roundscale spearfish
- Khan AS, Campbell D, Sing-Renton S, Murray A, Eyzaguirre J (2019) Toward climate-smart value chains in Caribbean fisheries CRFM Research Paper Collection. CRFM, Belize and St Vincent and the Grenadines, pp 252-272

- Lopez J, Ferarios JM, Santiago J, Ubis M, Moreno G, Murua H (2019) Evaluating potential biodegradable twines for use in the tropical tuna FAD fishery. *Fisheries Research* 219 doi 10.1016/j.fishres.2019.105321
- Lopez J, Moreno G, Boyra G, Dagorn L (2016) A model based on data from echosounder buoys to estimate biomass of fish species associated with fish aggregating devices. *Fish Bull* 114: 166-178 doi 10.7755/fb.114.2.4
- Lopez J, Moreno G, Ibaibarriaga L, Dagorn L (2017a) Diel behaviour of tuna and non-tuna species at drifting fish aggregating devices (DFADs) in the Western Indian Ocean, determined by fishers' echo-sounder buoys. *Mar Biol* 164 doi 10.1007/s00227-017-3075-3
- Lopez J, Moreno G, Lennert-Cody C, Maunder M, Sancristobal I, Caballero A, Dagorn L (2017b) Environmental preferences of tuna and non-tuna species associated with drifting fish aggregating devices (DFADs) in the Atlantic Ocean, ascertained through fishers' echo-sounder buoys. *Deep-Sea Research Part II-Topical Studies in Oceanography* 140: 127-138 doi 10.1016/j.dsr2.2017.02.007
- Mallalieu K (2020) Following the lead of fishers in ICT development in the Caribbean Information and communication technologies for small-scale fisheries (ICT4SSF). *FAO/Worldfish*, Bangkok, pp 52-62
- Mathieu H, Reynal L, Magloire A, Guyader O (2014) Does FAD deployment have a real effect on fishing redeployment towards offshore resources? *Proc Gulf Caribb Fish Inst* 66: 511-517
- Merten W, Rivera R, Appeldoorn R, Serrano K, Collazo O, Jimenez N (2018) Use of video monitoring to quantify spatial and temporal patterns in fishing activity across sectors. *Sci Mar* 82: 107-117 doi 10.3989/scimar.04730.09A
- Monnereau I, Oxenford HA (2017) Impacts of Climate Change on Fisheries in the Coastal and Marine Environments of Caribbean Small Island Developing States (SIDS). *Caribbean Marine Climate Change Report Card: Science Review 2017*: 124-154
- Morales-Nin B, Cannizzaro L, Massuti E, Potoschi A, Andaloro F (2000) An overview of the FADs fishery in the Mediterranean Sea *Pêche thonière et dispositifs de concentration de poissons*, Caribbean-Martinique
- Moreno G, Dagorn L, Capello M, Lopez J, Filmalter T, Forget F, Sancristobal I, Holland K (2016a) Fish aggregating devices (FADs) as scientific platforms. *Fisheries Research* 178: 122-129 doi 10.1016/j.fishres.2015.09.021
- Moreno G, Jauhary R, Adam SMR, V., (2018a) Moving away from synthetic materials used at FADs: evaluating biodegradable ropes degradation. *Collect Vol Sci Pap ICCAT* 74: 2192-2198
- Moreno G, Orue B, Restrepo V (2018b) Pilot project to test biodegradable ropes at FADs in real fishing conditions in western Indian Ocean. *Collect Vol Sci Pap ICCAT* 74: 2199-2208
- Moreno g, Restrepo v, Dagorn l, Hall M, Murua J, Sancristobal I, Grande M, Le Couls S, Santiago J (2016b) Workshop on the use of biodegradable fish aggregating devices (FAD). *ISSF Technical Report 2016-18A*.
- USA. International Seafood Sustainability Foundation, Washington, D.C.
- Orúe B, Lopez J, Moreno G, Santiago J, Boyra G, Soto M, Murua H (2019) Using fishers' echo-sounder buoys to estimate biomass of fish species associated with drifting fish aggregating devices in the Indian Ocean. *Revista de Investigación Marina, AZTI* 26: 1-13
- Orue B, Lopez J, Moreno G, Santiago J, Boyra G, Uranga J, Murua H (2019) From fisheries to scientific data: A protocol to process information from fishers' echo-sounder buoys. *Fisheries Research* 215: 38-43 doi 10.1016/j.fishres.2019.03.004
- Orúe B, Pennino MG, Lopez J, Moreno G, Santiago J, Ramos L, Murua H (2020) Seasonal Distribution of Tuna and Non-tuna Species Associated With Drifting Fish Aggregating Devices (DFADs) in the Western Indian Ocean Using Fishery-Independent Data. *Frontiers in Marine Science* 7 doi 10.3389/fmars.2020.00441
- Oxenford HA, Monnereau I (2017) Impacts of Climate Change on Fish and Shellfish in the Coastal and Marine Environments of Caribbean Small Island Developing States (SIDS). *Caribbean Marine Climate Change Report Card: Science Review 2017* 83-114
- Reynal L, Dromer C, Eugène F, Frangoudes K, Gervain P, Guyader O, Le Roy Y, Mathieu H, Pau C, Regina F, Thouard E, Magloire A, Archibald M, Cruickshank-Howard J, Diaz N, Ishida M, Lay M, Le Quellec J, Medar P, Mohammed E, Moran M, Saddler K, Theophile D, Volny-Anne C (2015) Rapport de la réunion finale du projet MAGDELESA. *R.INT.RBE/BIODIVENV 2015-1*

- Reynal L, van Buurt G, Taquet M (1999) Perspectives de développement des DCP ancrés dans les Petites Antilles. L'exemple de trois îles: Guadeloupe, Martinique et Curacao. In: Le Gall J-Y, Cayré P, Taquet M (eds) Actes de colloques Pêche thonière et dispositifs de concentration de poissons Martinique, 15-19 Octobre 1999, pp 36-54
- Sadusky H, Chaibongsai P, Die DJ, Agar J, Shivilani M (2018) Management of moored Fish Aggregation Devices (FADs) in the Caribbean. *Collect Vol Sci Pap ICCAT* 74: 2230-2242
- Santiago J, Uranga J, Quincoces I, Orue B, Grande M, Murua H, Merino G, Urtizbera A, Pascual P, Boyra G (2020) A novel index of abundance of juvenile yellowfin tuna in the Atlantic ocean derived from echosounder buoys. *Collect Vol Sci Pap ICCAT* 76: 321-343
- Schneider EVC, Brooks EJ, Bailey DM, Killen SS, Cortina MP, Van Leeuwen TE (2021) Design and Deployment of an Affordable and Long-lasting Deepwater Subsurface Fish Aggregation Device. *Caribbean Naturalist* 83: 1-16
- Sinopoli M, Cillari T, Andaloro F, Berti C, Consoli P, Galgani F, Romeo T (2020) Are FADs a significant source of marine litter? Assessment of released debris and mitigation strategy in the Mediterranean sea. *J Environ Manage* 253: 109749 doi 10.1016/j.jenvman.2019.109749
- Sokimi W, Blanc M, Colas B, Bertram I, Albert J (2020) Manual on anchored fish aggregating devices (FADs): An update on FAD gear technology, designs and deployment methods for the Pacific Island region. Pacific Community, Noumea, New Caledonia
- Tamura M, Ishida M, Sidman C, Montes N, Lorenzen K (2018) Facilitating Co-managed Fisheries in the Caribbean Region: Good Practices and Guidance from the CARIFICO Experience. *CARIBbean Fisheries Co-Management*
- Tietze U, Singh-Renton S (2012a) Draft of Sub-regional Fisheries Management Plan for Blackfin Tuna Fisheries in the Eastern Caribbean Region, pp 49
- Tietze U, Singh-Renton S (2012b) Strategic Action Programme for the Effective Governance and Management of Large Pelagic Fisheries in the Caribbean Large Marine Ecosystem (CLME). CRFM Technical & Advisory Document - Number 2012 / 15. CRFM Secretariat, Belize
- Tilley A, Dos Reis Lopes J, Wilkinson SP (2020) PesKAAS: A near-real-time, open-source monitoring and analytics system for small-scale fisheries. *PLoS One* 15: e0234760 doi 10.1371/journal.pone.0234760
- Wang Y, Zhou C, Xu L, Wan R, Shi J, Wang X, Tang H, Wang L, Yu W, Wang K (2021) Degradability evaluation for natural material fibre used on fish aggregation devices (FADs) in tuna purse seine fishery. *Aquaculture and Fisheries* 6: 376-381 doi 10.1016/j.aaf.2020.06.014
- WECAFC (2018) Proposal for regional logbook guidelines for fishery management and stock assessment purposes. WECAFC
- WECAFC (2022) Interim Data Collection Reference Framework. Version 0.8. Rome
- Vallès H (2015) A snapshot view of the fishery associated with Fish Aggregating Devices (FADs) in selected communes of the Southeast, South and Grande Anse Departments, Haiti. Inter-American Development Bank (IDB), Haiti
- Vallès, H. (2023) Moored Fish Aggregating Device (MFAD) fisheries in the Caribbean: regional challenges from the practitioners' perspective. *Curr Opin Environ Sustain* 61:101267.
- Weiroski F, Hall SJ (2008) Public-Private Partnerships for fisheries and aquaculture: getting started. *WorldFish Center Manual number 1875*. The WorldFish Center, Penang, Malaysia
- Widyatmoko AC, Hardesty BD, Wilcox C (2021) Detecting anchored fish aggregating devices (AFADs) and estimating use patterns from vessel tracking data in small-scale fisheries. *Sci Rep* 11: 17909 doi 10.1038/s41598-021-97227-1
- Wilson MW, Lawson JM, Rivera-Hechem MI, Villaseñor-Derbez JC, Gaines SD (2020) Status and trends of moored fish aggregating device (MFAD) fisheries in the Caribbean and Bermuda. *Mar Policy* doi 10.1016/j.marpol.2020.104148