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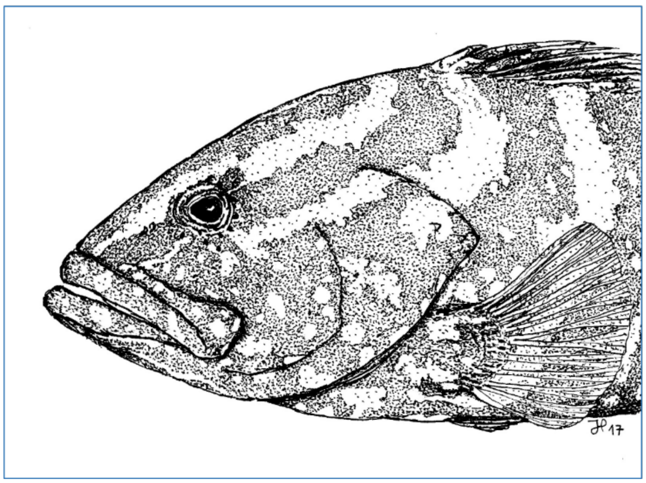
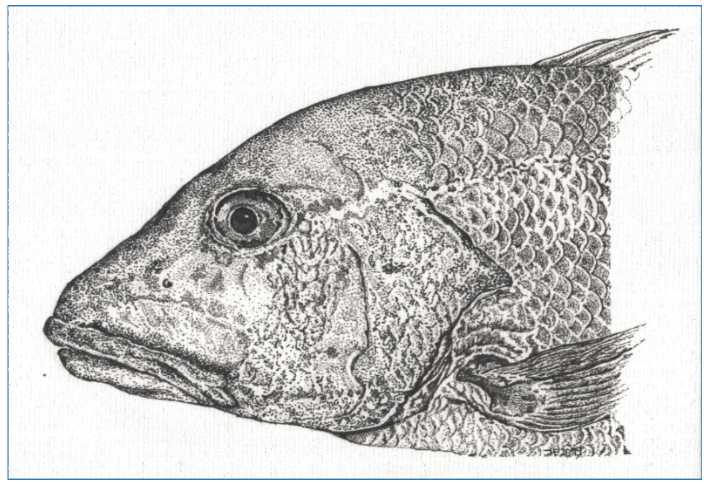
Regional Fish Spawning Aggregation Fishery Management Plan: Focus on Nassau Grouper and Mutton Snapper





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Acronyms

ACS	Association of Caribbean States
BIOPAMA	Biodiversity and Protected Areas Management Programme
CFMC	Caribbean Fisheries Management Council
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLME+	Caribbean Large Marine Ecosystem Plus project
CRFM	Caribbean Regional Fisheries Mechanism
EAF	Ecosystem Approach to Fisheries
EBM	Ecosystem Based Management
ESA	Endangered Species Act (of the USA)
FSA	Fish Spawning Aggregation
FSAMP	Regional Fish Spawning Aggregation Fishery Management Plan
FAO	Food and Agriculture Organization of the United Nations
GMFMC	Gulf of Mexico Fishery Management Council
INPESCA	Instituto Nicaragüense de la Pesca y la Acuicultura
IUU	Illegal, Unreported and Unregulated Fishing
IUCN	International Union for Conservation of Nature
MRFSS	Marine Recreational Fishing Statistics Survey
MRIP	Marine Recreational Information Program
MPA	Marine Protected Area
MS	Mutton snapper
NG	Nassau grouper
NOAA	National Oceanographic and Atmospheric Administration
OLDEPESCA	Latin American Organization for Fisheries Development
OECS	Organization of Eastern Caribbean States
OSPESCA	Central American Fisheries and Aquaculture Organization
SAFMC	South Atlantic Fishery Management Council
SAG	Scientific Advisory Group
SCRFA	Science and Conservation of Fish Aggregations
SEDAR	South East Data Assessment and Review
SDG	Sustainable Development Goal
SICA	Central American Integration System
SPAW	Specially Protected Areas and Wildlife
TAC	Total allowable catch
UN Environment	United Nations Environment Programme
VMS	Vessel Monitoring System
WECAFC	Western Central Atlantic Fishery Commission
WCMC	World Conservation Monitoring Center

Executive Summary

Background

The "Regional Fish Spawning Aggregation Fishery Management Plan: Focus on Nassau Grouper and Mutton Snapper" (FSAMP) was developed by the Fish Spawning Aggregation (FSA) WECAFC/CFMC/OSPESCA/CRFM working group. It is the outcome of a decade of dedicated work to significantly improve fishery management to stop and reverse the declines associated with uncontrolled exploitation of vulnerable fish spawning aggregations.

Spawning aggregations, the only known means of reproduction of Nassau grouper (NG, *Epinephelus striatus*) and mutton snapper (MS, *Lutjanus analis*), are essential for the long-term replenishment and productivity of their natural populations. Therefore, efforts are needed to ensure that they remain healthy (i.e. viable or functional-see Glossary) Spawning aggregations are understood as gatherings where, and during which, adult males and females assemble briefly at predictable times and places each year for the sole purpose of reproduction (courtship, spawning, mate choice, etc.). NG spawn for a week or so during one or two (uncommonly three) full moon periods in a given year between December and March, in some locations into April. Conversely, MS aggregate during one or two (sometimes three) times during a four-month period between May and June, that may extend earlier or later into April and July. Exact timing each year may depend on when the full moon periods fall at the start and end of the spawning seasons.

Both species are important for livelihoods, the tourism industry and food security in local economies and trade in the region, and, although already subjected to a range of protective measures, these are either insufficient to stop declines or aid recovery, or are not effectively implemented or enforced. Because species-specific landings and other associated fishery-dependent or –independent data are typically not available in most countries, managers are challenged to assess the current status of their stocks with confidence, or to recognize changes in catch volumes and sizes of fish landed. Fortunately, when scientific information from their spawning aggregations is available, management can be meaningfully implemented. If there is no information, this should be collected. In either case, precautionary management and the ecosystem approach to fisheries are urgently needed. Importantly, sufficient information now exists to begin a planning process for management, even if more data need to be collected subsequently.

For management to be effective, both regional and national approaches need to be coordinated, implemented and enforced. Hence inter-sectoral coordination, within countries and internationally, is indispensable to ensure harmonized planning and, given the transboundary nature of adult and egg/larval movements and the shared nature of these stocks, is necessary. The proposed FSAMP concentrates on protecting a critical and highly specific aspect of the life cycle of the two focal species, with particular attention needed to ensure active engagement by and involvement of fishers, especially small-scale and artisanal fishers, as well as governments, academics and Non-Governmental Organizations (NGOs), among other key stakeholders. The plan calls for actions to build support for management and to apply positive lessons already learnt from successful management initiatives to date. It also recognizes that community-based solutions, the development of alternative livelihoods and public understanding and engagement should be prioritized, and actively pursued.

These actions need to be progressive and adaptive, and based on clear management objectives and the best scientific information available, including broader factors such as fishery-independent factors, climate change, biodiversity, and ecosystem-scale considerations. There is also a need to be precautionary in developing management measures, undertake regular monitoring and retain the flexibility to adapt measures, such as the closed season, according to prevailing or changing circumstances. Seasonal closures, for example, may need to vary slightly between and even within locations according to the timing of the full moon phases and may be influenced by climate change. Exploration of the benefits of and options for non-extractive uses is needed.

Management Actions, Rationale, Implementation and Timeframes **Objective**	**Action No.** **Timeframe**	**Action**	**Rationale**	**Implementation**
I. To **increase the availability of information** for and **understanding** of NG and MS population status to build support for FSA protection	1. 1-10 years	Generate and compile scientific and traditional information that highlights the importance of healthy NG and MS FSAs for securing the stability and productivity of their populations, the fisheries they support and the range of ecosystem services they provide.	Insufficient involvement and understanding of key issues about NG and MS FSAs functioning by different stakeholders.	Utilize expertise within the FSA Working Group, and beyond, to promote understanding and integration of FSA-relevant issues and their integration into fisheries management and conservation strategies.
	2. 1-10 years	Promote and facilitate fisher participation in traditional information compilation to support regional / sub-regional FSA conservation strategies.	Knowledge and experiences of fishing in FSAs are not commonly used in fisheries management across the Caribbean region despite the breadth of knowledge and experience of fishers that exploit these species.	Secure and expand opportunities for deep involvement of fishers in providing information on the fishery history and current status of NG and MS FSAs, participation in data assessments and development of management recommendations.

II. To **determine the current status, including presence and fish abundance, location/timing**, of known FSAs and identify those most in need of protection	3. 1-3 years	Define criteria to determine sites/countries at high risk of losing their NG and MS FSAs, or that are particularly important for the species, by considering ecosystem, biological, ecological and socio-economic elements and considering current known status of the species. Where no information is available, the approach should be precautionary.	NG and MS spawning aggregations are subjected to varying levels of fishing pressure, with some at higher risk of overfishing than others.	Identify FSAs at higher risk, based on a set of criteria agreed upon among users, scientists and managers. These criteria need to include bio-ecological, geographical and socio-economic components.
	4. 1-10 years	Map locations and timing of known NG and MS FSAs, pre-and post-spawning migration routes (if any) and determine the population status, using appropriate methods, including fisher knowledge.	FSAs are dynamic and can vary through time. Therefore, improved understanding of aggregation locations and seasons, status (number of fish gathering) and impacts of environmental conditions are all essential for developing and/or improving management measures.	Joint efforts and resources across all stakeholders to package and increase access to available information, including in the form of thematic maps and seasonal aggregation patterns. This information can be acquired using a broad range of technologies and traditional knowledge and is needed to increase the probability of developing successful and effective protective measures.

III. To develop regionally consistent/harmonized **monitoring frameworks and protocols** to collect key biological, trade and other socio-economic information associated with NG and MS, both during and outside of FSA seasons/areas.	5. 1-10 years	Considering the transboundary nature of NG and MS stocks, adopt and progressively implement regional monitoring frameworks to collect fishery-dependent and -independent data in a standardized format and considering a long-term basis.	Several FSA monitoring protocols for understanding population dynamics and threats exist. However, data collected in a standardized format at the regional level is absent, incomplete, is not readily available or lacks the necessary statistical rigor.	More efficient strategies to collect/share data and increase collaborations to monitor FSAs at the regional level are urged. Existing protocols may need to be updated and adopted/adapted at the regional level for better understanding of FSA dynamics.
	6. 1-10 years	Develop effective national/sub-regional/regional alliances and protocols to collect socio-economic and trade (domestic and international) data associated with NG and MS fishing at/during FSA areas/seasons as well as at other times and places.	Few or no data are available to determine the extent of the food security value and the full economic importance of NG and MS derived from fishing at FSAs or outside of aggregation locations and periods.	Promote collaboration for the collection of socio-economic data from fishing communities and all along the trade chain to the retail sector, derived from NG and MS, considering both extractive and non-extractive uses, and during both aggregation and non-aggregation seasons.

	7. 1-5 years	Countries expand commitments to counteract IUU fishing and include strong enforcement of management measures aimed at protecting NG and MS FSAs.	While strategies to counteract IUU fishing sometimes exist, in general these suffer from resource limitations and other management and political difficulties. At present, they do not specifically include NG and MS FSA protection which demands special arrangements given the typically offshore locations and implementation challenges.	Improve coordination among WECAFC Working Groups and other regional authorities to achieve more effective control of IUU fishing at FSA areas/seasons in regional strategies. Such collaborations need to be clearly identified and protocols developed in accordance with existing international/regional legal frameworks.
IV. To **establish coordinated and harmonized mechanisms** for **effective protection** of FSAs from extractive use across the Caribbean region.	8. 1-3 years	Promote the establishment of synchronized or harmonized regional closed seasons for commercial and recreational fishing for protecting NG and MS FSAs and ensure their reproduction is safeguarded. Recommended region-wide seasonal closures are four months for NG (1 Dec. to 31 Mar.) and four months for MS (1 Apr. to 31 Jul.). However, the length of seasonal closures may vary somewhat over time or by location depending on variations observed from regular monitoring, for example resulting from climate change impacts or to address regional variability.	The establishment of synchronized/harmonized closed seasons to protect NG and MS FSAs is strongly endorsed by WECAFC. However, to date few countries have responded positively to this call.	Increase the number of countries that adopt spatial/temporal closures to protect NG and MS FSAs. Promote additional voluntary efforts to develop special regulations that consider acceptable levels of incidental take and other stronger actions for recovery and safeguarding their populations. Special attention should be paid to countries in which FSAs are at higher risk.

	9. 1-10 years	Countries develop and implement national plans to protect FSAs and aggregating species, starting with NG and MS.	The Ecosystem Approach to Fisheries calls for comprehensive and specific conservation strategies and fishery management at the national level. However few countries have developed their own FSA national management plan or implement existing plans effectively.	Recommendations from this regional plan can help to guide the development of national management plans, thereby responding to the unique challenge of FSA management, while at the same time recognizing the potentiality of shared fish stocks (see No. 8 above).
	10. 1-3 years	Evaluate the effectiveness, applicability, objectives and benefits of current NG and MS fisheries management and the degree of protection their FSAs are receiving.	Management regulations issued by different bodies and instruments or with unclear objectives can lead to confusion or inappropriate measures which may impede their main objective of FSA recovery and avoidance or reversal of negative trends. Studies to evaluate the effectiveness of current regulations in maintaining healthy NG and MS FSAs may be needed.	Quantitative evaluations of existing or new regulations are required to reduce subjectivity, securing its enforcement and ultimately achieving effective protection of NG and MS FSAs.

	11. 1-10 years	Identify and implement viable alternative livelihood options for small-scale fishers seriously affected by NG and MS FSA protective measures, with priority given to countries with higher risks of losing FSAs.	Few alternative livelihoods for traditional fishers impacted by conservation measures are being applied. Exploration of viable alternatives should incorporate cultural considerations, maintain linkages with the ocean and promote active involvement with conservation strategies.	Progressively increase financial resources for developing alternative livelihoods, focusing on innovative approaches and long-term commitments. Priority should be given to those countries with FSAs at higher risk.
	12. 1-5 years	Establish regional guidelines for conducting non-extractive use of NG and MS FSAs (tourism, research, education).	There is considerable potential for gaining benefits from non-extractive use of NG and MS FSAs, in addition to their importance in supporting fisheries outside of aggregation times and places. However, these activities need to be managed to avoid possible negative impacts and to keep the overall goal of protection.	Adapt existing guidelines for nature observers to include FSAs, offering chances for increasing income, research, and community participation in conservation and tourism.

V. To significantly increase **awareness and engagement** among key stakeholders to enhance support for the protection of FSAs, with special attention to equitable benefits for local communities	13. 1-10 years	Develop marketing and awareness regional/sub-regional strategies/campaigns for the general public on the importance of healthy aggregations to maintain ecosystem services, socio-economic benefits and biodiversity, initially focused on NG and MS, and in support of the FSA Working Group regional communication strategies.	There is need to improve understanding of FSAs in securing productive NG and MS populations and in maintaining sustainable fishing. Despite several education initiatives already in place, further and regularly updated outreach is needed within the region to create and sustain public awareness for effective support of measures to conserve essential reproductive processes for aggregating species.	Secure support for a five-year tri-lingual strategy regional Communication Strategy for Fish Spawning Aggregation Conservation and Management in the Wider Caribbean with the theme "Recovering Big Fish". In addition, regional and sub-regional internet-accessible materials should be promoted to increase public awareness for supporting this plan.
VI. To integrate FSA protection into **broader planning and ecosystem-scale management** initiatives.	14. 1-5 years	Improve understanding of regional scale larval connectivity patterns.	Despite the high potential for transboundary connectivity of adults, and dispersal of the early larval stages from FSA sites, species distribution patterns at broad geographic scales and their relationship(s) with adult abundance dynamics over time remain poorly understood.	Coordinated efforts by scientists, managers and fishers to conduct studies to improve understanding of regional scale connectivity is needed for NG and MS to advise on appropriate spatial scales of FSA conservation and fishery management.

	15. 1-10 years	Identify the possible spatial and/or temporal implications of climate change for the spawning processes of both species.	Reproductive seasons could be particularly susceptible to climate change impacts and result in shifting spawning seasons, alter sensory systems of pelagic larvae, or affect food supplies. Several factors associated with climate change are likely to increase uncertainty in conservation and fisheries management calling for precautionary approaches.	Integration of dispersed resources is required to develop specific projects to better understand the potential impacts of climate change on FSAs and to develop mitigating measures.
	16. 1-10 years	Increase NG and MS FSA protection by improving management of current MPAs or establishment of new MPAs where the conservation of FSAs is specifically included in the objectives.	Not all MPAs are effective in safeguarding NG and MS FSAs because they are either not adequately enforced, not 'no-take' MPAs, do not include known FSAs, or do not incorporate the necessary habitats for securing functional bio-ecological processes (e.g. spawning and nursery areas).	Utilize measurable goals and metrics to evaluate the degree of protection of NG and MS FSAs received from MPAs. Determine the need for, or make adjustment to, existing MPAs or create new ones with FSAs incorporated into spatial design.

Summary of Plan Adoption & Implementation

The gradual implementation of the FSAMP envisions the achievement of FSA protection and management in response to successful actions in four major components: a) coordination/collaboration; b) education and outreach; c) technical/scientific advisory; and d) legal advisory/enforcement.

Existing mechanisms of regional coordination and collaboration from the Interim Coordination Mechanism were established under the framework of the Caribbean Large Marine Ecosystem project. This project aims to improve ocean governance in the Wider Caribbean. As such, the WECAFC Secretariat shall continue coordinating activities around fisheries-related issues among WECAFC, OSPESCA and CRFM members. These members have already agreed to begin working on topics related to Illegal, Unreported and Unregulated (IUU) fishing, management of spiny lobster and migratory fish resources, explore new alternatives for aquaculture and address relevant impacts of disaster risk management and climate change. Thus, they should include the protection of FSAs in the priority agenda. In the meantime, the FSA Working Group is urged to create a Sub-committee that would concentrate on coordinating the progressive implementation of the proposed FMP measures. In particular, this Sub-committee needs to coordinate with other WECAFC Working Groups including the IUU Fishing, Demersal Fisheries, Shrimp and Ground Fisheries, and Recreational Fisheries Working Groups.

Coordination and support for the implementation of this FSAMP can be also obtained from the Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region, also referred as the Cartagena Convention, a legally binding agreement (involving 34 countries / overseas territories out of the 42 comprising the Wider Caribbean region). The Cartagena Convention and its Specially Protected Areas and Wildlife (SPAW) expressed commitment to protect and manage their common coastal and marine resources individually, jointly, and in a sustainable manner, and thus in 2017 listed Nassau grouper to its Annex III.

Education and outreach can be developed along with the implementation of the regional communication initiative, “Recovering Big Fish”, a strategy adopted for establishing capacities and capabilities to generate and sustain broad support for stronger FSA protection, as envisioned in this FSAMP. Complementarily, legal advice to evaluate the effectiveness and/or applicability of existing regulations, feasibility of projected regulations and effectiveness of enforcement, among other topics, can be coordinated through a special legal support group, taking advantages of already existing similar technical expertise within regional/sub-regional technical Groups.

Monitoring and evaluation of FSAMP implementation and effectiveness should be conducted bi-annually, including through inter-sessional communications and by the relevant national government departments and bodies.

Further information and analysis are provided in the four chapters and five annexes comprising this regional FSAMP.

Chapter 1: Background and Context

This document is the result of agreements made at regional workshops initiated in October 2008, and subsequent meetings through 2018 that have been coordinated by the Caribbean Fishery Management Council (CFMC) and the Western Central Atlantic Fishery Commission (WECAFC). At the 2008 meeting, which focused on the endangered Nassau grouper (NG), *Epinephelus striatus*, an *ad hoc* working group on Nassau grouper was created to deal with the urgency of its populations plummeting in much of the region. Subsequently, a Fish Spawning Aggregation (FSA) Working Group was established by the fourteenth session of WECAFC in February 2012, with the support of the Central American Fisheries Organization (OSPESCA) and the Caribbean Regional Fisheries Mechanism (CRFM).

The first meeting of the FSA Working Group of the WECAFC/CFMC/OSPESCA/CRFM was held in Miami, Florida, USA, from the 29th to 31st October 2013, and brought together 23 stakeholders working on fish spawning aggregations from the Wider Caribbean region. These scientists, managers and fishers expressed concern about ongoing declines in stocks of many aggregating species of reef fish in the Wider Caribbean Region, primarily due to declines associated with direct exploitation of vulnerable spawning aggregations, and enabled by insufficient management. The FSA Working Group further emphasized the high ecological, biological and socio-economic values of aggregating reef fish (mainly groupers and snappers) and their importance for marine biodiversity and local communities throughout the region. The meeting produced a Declaration to develop a Regional Spawning Aggregation Fishery Management Plan for two aggregating species of concern, the Nassau grouper and the mutton snapper (MS), *Lutjanus analis*.

These two species are considered to be undergoing declines. The Nassau grouper was listed as Critically Endangered (reassessed in 2018) and the mutton snapper was assessed as Near Threatened (2015) according to the categories and criteria of the Red List of the International Union for Conservation of Nature (IUCN). In recognition of its much reduced populations, the Nassau grouper received protection from the US government with its inclusion in the Endangered Species Act (2016), and from its listing on Annex III, as a threatened species, on the Cartagena Convention's Protocol for Specially Protected Areas and Wildlife (SPAW Protocol) in 2018. Concerns over the Near-Threatened conservation status of the mutton snapper have not yet been addressed.

The second meeting of the WECAFC/CFMC/OSPESCA/CRFM FSA Working Group was held on the 27th to 29th March, 2018 in Miami, Florida, USA. During this meeting, the FSA working Group adopted the 2013 Declaration, and recommended to advance this regional framework, with an initial focus on conservation of the Nassau grouper and mutton snapper the two species of most immediate concern. At that meeting, it was agreed to develop a Regional Spawning Aggregation Fishery Management Plan for the two species that it would serve as a template for additional species. The CFMC supported a writing team to draft this document.

A first draft of the Fish Spawning Aggregation Management Plan (FSAMP) was circulated within the FSA Working Group in December 2018, and a revised version, incorporating comments received, was submitted to the WECAFC - SAG (Scientific Advisory Group) in May 2019 for review. After its 10th session on June 8th, 2019, the SAG produced recommendations for the current version of the Regional Fish Spawning Aggregation Fishery Management Plan, hereafter FSAMP (or the Plan).

Country representatives at the WECAFC 17 Session, held on the 15th to 18th July 2019, supported the development of the FSAMP and recommended that a final version be adopted by the FSA Working Group. The FSAMP was adopted at the third meeting of the WECAFC/CFMC/OSPESCA/CRFM FSA Working Group, which was held in San Juan, Puerto Rico, December 16-17, 2019 upon the incorporation of additional comments received at this meeting. Final version will be submitted to the WECAFC secretariat, with the purpose of translation, and presentation at the 11th session of the WECAFC - SAG scheduled in November 2020, and at the WECAFC 18th Session expected to take place in 2021. Most importantly, the call for near-term international action to protect FSAs was strongly endorsed, including improving enforcement of closed seasons, closed areas, and species-specific sales bans during the closed season. Other actions recommended at this meeting are included in this management plan.

1. Nassau grouper and mutton snapper

The Nassau grouper and mutton snapper are significant components of multi-species reef-fish fisheries in the Wider Caribbean region. They are taken by artisanal, recreational and some industrial scale fisheries and are important for livelihoods, the tourism industry and food security in local economies. In addition, these intermediate-level reef predators provide multiple ecosystem services by variously regulating, shaping and sustaining habitats and communities. At natural levels of abundance, when not overfished, each of these two, are estimated to be capable of producing at least 5,000-10,000 mt across the region annually and generating millions of USD in income (Chapter 2). To put these volumes into context, other highly valued marine species in the region include the queen conch, *Lobatus gigas*, with recent regional annual production of white conch meat, at current population levels, estimated at about 7,800 mt (Prada et al., 2017), and lobster (*Panulirus argu*s) at 30,000 mt (FA0, 2018a).

While species-specific landings data are not available for the mutton snapper in most countries and are lacking for many countries for the Nassau grouper, making it challenging to know the full extent of its landings or to understand trends over time, we do know that landings for both fish species have declined in many areas, particularly those of the Nassau grouper. We also know that the potential value of these species, when managed and restored, is substantial, both absolutely and relative to other high value species in the region. To better understand their full value and importance, consideration of all levels of extractive (commercial, recreational, subsistence fishing) and non-extractive use (ecosystem role, tourism, education, research, cultural values, reproductive value) must be evaluated and integrated.

The Nassau grouper was once the most important (by weight) grouper in much of the insular Caribbean but has undergone serious declines across most of the region (Evermann and Marsh, 1900). Currently few extant populations remain that contain substantial numbers of fish; approximately two-thirds of the known spawning aggregations may have disappeared entirely and most that remain are seriously reduced in fish numbers compared to former levels. Therefore, the species is now commercially extinct in much of its range, and currently most of their stocks are considered to be either depleted or of unknown status.

In the mutton snapper, many aggregations are believed to be depleted or overfished and countries with available information report declines in landings of as much as 50% depending on the time series, country or region (Chapter 3). As yet there are no reports of complete extirpation of mutton snapper FSAs from fishing. Given the limited availability of detailed fishery information, it is not possible to assess the current status of most of these stocks with certainty. However, management clearly needs to be implemented and has attained substantial fisher support in various areas, with indications of declines across multiple aggregations and fisheries not only in the Wider Caribbean and also into central Brazil.

1.2. Rationale for a focus on spawning aggregations

Both Nassau grouper and the mutton snapper form spawning aggregations, which are their only known means of reproduction and therefore essential for the long-term replenishment of their populations. Spawning aggregations are defined as the gatherings of adult males and females at predictable times and places each year for the sole purpose of reproduction (courtship, spawning, mate choice, etc.). Nassau grouper tends to spawn for a week or so during one or two (uncommonly three) full moon periods in a given year between December and March, possibly into April; aggregation timing can vary somewhat according to when in the month the full moon occurs. Also, there tends to be a peak month with one and maybe even two other moons also having elevated fish numbers. In comparison, mutton snapper aggregates during one or two (sometimes three) times during a four-month period between May and June, that may extend earlier or later into April and July.

Big gatherings of large adult spawners congregating predictably at specific places and during limited times are an attractive and easy target for fishers, but these characteristics also make these groupings very easy to overfish. In fact, declines in numbers of fish caught in aggregations, as well as in the numbers and sometimes sizes (number of fish) of spawning aggregations have occurred throughout much of the region. These declines are largely attributable to uncontrolled fishing on their spawning aggregations, and need to be stopped to safeguard the fisheries and stabilize the catches of these two species for small-scale fishers, food security, and for family income, among other benefits.

There is growing and strong consensus in the region of the need to improve management actions for Nassau grouper and mutton snapper spawning aggregations (FAO, 2019), with significant successes in aggregation protection already achieved in several countries (Chapter 4). While regional approaches need to be strengthened, effective management must also be implemented at the national level. Hence, coordination is needed for seasonal and spatial protection, fishery dependent and independent statistical monitoring, enforcement, outreach and education among other issues. Harmonized planning between or among countries is necessary because many biological processes associated with the life history of the species are transboundary. For instance, adults may migrate hundreds of kilometers to reach aggregations each year while egg and larval dispersal may take place over even greater distances, calling for management across country boundaries. An example of such sub-regional management planning is already in place in Guatemala, Honduras and Belize (Arrivillaga and Zepeda, 2011).

This regional FSAMP explicitly recognizes that Nassau grouper and mutton snapper spawning aggregations are vital for the survival of the species and the fisheries they support, and at the same time are highly susceptible to uncontrolled fishing, thus calling for their protection. It does not preclude or replace other, more conventional, fishery management measures such as controls on catch levels and gears, or minimum sizes, which may already be in place or are under development in some countries. Such measures are needed to manage the species at non-aggregating times.

As such, the FSAMP is a novel approach to protect a critical and highly specific aspect of the life cycle of the two species with particular attention to active engagement and involvement of fishers, especially small-scale and artisanal fishers, governments, academics and NGOs, among other key stakeholders.

Cross-sector collaboration in management seeks to enhance integration of the multi-sectoral WECAFC Working Groups with other regional and sub-regional fishery management bodies, as well as to incorporate recommendations from other international management commitments. Moreover, by following the Ecosystem Approach to Fisheries (EAF), the plan shall facilitate the building of support for adaptive and equitable distribution of benefits, using the best scientific information available, and apply positive lessons learnt from management experience to date, recognizing that community-based solutions and engagement should be prioritized. Management measures should also respond to fishery-independent factors, such as climate change, biodiversity, and ecosystem-scale considerations that can have direct implications for the maintenance of healthy FSAs and be effectively enforced.

Population recovery of NG and MS is expected to occur mostly by effectively protecting their spawning aggregations and significantly improving the application of Ecosystem Approach to Fisheries concepts to ensure functional (healthy/viable – see Glossary) spawning aggregations. There may be additional and separate opportunities to increase the production of the species for trade through hatchery-based mariculture. However, the application of hatchery-production to attempt restocking in the wild fry release is unproven and would need additional work test is feasibility and determine how to best conduct it. There would need to be clear indications of the success of restocking experiments by demonstrating that restocking let to recovery of adults and reproduction at the regional level. Net benefits from aquaculture production is still under debate regarding whether it can in fact increase the abundance of both species in the marine environment. Indeed, there is not yet any good evidence anywhere globally that restocking marine fishes assists in natural population recovery. Moreover, and importantly, if fishery management is not in place and fully complied with, any released hatchery-produced fish would likely be caught before reaching sexual maturation which would preclude their ability to contribute to recovery.

1.3. About this FSAMP

This FSAMP focused on the comprises four chapters and five annexes. Chapter 1 introduces the regional context and rationale for management; Chapter 2 provides summarized context of FSA aggregation sites and main fishing information including socio-economic knowledge needed for developing effective management actions; Chapter 3 outlines the proposed regional management actions and provides guidance for their implementation; and Chapter 4 provides an implementation strategy and identifies roles, responsibilities of several stakeholders at national level along with other relevant regional bodies and instruments needed to strengthen the coordination, integration, implementation and enforcement and timing the plan conceived.

To complement this main body of the FSAMP several annexes of supporting or reference material are available:
Annex 1. Compiles in a Glossary the definition of key words and concepts;
Annex 2. Contains governance frameworks and legal instruments influencing the plan implementation;
Annex 3. Summarizes bio-ecological information for the two focused species;
Annex 4. Examines the management challenges, including those related to climate change, and guidance for advancing an effective management and conservation agenda based on management experiences to date;
Annex 5. Provides guidance on the potential application of and benefits to other reef fish aggregating species across the Wider Caribbean region.

1.4. Objectives

Six objectives were identified to improve regional management of spawning aggregations of Nassau grouper (NG) and mutton snapper (MS) as follows:

I. To **increase the availability of information** for and **understanding** of NG and MS population status to build support for FSA protection.
II. To **determine the current status, including presence and fish abundance, location/timing,** of known FSAs and identify those most in need of protection.
III. To develop regionally consistent/harmonized **monitoring frameworks and protocols** to collect key biological, trade and other socio-economic information associated with NG and MS, both during and outside of FSA seasons/areas.
IV. To **establish coordinated and harmonized mechanisms** for **effective protection** of FSAs from extractive use across the Caribbean region.
V. To significantly increase **awareness and engagement** among key stakeholders to build support for the protection of FSAs, with special attention to equitable benefits for local communities.
VI. To integrate FSA protection into **broader planning and ecosystem-scale management** initiatives.

1.5. Into the future

While more research would enable a better understanding of the status of spawning aggregations, population structure, and the socio-economics and trade of the focal species, there is already sufficient information, and experience, as well as regional commitments made, to act sooner rather than later. The urgency to implement the proposed management actions is driven by the need to reverse stock declines, recognizing that when aggregations become severely reduced (i.e. fish numbers drop to low levels), their degraded reproductive capacity and fishery productivity make recovery increasingly difficult. The clear need for a markedly PRECAUTIONARY APPROACH to the management of the focal and other aggregating species is supported by large numbers of scientific studies conducted over many years and is strongly urged. **In addition to spatial measures, regional seasonal protective measures are**

recommended for the Nassau grouper (December to March, possibly into April) and the mutton snapper (April to July inclusive).

Fortunately, lessons learnt from case studies of the focal species demonstrate that recovery is possible and offer hope and promising insights for success in this endeavor. The plan is being formulated considering a 10-year time-frame and so evaluation and updates are recommended at the completion of this period, as well as every 2-3 years within this decade period.

1.6. Assumptions

The FSAMP aims to be practical, accessible to stakeholders, aligned across the region and viable in its execution; it is based on the following assumptions for its successful execution:

a) POLITICAL WILL exists to develop a regional structure in coordination with national authorities to address not only management goals but to focus heavily on implementation of conservation/management efforts and on reducing IUU fishing.

b) PARTICIPATION of all stakeholders in management is involved, particularly that of fishers, who endorse principles of sustainable use of these resources, by contributing information, increasing their understanding of the complex processes associated with spawning aggregation function, developing and implementing standardized monitoring protocols that enable long-term assessment.

c) Cross-cutting strategic ALLIANCES are in place or developed to implement all necessary management measures in a well-coordinated manner across all relevant instruments, governments, and organizations.

d) Coordinated and oriented COOPERATION occurs towards a common regional goal of fishery sustainability via appropriate and well-enforced regulations.

Chapter 2: Overview of Nassau Grouper and Mutton Snapper

Both the Nassau grouper (NG), *Epinephelus striatus*, and the mutton snapper (MS), *Lutjanus analis*, occur widely in the Wider Caribbean region and represent important reef fisheries. Because these species only reproduce in spawning aggregations that occur at specific locations and times, protecting these aggregations is of critical importance for securing future population viability and fishery production. Despite limited quantitative information, it is likely that tens of thousands of fishers catch these species, as part of the reef fisheries they exploit. Given the highly predictable nature of spawning aggregation formation, the importance of aggregations for population sustainability and considering the broad geographic distribution of the species, it is important that the FSAs of these targeted species must be safeguarded. With good management, FSAs will support fisheries of these species throughout the year and at locations distant from aggregation sites.

The following sections provide brief overviews of NG and MS FSA occurrence and the fisheries associated with these species. Additional bio-ecological information is summarized in Annex 3.

2.1. Nassau grouper

2.1.1. Nassau grouper FSAs

NG spawning aggregations are known in about 14 of 42 countries/overseas territories in the wider Caribbean Region, with over 100 aggregation sites described to date (Table 2.1). The locations and timing of many Nassau grouper spawning aggregations have been documented, however information may need to be updated to confirm the current status of many reported or suspected aggregations and to evaluate their current condition (number of fish present). In addition, fish migration routes to/from spawning sites are generally poorly known and can be impacted by fishing (Claro et al., 2009; Blincow et al., 2020).

Not surprisingly, given the importance of reef habitat for this species, there are more aggregations reported in countries with larger coastal platforms/reef edge areas, most notably Cuba, Belize, Mexico, the Bahamas, Cayman Islands and Honduras (Figs. 2.1-2.3). For Belize, some known sites are monitored regularly. For the Bahamas and Mexico, several aggregations have recently assessed with fish numbers (Table 2.1.), with the status of many others is awaiting confirmation. For Cuba, about 30 aggregations have been reported historically although little information of their current status is available. Overall, however, relatively few aggregations remain compared to historical records and few of them believed to contain more than a few hundred or a few thousand individuals today (Hill and Sadovy de Mitcheson, 2013; Table 2.1 and references therein), according to available information.

Considering that a significant proportion of the annual landings NG and MS are believed to take place at spawning aggregations, and that there is a trend of historical decline in landings (see below), it is indisputable that many FSAs were considerably larger in the past than they are today. In extreme cases, FSAs have evidently disappeared entirely. For example, at just one Bahamian site in the early 1970s 30,000-100,000 NG were estimated visually (Smith, 1972), but this aggregation no longer forms there (Erisman et al., 2013). However, fishing also occurs outside of aggregation times supported by the successful functioning of the FSAs.

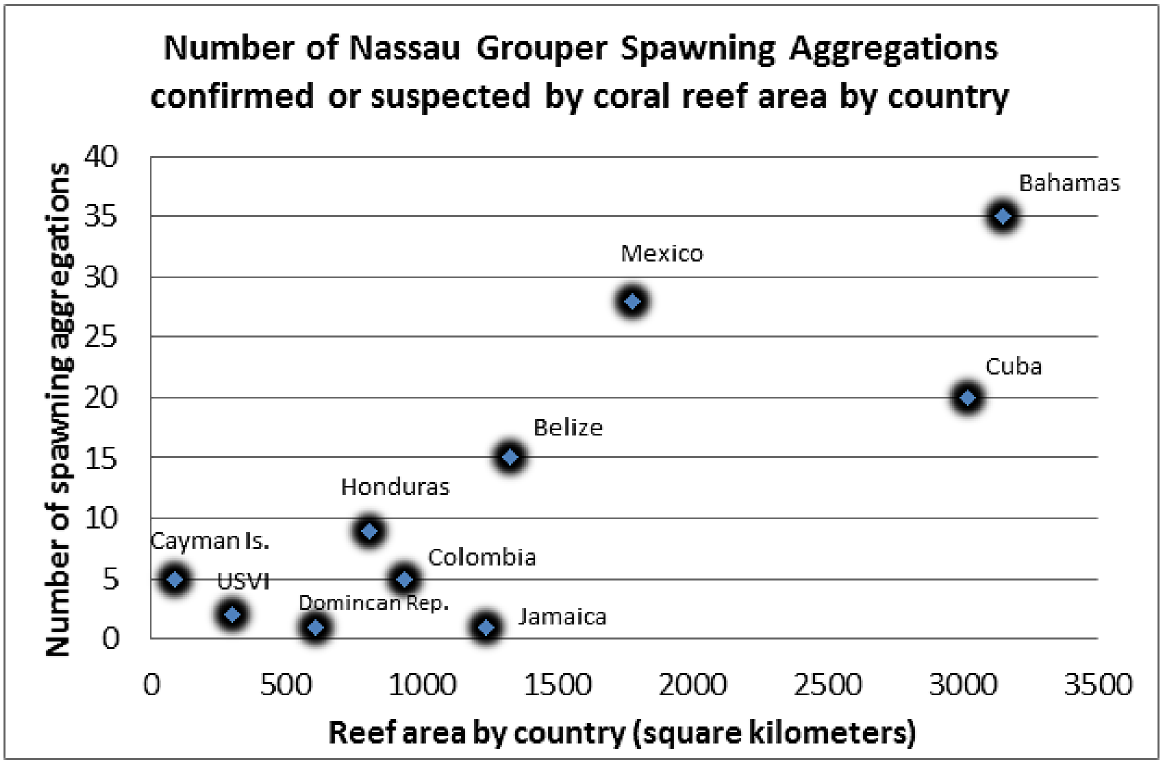

Figure 2.1. Number of Nassau grouper spawning aggregations reported (if a range in aggregation number is indicated in Table 2.1, the mid value was selected) in the 10 largest countries with reef area data. Relationship is significant (Pearson R=0.8323; N=10; P=0.0028). Coral reef areas from UNEP, Brice Semmens (Cayman Is. pers. comm.); Catanzaro et al. (2002) (USVI) and (Sadovy de Mitcheson , 2020).

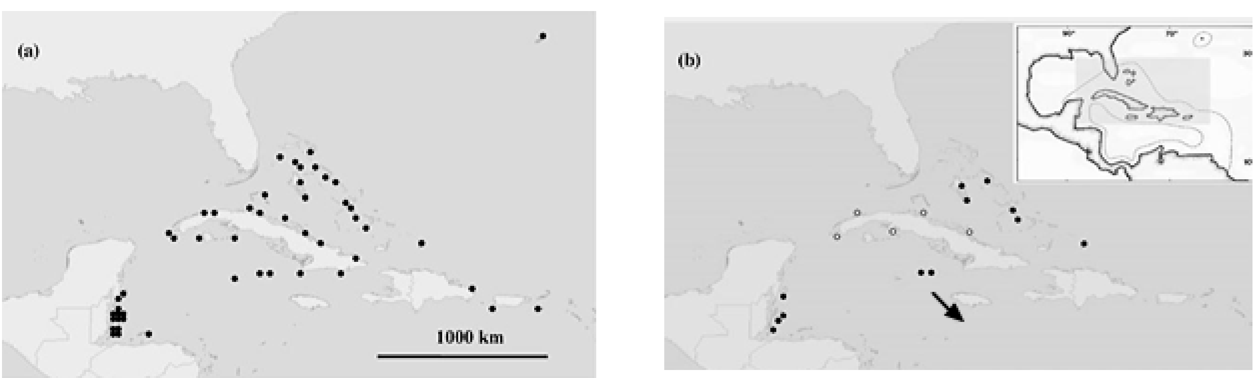

Figure 2.2. Known/reported spawning aggregations of Nassau grouper: (a) All known aggregations reported since 1884. (b) Sites believed to exist today. Each black circle represents one or several aggregations, open circles represent aggregations of unknown status. Recently noted site is indicated by arrow (Hill and Sadovy de Mitcheson, 2013). Inset shows geographic range (line) of species.

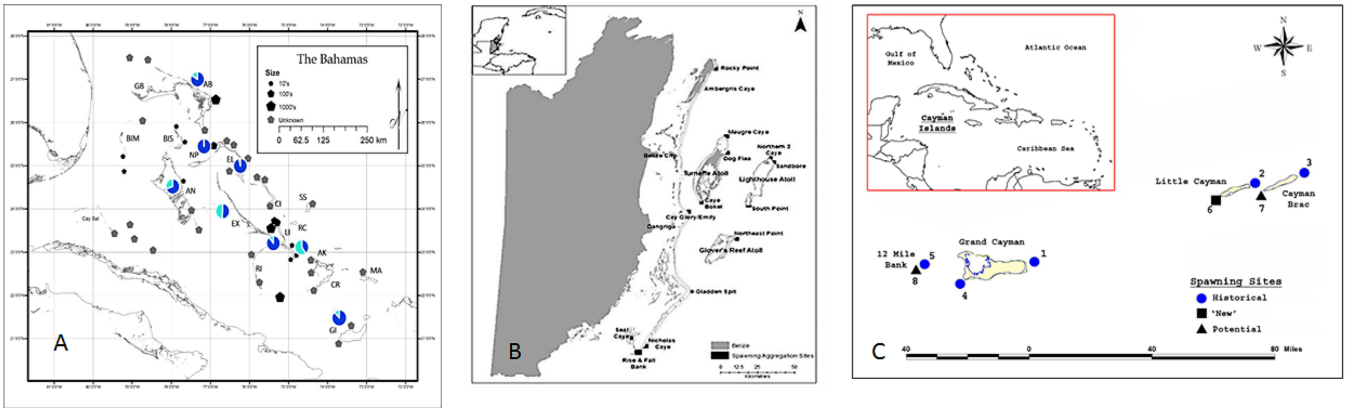

Figure 2.3. Known or reported spawning aggregations of Nassau grouper in three countries: A. The Bahamas from Sherman et al. (2016), B. Belize from Burns Perez and Tewfik (2016), and C. Grand Cayman from Bush (2013).

Table 2.1. Known/probable number of and additional information on Nassau grouper spawning aggregation sites. For more management information, see Annex 3.

Country	Number of sites known	Peak spawning months*	Aggregation status (numbers of fish in aggregations) from UVC or catches	FSA Mana-gement	References
The Bahamas	30	December-February	Mostly of unknown status but many sites anecdotally indicated. Two with thousands of fish, three with fish in hundreds and many tens of fish, or FSAs known or reported but of unknown sizes. Declines across many FSAs and some no longer form. One site estimated to have between 30,000 and 100,000 fish has disappeared.	1,2	Smith, 1972; Colin, 1992; Sadovy, 1999; Cushion et al. 2008; Erisman et al., 2013; Sherman et al., 2016
Belize	15	December-January	Aggregations fished since at least 1940s. Two FSAs had 30,000 and 15,000 fish each (1960s/1970s). Historically, one aggregation yielded 200 t in a single season and up to 300 boats with a single experienced crew catching from 1,200 to 1,800 fish during a single reproductive season and estimated catches reached 90 t per season. FSAs surveyed 2003-2012 each contained < 100 to a few thousand fish.	1,2	Thompson, 1945; Craig, 1966; 1968; Carter et al., 1994; Sala et al., 2001; Heyman and Requena, 2002; Gibson et al. 2007; Paz and Truly, 2007 ; Gongora 2013; Burns Perez and Tewfik, 2016
Bermuda	4	May-July	FSAs fished at least since late 1970s. All sites now gone.	1,2	Luckhurst, 1996
British Virgin Islands	At least one		Early 1990s low fishing pressure on the species.	?	Beets and Friedlander, 1992

Cayman Islands	5-7	December - March	Exploited from early 1900s. Declines by 1980s. One FSA discovered had 7,000 fish but declined from fishing in two years. Two remaining FSAs recovering, one to 7,000 fish. From one aggregation, 2,000 fish caught in a 10 day fishing period.	● 1,2	Whaylen et al., 2004, 2007; Bush et al. 2006; Semmens et al., 2007, 2012; Shouse et al., 2018, Waterhouse et al., 2020 ; Stock et al., 2021
Colombia	2	December - February	10's to 100s of individuals seen during full moon at FSAs within Old Providence and Santa Catalina, Seaflower Biosphere	● 1	Bent, 2012
Cuba	> 20	December - March	Unknown status of all FSAs today; fished since 1880s. Fish also extensively fished on pre-spawning migrations.	1,2	Vilaro Diaz 1884; Claro and Lindeman 2003; Claro et al., 2009; Claro and Valle 2013; ; Claro et al., 2019;
Dominican Republic	1	?	Possibly disappeared.	?	Sadovy 1999; Sadovy de Mitcheson et al., 2012; P. C. Colin, pers. comm.,
Honduras	5 - 12	December-March	Mostly unknown, but possibly gone, one decreasing. One site dropped from approx. 10,000 fish in early 1990s to 500 two years later. One recently validated.	1,2	Craig 1968; Fine 1990, 1992; Box and Bonilla-Mejia 2008; Canty and Box 2014
Jamaica	At least 1	February	No recent record	?	Thompson and Munro 1983
Mexico	28 sites reported	December-March	FSAs fished since early 1900s - very productive 30-35 years ago. Mahahual site gone; this site once yielded 24 t in a season. Status of many other FSAs unknown. 15,000 fish at one site in early 1990s, collapsed by 1996. Second site with 4,100 fish in 2004-5. Xcalak with 3,000 groupers in 2002. Sian Kaan biosphere reserve with two aggregations (1,000 in 2010 and the second one with 150 in 2015).	1	Aguilar-Perera, 1994, 2006, 2013, pers. comm.; Aguilar-Perera and Tuz-Sulub 2012; Aguilar-Perera et al. 2009; Medina-Quej et al., 2004; Sosa-Cordero et al., 2009; Heyman et al., 2014; Fulton et al. 2016, 2017, 2018;

Puerto Rico	2	December- April	Anecdotally, several aggregations are known from past accounts in south and southwest Puerto Rico and Mona Is.. One small one today of about 100 fish regularly forms. Once the southwest site produced enough to fill fishing boats with multiple tons during the aggregation period.	1,2	Sadovy 1999; Ojeda-Serrano et al., 2007; Schärer -Umpierre et al. 2012, 2014; Olson et al., 2018; Tuohy et al., 2016
Turks & Caicos	1	December - March	Status unknown but probably good given relatively low focus on aggregation. Trap boat fishers targeted but few free-divers. Trap CPUE was 85 kg/person/day ranging from 4 to 425 kg and spear fishers CPUE was 30 kg/person/day ranging from 0 to 76 kg. Over the spawning season trap boats caught 8 to 22 metric tons of Nassau grouper.	1,2	Rudd 2003, National Parks Ordinance and Subsidiary Legislation CAP. 80 of 1988; Vo et al., 2008; Landsman et al., 2009; Calosso and Claydon, 2016
U.S., Florida Keys	Anecdotal	?	No information.	1,2	Sadovy and Eklund 1999; Hill and Sadovy de Mitcheson 2013
U.S. Virgin Islands	2	December – April	Fished at least since 1960s. One site with 2,000-3,000 fish present; late 1970s collapsed. Peak landings at St. Thomas aggregations 2.3 t per day. One FSA possibly recovering with c. 200 fish.	1,2	Olsen and LaPlace 1979; Munro and Blok 2005; Nemeth et al., 2009; Kadison et al., 2010; Sharer-Umpierre et al., 2014; Rowell et al., 2015, Chérubin et al., 2020
Venezuela	Anecdotal	January	No information.	1	Boomhower et al. 2010

Notes: Level of management is indicated by '0 'for little to none; '1 'for general measures (such as MPAs that could benefit the species but are not specifically focused on Nassau grouper or their aggregations), and '2 'for species-specific measures (temporal/spatial protection of aggregations, minimum size, etc.).
*= All full moon
UVC=Underwater Visual Census.

2.1.2. Fishing operations, landings, and stock assessments

Fishing operations

The NG is fished commercially and recreationally by hand-lines, longlines, Antillean fish traps, spear-guns (sometimes with the use of compressed air) and gillnets. Many operations are small-scale, involving both full- and part-time fishers, but there are/were some industrial-scale fishing operations, particularly out of Honduras, Nicaragua, Cuba and Mexico. In Mexico, initially, catches were only with hook and line, but there was a marked decline, and disappearance of at least one large aggregation, after introduction of Scuba and harpoons to achieve higher catches (Miller, 1984; Aguilar-Perera, 2006; Castro-Pérez et al., 2011). Large nets were deployed to take fish during their migrations to spawning sites (e.g. in Cuba) (Claro et al., 2009). As catches declined other changes occurred, including the exit of larger commercial vessels from the fishery and cessation of exports (e.g. Honduras, Belize), and shifts to other grouper species, as in Puerto Rico (Matos-Caballero, 1997; Box and Canty, 2010; Gongora, 2013). IUU was known to occur in Belize (by Hondurans) (Zepeda et al., 2011) and in Bahamian waters by non-Bahamian fishers (Casuarina McKinney, pers. comm. 2013, Krista Sherman, pers. comm. Nassau grouper community, 2016, Georgina Bustamante, pers. comm. 2019).

Landings

In the first part of the 1900s, the Nassau grouper was the most important exploited grouper in much of the insular Caribbean, with catches mostly taken from its spawning aggregations, but also at non-spawning sites/times. Declines in catches have occurred in almost all countries where the species was regularly caught (with the possible exception of the Turks & Caicos that does not appear to have a long history exploiting this species), as judged by both catch data and underwater visual census data (see examples of aggregation fish numbers in Table 2.1). Considering available, albeit incomplete, data, it is likely that the species once produced at least 4,000-5,000 mt annually across the region prior to collapses, and was a highly lucrative and important fishery.

According to FAO (2018a), 27,380 mt of NG were landed between 1967 and 2017. The FAO data, however, substantially underestimates total landings of the species since they only come from three country reports (Cuba, The Bahamas and Colombia) (Fig. 2.4), and do not include many areas where this species is fished (e.g. Mexico, Belize, Honduras) (Fig. 2.1). Moreover, these data cannot discriminate NG landings from the ‘grouper ’category, the one most countries utilize for data collection, and usually do not account for all kinds of landings (recreational, family and local consumption, etc).

Across much of the Wider Caribbean region and over multiple decades, there is a consistent and serious trend in declines in Nassau grouper fisheries. In addition, and worryingly, some reports indicate an increasing proportion of juveniles in catches (Honduras; Gobert et al., 2005; Turks & Caicos; Vo et al., 2014). Reported national production dropping by ten to a hundred-fold are clear and alarming signs of declining stocks, with significant associated losses to livelihoods.

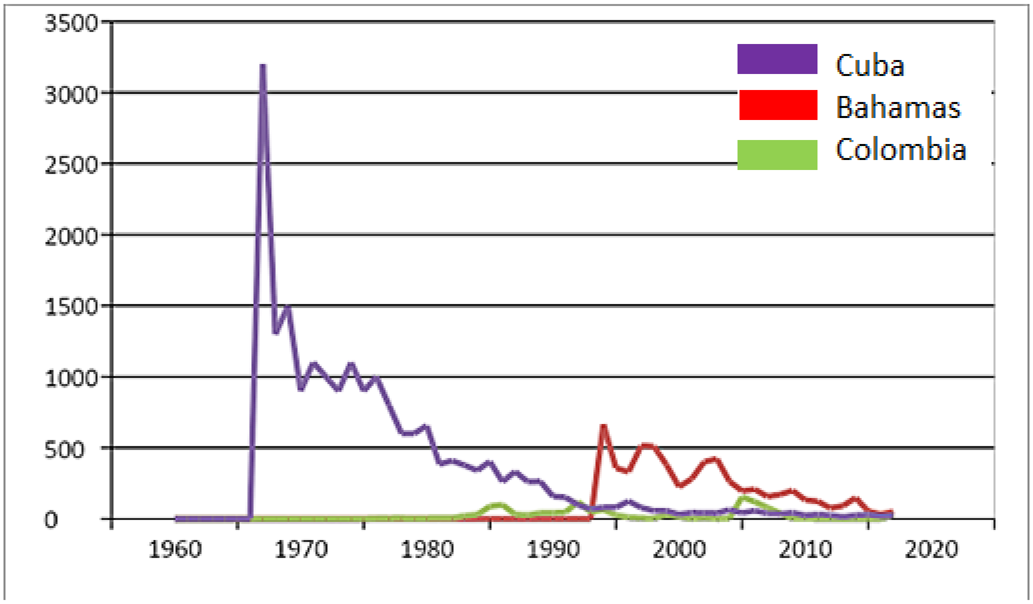

Figure 2.4. Nassau grouper landings (in mt) reported to FAO from 1960 to 2017. No reports were made prior to 1960 (FAO 2018a). No other countries report this species to FAO.

Countries that were once major NG producers can illustrate the importance of the species and its fisheries. For instance, in Cuba, annual landings of >3,000 tons comprised approximately 35-50% of the entire national coastal fisheries prior to collapse in the 1980s (Claro et al., 2001, 2009) (Table 2.1); note that many or most fish landed in the NE Zone were caught in Bahamian waters before 1970 (Claro et al. 2001; Georgina Bustamante, pers. comm. 2019). In the Bahamas, NG landings dropped more than tenfold, from 510 mt in 1998 to 32 mt in 2016 (Cushion and Sullivan-Sealey, 2008; Cheung et al., 2013; Sherman et al., 2016; Vallierre Deleveaux and Lester Gittens, pers. comm., Bahamas Dept. of Fisheries). In Belize, the species was once the second most commonly caught reef fish and was also exported (Craig, 1968; Carter et al., 1994; Paz and Truly, 2007). In Honduras, NG landings peaked in the 1990s, but dropped thereafter to the point is no longer a significant fishery or export commodity (Box and Bonilla-Mejia, 2008; Funes et al., 2015). In Mexico, the Nassau grouper is subsumed under a general 'grouper 'category and hence its landings are unknown, although groupers (much of which are likely to be *E. morio*) are important to national fisheries. However, the species was undeniably very important for multiple local communities in the country, sustaining productive aggregation fisheries some 30-35 years ago (Sosa-Cordero et al., 2009).

Elsewhere in the region, as in Bermuda, Florida, Puerto Rico, U.S. Virgin Islands and the Lesser Antilles, among other countries, available data based on annual landings, or those from specific aggregations, also indicate declines in both recreational and commercial fishing sectors (Olsen and LaPlace, 1979; Luckhurst 1996; Matos-Caraballo, 1997; Sadovy and Eklund, 1999; Martinique, Gobert, 2005). The scarcity of species-specific landings data, volumes and sizes from all fishing sectors is a major data gap for the taxon and must be resolved for better understanding and management of their fisheries.

Stock Assessments

Given the paucity of data on annual landings and corresponding fishing effort for this species, only a few assessments of Nassau grouper stocks have been conducted. The only recent published assessment, conducted in 2013 in The Bahamas, indicated that annual fishing effort needed to be reduced back down to that between 1998 and 2001 (yielding about 300 mt), otherwise stocks were likely to become overexploited relative to biological reference points (Cheung et al., 2013). The ongoing declines in The Bahamas after this study was completed are consistent with this conclusion because there was no subsequent reduction in fishing pressure; annual landings continued to drop and stood at 32 mt in 2016 (Bahamas Department of Marine Resources; Lester Gittens, pers. Comm.).

2.1.3. Socio-economic value and trade

The species is traded fresh, frozen, whole and filleted. While few economic estimates are available for Nassau grouper generated income some examples clearly indicate its national worth as a well-regarded, valuable (historically) of this highly desirable species. Not surprisingly, in some of the main producer countries heavy economic losses have accompanied declines. In The Bahamas, for example, annual value dropped from 3.4 million USD in 2004 (at 2004 prices) to less than 0.5 million USD in 2016 (Lester Gittens, pers. comm. Bahamas Dept. Marine Resources); the species fell from about 10% of the total reef fishery (fish and invertebrates combined) landings in the late 1990s to less than 1% after 2010 (Cheung et al., 2013). NG landings totaling 511 mt were valued at $2,674,401 USD, making it one of the largest fisheries in the Caribbean before 2000 (Buchan, 2000). In Belize, shortly before fishing on spawning aggregations was banned, the economic value of the 2000-2001 NG fishery, although negligible compared to its former value, was estimated at approximately $210 USD per fisher, or $40 USD per fisher per day; approximately four times the minimum wage in Belize (Paz and Grimshaw, 2011). In Honduras the Nassau grouper was once an important source of income for communities living in the Islas de la Bahia (Box and Canty, 2010; Zepeda et al., 2011).

Data on exports of this species are limited but export trade for ‘groupers ’to the US market is considerable (as determined by NOAA import data; https://www.st.nmfs.noaa.gov/commercial-fisheries/foreign-trade/) and comes from many countries in the region. Available national estimates of value are conservative because revenue from recreational and tourism-related activities in many countries is not included (Rudd & Tupper, 2002; FAO, 2009; Cheung et al., 2013; Sherman et al., 2016). To fully understand the extent and nature of the economic value of this species to prompt and improve management efforts and strategies, better data are needed on trade (domestic and international), socio-economics (through value chain analyses of recreational and commercial fisheries of all products in trade), non-extractive values (eco-tourism and scientific studies), and the income from both spawning and non-spawning seasons. The need to conduct value chain analyses and ensure that fair prices are paid to fishers is well-illustrated for instance by the persistently low prices received by Honduran fishers over many years, despite the increasing value of the species in international markets (Box and Canty, 2010; Zepeda et al., 2011).

2.2. Mutton snapper

2.2.1. Mutton snapper FSAs

Spawning aggregations are known from at least 11 countries or territories with over 25 aggregation sites identified (Table 2.2). Identification of many of these sites and times is based on elevated seasonal catch trends and fisher knowledge. For example, in Puerto Rico, at least two confirmed FSA sites for MS and 19 possible sites were reported in fisher interviews (Ojeda-Serrano et al., 2007; Schärer-Umpierre, 2013). Many data gaps exist even where the species may occur in abundance e.g. the Bahamas, Brazil, Honduras, and southern parts of the Caribbean (Kobara et al., 2013), the species is scarce in the Lesser Antilles (Georgina Bustamante, pers. comm. 2019). The species occurs well into Brazil with regional variations in information on the presence of MS spawning aggregations (e.g., Freitas et al., 2011; França and Olavo, 2015). For almost all known MS FSAs in the Western Atlantic, on-site monitoring information is needed to estimate current aggregation status. Prioritization of important FSA sites (by size, threat-level and other factors) will help focus field research resources.

Some MS spawning aggregation sites have been fished heavily for years without extirpation of aggregations as seen in the NG. For example, Cuban national catch data shows some resilience in MS catches despite heavy fishing on FSAs over a near fifty-year time span (Figure 2.5). Total annual catches have varied from approximately 500-900 mt since 1995, with post-2005 trends between 500-700 mt (Claro and Valle, 2013). Although Cuban MS catches have exhibited clear declines (catches were over 1200 mt in the late 1980s), these declines are much less marked than for lane snapper, *L. synagris*, and the NG in Cuba. Of relevance, MS do not form aggregations as large as those of lane snapper in shallow waters, were perhaps not as heavily impacted by trawls and channel nets, and have been subject to a series of regulatory efforts also applied to other snapper species (Table 1 in Claro et al., 2009; Claro and Valle, 2013). There is a management need to better understand how snapper and grouper species might differentially respond to long-term aggregation fishing on FSAs and migrating pre-spawners.

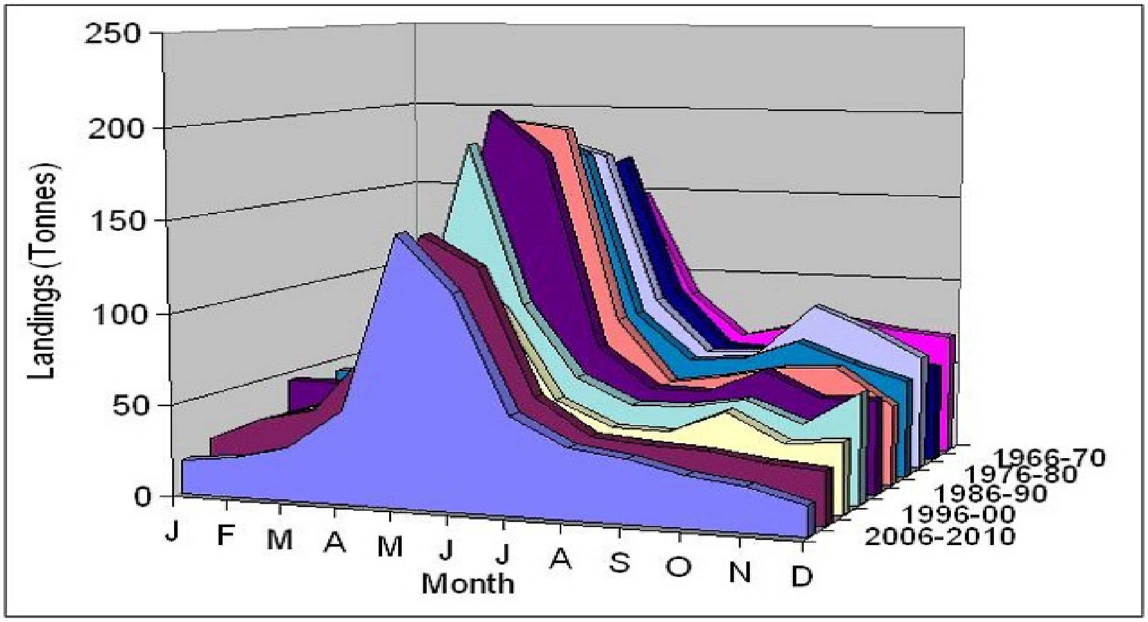

Figure 2.5. Monthly catch of mutton snapper (*Lutjanus analis*), pooled for all regions in Cuba (from Claro and Valle, 2013).

Pre-spawning movements to spawning sites are important in the MS, involving large shifts in fish biomass across multiple shelf habitats. In Cuba, such pre-spawning migrations often involve considerable fishing mortality before reaching the spawning site (Claro et al., 2009). In the Dry Tortugas, Florida, acoustic telemetry measured individual MS engaged in reproductive migrations of up to 5 trips/year from resident areas to the spawning site (an estimated 63 cm/sec) over minimum linear distances up to 35.2 km, with a minimum catchment area of 291 km^2 (Feeley et al., 2018).

Table 2.2. Countries with known/probable spawning aggregation sites (FSAs) of mutton snapper (*Lutjanus analis*) in the WECAFC region. For more management information, see Annex 3.

Country	Number of sites	Peak spawning months*	Aggregation status (numbers of fish in aggregations) from UVC or catches	FSA management	References
The Bahamas	1	?	Fished in aggregations.	1	SCRFA dbase www.SCRFA.org (Eggleston, pers. comm. 2002; Gittens, 2013; Sherman et al. 2016, 2020
Belize	1	May-June	Stabilized, some increases. Catch/boat/day declined from 82 kg in 2000 to 64 kg in 2002. In 2011, ca. 20 boats caught 20 t total, down from ca. 75 t by 70 boats in 1987.	1	CSO, 2001; Graham et al., 2008; Heyman and Kjerve, 2008; Gongora, 2013; Granados-Dieseldorff et al., 2013
Brazil	Multiple sites, potentially	Apr-July	Declines in some areas.	?	Klippel et al., 2005; Fredou et al., 2009; Teixeira et al., 2010; Freitas et al., 2011; França and Olavo, 2015; Caltabellotta et al., 2016
Cuba	14	May-June	Declines suggested in most FSAs.	1,2	Claro et al., 2001; Claro & Lindeman, 2003; Quirós Espinosa and Rodríguez-Moya, 2007; Claro and Lindeman, 2008; Cobian-Rojas and Chevalier-Monteagudo, 2009; Claro and Valle, 2013; de la Guardia et al., 2018; Claro et al., 2019

Mexico	2	Mar-June	Declines. Healthy aggregation at Banco Chinchorro Biosphere reserve with approximately 3,000 individuals, and Sian Kaan Biosphere reserve with approximately 1,500 individuals.	1	Klima, 1976; Sosa Cordero et al., 2002; Castro-Perez et al., 2011; Heyman et al., 2014; Fulton et al., 2016, 2018; Castro-Perez et al., 2018
Nicaragua	?		?	2	Barnuty Navarro, 2013
Puerto Rico	Multiple sites	March-May;	FSAs fished and assumed in decline. Many fish also caught before sexual maturation. Many aggregations suggested.	2	Esteves Amador, 2005; Matos-Caraballo et al., 2006; Cummings, 2007; Ojeda-Serrano et al., 2007; Schärer -Umpierre, 2013
Turks & Caicos	1	April-May	?	?	Domeier et al., 1996
U.S.A.	4, all in the Florida Keys	May-June/July	One in federal no-take zone (Riley's Hump) with recovery after protection: 300 fish in 2004, 4,000 in 2009. One FSA heavily fished (near Western Dry Rocks), possibly two of unknown status.	1, 2	Domeier et al., 1996; Domeier and Colin, 1997; Lindeman et al., 2000; Burton et al., 2005; Gleason et al., 2011; Taylor et al., 2014; Feeley et al., 2018; W. Heyman, unpubl. data; P. Gladding and D. DeMaria, pers. comm.
U.S. Virgin Islands	1	May-Jun	Declines, limited information.	1,2	Kojis and Quinn, 2010a, b; Nemeth, 2012
Venezuela	2	May-June	Fished, declines assumed.	1	Boomhower et al., 2010; Romero et al., 2011

Note: Level of management is indicated by ‘0 ’for little to none; ‘1 ’for general measures (such as MPAs that could benefit the species but are not specifically focused on MS), and ‘2 ’for species-specific measures (temporal/spatial protection of aggregations, minimum size, etc.).
* = two days before full moon to 7 d after, can be site-dependent.
UVC = underwater visual census.

2.2.3. Fishing operations, landings, and stock assessments

Fishing operations

The mutton snapper is a prized fishery species and among the more abundant snappers landed in the region, supporting many local economies. It is taken in commercial, recreational and artisanal fisheries across portions of the southeast United States and Gulf of Mexico, much of the Caribbean and Brazil. The species is often captured as part of a larger multi-species reef fishery referred to as the 'snapper-grouper complex", both on spawning aggregations as well as outside of the reproductive season. Species-level fishery information is often absent and the value of this large species complex is poorly documented, seriously undermining the ability of governments to estimate full economic worth, and importance for food security and livelihoods in fishing communities of the region.

Commercial fishing on mutton snapper has long occurred in the WECAFC region using boat seines, beach gill nets, set nets, hooks and lines with electric or manual winches, bottom longlines, traps and divers using spearguns. In Cuba, set nets were used in channels that congregated groups of migrating pre-spawners of several snapper species (Claro et al., 2001) just prior to the reproductive seasons. MS spawning aggregations were often heavily targeted by commercial fishers and contributed to around 50% of the total annual catch of the species in Cuba (Claro et al., 2009).

Recreational fishers target this species as a prized game fish typically by bottom fishing with medium or light equipment using monofilament or braided lines with lures or live/fresh/frozen bait. Whole or half sardines, small (2-3 inches) pieces of ballyhoo, crabs, shrimp and both rigid and rubber lures are among common baits. Spear fishing is also utilized in many countries. The species is prized in warmer Florida state waters and recreational fishing accounts for more fishing mortality in Florida than commercial or headboat fisheries (O'Hop et al., 2015).

Landings

Species-specific landings data are not available for the mutton snapper in most countries making it challenging to know the full extent of its landings or understand trends over time. The species is typically lumped into a general 'snapper' category in both landings and trade data. Following FAO (2018), only three countries report landings of this species annually and harvest is undoubtedly underestimated (Fig. 2.6). Moreover, landings data rarely include recreational catches for the species, which can be substantial in some countries and territories.

Though many countries only report data at the family level, when species-specific data are considered, mutton snapper can comprise a significant proportion of 'snapper' landings. Considering available information in the literature, it is likely that the species once produced at least 4,000-5,000 mt annually around the region and is, or once was, a highly lucrative and important fishery throughout the region.

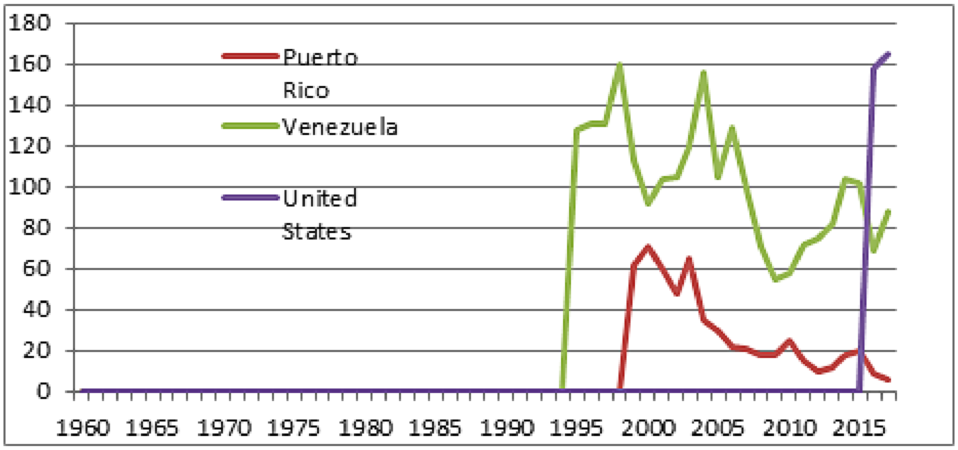

Figure 2.6. Mutton snapper landings (mt) reported to FAO 1960-2017. No reports were made prior to 1994 and no other countries report this species (FAO, 2018a).

National commercial catch levels for the biggest producers of the species have shown both declines and increases. Since the 1970s in Cuba, annual landings have varied from 800-1300 mt, peaking at 1,300 mt in the late 1980s and then dropping to about 600-700 mt in the 2010s (Claro et al., 2009; Claro and Valle, 2013). Highest annual catches were about 3,000 mt in Brazil in 2011 (representing about 30% of the 'snapper' landings by weight), an increase from 1,400 mt in 1998 (Caltabellotta et al., 2016).

Elsewhere in the region, annual national landings have generally shown declines of 50% or more across many countries. For example, commercial landings dropped from 69 mt in 2000 to 31 mt in 2005 in the U.S. Caribbean. On the Atlantic coast of Florida, coast and in the eastern Gulf of Mexico, recreational and commercial landings combined dropped from 829 mt in 1983 to 386 mt in 2013 while the commercial fishery peaked in 1989 at 164 mt and decreased to 29 mt by 2013, highlighting the importance of the recreational sector (O'Hop et al., 2015). In Venezuela, landings dropped from 160 mt 1998 to 88 mt in 2017 (FAO 2018a). For continental Caribbean waters (including Colombia) landings were 24 mt and 10 mt in 2006 and 2007, respectively (CCI-Min-Agricultura, 2007). In Belize, mutton snapper landings declined from 72 mt in 1977 to 38 mt in 2011 (Seaaroundus, 2016). In Nicaragua, landings increased from 6 mt to 29 mt from 2005 to 2015 (ADPESCA, 2001, 2005; INPESCA 2006-2016). More information on effort is needed in most countries to develop estimates of catch per unit of effort.

More data on both catch and especially effort should be collected regularly and at the species level for commercial and recreational sectors to assess the status of the species and enable adaptive management. Size of capture is also important to track with several reports noting that substantial proportions of the species were being taken as juveniles (Gobert et al., 2005) in Honduras and as bycatch in other fisheries, such as the Gulf of Mexico.

Stock assessments

In the U.S. South Atlantic and Gulf of Mexico the mutton snapper is considered a single stock centered in south Florida (O'Hop et al. 2015). In 2013, the SEDAR Update Assessment of mutton snapper concluded that the species was not considered overfished or to be undergoing overfishing. Despite declines from peak numbers, the stock is responding positively to fishing regulations (O'Hop et al., 2015). However, benchmarks for fishing mortality rate and stock reproductive biomass for mutton snapper in Florida showed estimated sustainability risks being high, at greater than 95% for both benchmarks (Ault et al., 2019).

A stock assessment of the commercial fishery of mutton snapper in the US Caribbean, focusing on Puerto Rico, was conducted in 2007 (using data from 1983 to 2005) and concluded that MS in federal and state waters are not overfished (Cummings, 2007). It was estimated that commercial landings went from 48.1 mt in 1983 to a maximum of 68.5 mt in 2000, dropping to 30.5 mt in 2005. However, reported landings in Puerto Rico are still poorly understood (Matos-Caraballo et al., 2008; Matos-Caraballo, 2012).

In Brazil, landings of snappers have decreased over the last decade in the northeast and southeast regions, while remaining steady in the north (Caltabellotta et al., 2016). For the northeastern coast, MS is considered to be overexploited at 20% above the recommended level and with potentially low resilience (Begossi et al*.,* 2012).

Considering the landings data, stock assessments, and the biological research literature, in various countries across the region, 50% or more stock declines have occurred for mutton snapper. Although for well-managed fisheries at Maximum Sustainable Yield (MSY) 50% of maximum biomass can be considered a conceptual fishery target (Caddy and Mahon, 1995), if aggregation fishing and catch declines continue, this could lead to biological overfishing or even collapse of stocks. More precautionary management is called for and this logically includes highly expanded conservation of important mutton snapper spawning aggregations.

2.2.4. Socio-economic value and trade

In many countries, the mutton snapper fishery is important domestically and in international trade for both industrial and small-scale sectors. The species supplies domestic markets with fresh and frozen fillets or whole fish considered to be of exceptional quality, often labelled (and priced) as "red snapper". In most Caribbean islands, mutton snapper, as several other high-value species, are typically sold directly to hotels, restaurants, and fish markets for local consumption, particularly when captured by commercial fishers. In Cuba "sport fishers" often sell their unreported catch totally or partially to private restaurants or directly to consumers (R. Claro, pers. comm. 2019). This trade sector is not well-documented by volume or fish size.

Data on exports at the species level are limited but export trade for 'snappers' to the US market is considerable (as determined by NOAA import data; https://www.st.nmfs.noaa.gov/commercial-fisheries/foreign-trade/) and comes from many countries in the region. While much of the international snapper trade is documented at the family (i.e. snapper) level, there are a few illustrative examples which point to the importance of mutton snapper in exports. For example, Cunha et al. (2012) found mutton snapper to be the tenth most abundant reef fish exported from Rio Grande do Norte, Brazil. However, lack of data at the species-level typically limits assessment of this species in domestic and international markets.

Chapter 3. FSAMP Objectives and Logical Framework

The FSAMP aims to achieve effective regional management to protect Nassau grouper (NG) and mutton snapper (MS) spawning aggregations through measures that address multiple issues considered in the ecosystem approach to fisheries. For instance, it proposes the management must promote the engagement of industrial and small-scale fishers, academics, resource managers and NGOs and prompts them to work collaboratively in education, research and monitoring, among other topics. Such national cross-sector and international collaboration can involve the expertise of the FSA WECAFC Working Group in close collaboration with other WECAFC Working Groups, such as the IUU Fishing, Fisheries Data and Statistics and Demersal Fisheries Working Groups, which are also dedicated to building adaptive and equitable management based on the available science and best practices in fishery management.

For maintenance of healthy FSAs, proposed management actions must move beyond considering only fishery-dependent factors and extend to climate change, biodiversity maintenance and ecosystem-scale considerations, all of which have direct implications for the stability of the targeted species 'natural populations and their long-term persistence. While more research is needed to better understand details of the biology and population structure of the two priority species and to further document the socio-economics and trade aspects associated with their fisheries, sufficient scientific and supporting information is already available for both species, and valuable lessons learned from specific case studies (Table 3.1), to identify and implement key regional management measures and counteract progressive declines in their natural population.

The 16 recommended actions in this FSAMP are based from in-depth analysis of the various management challenges and from analyzing lessons learnt from six countries having broad points of view which encompass EAF concepts as presented in Annex 4.

3.1. Logical framework

Six objectives were identified to improve regional management of spawning aggregations of Nassau grouper and mutton snapper (Chapter 1) and 16 management actions are proposed in the Logical Framework (Table 3.1). These consider the ecosystem approach to fisheries concept and the use of the precautionary principle while identifying opportunities for collecting the additional information needed to progressively fill identified knowledge gaps through research or by inclusion of traditional information/evidence.

The successes and failures in fisheries management, following the lessons from the case studies, highlight the importance of having:

1) long-term commitment/support from government along with clear management objectives,
2) consistent, clear and enforced legislation on spatial and/or seasonal management,
3) active engagement of multi-stakeholder groups, especially fishers,

4) good quality, long-term, regular and standardized monitoring to inform about the performance of the species, the outcomes of management and to aid planning, and

5) ongoing education and outreach on specific aggregations and on species that aggregate to spawn in general and their vulnerabilities.

Therefore, the proposed actions in this FSAMP are expected to guide regional stabilization and recovery from ongoing declines and prevent future declines of populations and fisheries of Nassau grouper and mutton snapper. They also provide guidance for managing other aggregating groupers and snappers in the Wider Caribbean Region (Annex 5).

Table 3.1. Logical framework matrix for protection of Nassau grouper (NG) and mutton snapper (MS) spawning aggregations

Objectives	Proposed actions	Indicators	Means of verification	Assumptions
I Increase the availability of information for and **understanding** of NG and MS population status **to build support** for FSA protection.	1. Generate and compile scientific and traditional information that highlights the importance of healthy NG and MS FSAs for securing the stability and productivity of their populations and the ecosystem services they provide.	- Increased number of public documents to improve the understanding of the importance of healthy FSAs in the Caribbean context. -At least 10 new documents integrating traditional knowledge aimed to promote FSA protection are produced in the next 10 years.	- Internet searches demonstrate increased documentation about FSAs. - Compilation of published and unpublished references available. Incorporation of agenda items on FSA protection in regional fishery management and conservation agendas	- Fisheries, academics and conservation agencies are committed to developing and disseminating technical information on the importance of healthy FSAs in the Caribbean. -Sufficient funding is made available to enable commitments to be fulfilled. This may involve a higher government priority, than exists at present, assigned to coastal fisheries and threatened species in general and to NG and MS in particular. Fishers and scientists develop trust and good communication.

	2. Promote and facilitate fisher participation in traditional information compilation to support regional / sub-regional FSA conservation strategies.	- Increase in number of events that include fishers in the promotion of FSA conservation in the Caribbean. - Increase in number of fishers supportive of FSA management and providing information on MS and NG. - Use of fishery dependent information to increase understanding of the importance of NG and MS FSAs.	Online and published reports denoting broad stakeholder participation. -Recognition in social media of the number of fishers supportive of better management and protection of NG and MS FSA.	- Fishers are interested in promoting the conservation of FSAs because they understand the critical role of successful reproduction in maintaining healthy NG and MS fisheries. - Governments, scientists, NGOs and other stakeholders support active participation of fishers in promoting the conservation of FSA.

II. To **determine the current status, abundances and location/timing of** known FSAs and identify those in most need of protection.	3. Define criteria to determine sites/countries at high risk of losing their NG and MS FSAs by considering ecosystem, biological, ecological and socio-economic elements and considering current known status of the species. Where no information is available, approach should be precautionary.	- List of indicators that can be utilized to determine the degree of risk for NG and MS FSAs using ecosystem, biological, ecological and socio-economic elements.	- Priority rankings produced for known NG and MS FSA sites and threat levels. -Thematic maps illustrating degree of risks of anthropogenic activities to known NG and MS FSAs.	- Government representatives, fishers, academics, NGOs and other stakeholders trust each other and so are willing to share information on NG and MS FSAs. - There is an agreement for the use of sensitive information on FSA, particularly regarding aggregation locations - Government staff and local fishers can work together to verify reported sites and prevent extinction events, while maintaining site locations confidential if appropriate.

	4. Map locations and timing of known NG and MS FSAs, pre-spawning migrations routes and determine their population status, using proper methods and fisher knowledge.	- Increase in number of known/exploited FSAs mapped and complemented with habitat characteristics and information on NG and MS population status. -Number of methods and technologies utilized in study NG and MS FSA increases or existing methods are refined. -In 10 years from the adoption of the regional FSAMP, all known NG FSAs will be spatially and/or temporally protected from extractive use.	- Technical reports summarizing results from research on NG and MS spawning aggregation dynamics, habitat characteristics and population status widely available. - Maps illustrating NG and MS areas/seasons, pre-spawning migration routes, fish abundance and habitat types.	- Scientists, NGOs and fishers work collaboratively. - Funding is made available to conduct interviews and data compilation, and field work to map and increase information on population status of targeted species.

III. To develop regionally consistent/harmonized **monitoring frameworks and protocols** to collect key biological, trade and other socio-economic information associated with NG and MS and NG, both during and outside of FSA seasons/areas.	5. Adopt and progressively implement regional monitoring frameworks to collect fishery dependent and independent data on a standardized, long-term basis.	- Number of protocols adopted at the regional level to monitor the performance of NG and MS both during and outside of spawning aggregation seasons/areas. - Protocols are translated into the three main Caribbean languages.	- Documents and online portals contain the regional monitoring frameworks on fishery dependent and independent data. - Fishery dependent and independent protocols are available in English, Spanish and French.	-Data collected on NG and MS follow the adopted protocols. - Regional protocols incorporate cost effective methods and are evaluated and updated periodically as needed. - Monitoring of FSAs and associated fisheries has regional political will. Protocols are easy to understand and translations are done properly.

	6. Develop effective national/sub-regional/regional alliances and protocols, to collect socio-economic and trade data associated with NG and MS fishing at/during FSA areas/seasons.	- Estimate the costs/benefits generated from fishing NG and MS FSA areas/seasons compared to fishing the same species in non-reproductive seasons/areas. - Socio-economic and trade protocols are developed and adopted. - Trade databases are established and/or improved at national/sub-regional levels. - Species identification of NG and MS products are improved to enable development of trade databases along with harmonized trade codes.	- Technical reports denoting cost/benefits analysis of fishing at and outside NG and MS FSAS. - Web portals and technical documents reporting on degree of socio-economic information and trade activities associated with NG and MS FSA. - Functional websites showing the trade databases. -Access to socio-economic databases with identification of NG and MS products. -Value Chain Analyses (VCAs) for NG and MS reports for key producer countries.	- Fisherfolk organizations collaborate with scientists and managers in gathering necessary information. Consumers and tourism sector will engage if relevant. - Training is received for improved identification of NG and MS products in trade (e.g. DNA testing, species identification). -Fisheries managers, conservation organizations, port and custom authorities, and health inspectors work collaboratively to identify and trace product and value of the NG and MS products in trade. - VCAs used to develop policy relevant to MS and NG for the economic benefit of producer communities and countries

	7. Countries expand commitments to counteract IUU fishing and include strong enforcement of management measures aimed to protect NG and MS FSA.	-Conduct regional enforcement workshops and protocols for dealing with IUU fishing at NG and MS FSA areas/seasons. -Compile existing regulations on NG and MS fisheries management and conservation supported at regional/sub-regional level. -Update existing IUU fishing agreements to incorporate special actions to protect NG and MS FSAs.	-Enforcement workshop reports available to the general public. -Web page compilations of NG and MS regulations. - Existing regional on IUU fishing plan incorporates aspects of NG and MS FSA.	- Countries are willing to develop mechanisms for improving control of IUU fishing of MS and NG FSA. Countries are committed to improve traceability of NG and MS products in trade as a way to reduce IUU fishing.

. To establish **coordinated mechanisms** for effective protection of FSAs from extractive use across the Caribbean region.	8. Promote the establishment of synchronized or harmonized regional closed seasons for commercial and recreational fishing for protecting NG and MS FSAs and safeguard their reproduction. Recommended seasonal closures: four months for NG (1 Dec. to 31 Mar.) and four months for MS (1 Apr to 31 Jul).	- Increase in number of countries with synchronized regional closed seasons for protecting NG and MS FSAs. - A voluntary moratorium for the entire NG fishery (until recovery is confirmed) for those FSAs identified in higher risk.	- Regional regulations or agreements adopting a synchronized closed season for protecting NG and MS FSAs. - Sub-regional agreements for establishing a voluntary moratorium (until recovery is confirmed) for FSAs of NG in higher risk. - Reports documenting signs of recovery in Nassau grouper populations within a decade.	- WECAFC and its Spawning Aggregation Working Group are effective in finding country support for establishing NG and MS closed seasons or a moratorium is proposed. -WECAFC is effective in securing NG and MS FSA protection under other international initiatives and organizations. - Countries are prepared to ensure enforcement of closed seasons.

	9. Countries develop and implement national plans to protect FSAs and aggregating species, starting with NG and MS.	- Increase in number of national plans aimed at conserving FSAs for targeted species, starting with NG and MS. - Improvement of country capabilities to extend protection at NG and MS FSA areas/seasons.	- Reports from technical guidance provided to countries for developing/improving their national FSA conservation and fisheries management plans. - National plans that incorporate existing information on NG and MS and apply the precautionary approach to overcome data gaps.	- Countries seek and welcome technical advice and are interested in developing their national conservation plans. - Universities and fisheries agencies commit to funding robust research programs and the progressive implementation of the plan. -Information is widely shared with a common goal of improving fisheries and reducing threats to NG and MS FSAs.

	10. Evaluate the effectiveness, applicability and benefits of current NG and MS fisheries management and the degree of protection their FSAs are receiving.	- Increase in number of evaluations of existing regulations affecting FSAs. -Quantify the benefits that NG and MS FSAs are receiving from current or need fisheries management regulations and actions.	- Technical reports on evaluations of existing regulations relevant to FSAs. Regular reviews and updates, as needed, of regulations	- Key stakeholders are willing to conduct impartial evaluations on existing regulations affecting FSAs. -Support will be available to assist activities identified as necessary for adaptive management, if identified in evaluations, or to participate in the oversight of the evaluation process. - Management Plan will catalyze the process of evaluation at the national level to ensure that regular evaluations are conducted

	11. Identify and implement viable alternative livelihood options for small scale fishers seriously affected by protecting NG and MS FSA, with priorities on countries with higher risk of losing FSAs.	- Number of regional initiatives or projects/programs addressing alternative livelihoods in connection with small scale fishers affected by restrictions on FSAs increases.	- Reports of implementation of alternative livelihoods prioritized. - Programs, timeframes and budgets of regional/sub-regional institutions developed for alternative livelihood options.	- Communities take an active role in protecting FSAs. - Communities work actively in finding alternative livelihoods for affected small-scale fishers who are willing to consider them. - Outside sources (NGOs, business) aid communities with alternative livelihood creation.
	12. Establish regional guidelines for conducting non-extractive use of NG and MS FSAs (e.g. tourism, research, education).	- Increase in number of guidelines for non-extractive uses of NG and MS FSAs (e.g. tourism, research, education).	- Printed or online publication of guidelines documenting the use of FSAs for non-extractive uses (e.g. for dive tourism, education or research)	- Scientists, managers, educators and tourism operators work collaboratively in developing and applying sound FSA-related practices. -The establishment and implementation of new regulations for non-extractive use of NG and MS FSA are conducted in a timely manner.

V. To significantly increase **awareness and engagement** among key stakeholders to enhance support for the protection of FSAs, with special attention to equitable benefits for local communities.	13. Develop marketing and awareness regional/sub-regional strategies/campaigns for the general public on the importance of healthy aggregations to maintain ecosystem services and socio-economic benefits, initially focused on NG and MS and in support of the FSA Working Group regional communication strategies.	- Number of regional/sub-regional campaigns developed to highlight the relevance of FSA increases. - Increase in the use of social media to promote conservation of NG and MS FSAs. - Increase in number of websites promoting productive populations of these two species. -Increase in online searches for NG and MS FSA topics.	- Increase in FSA campaign products and availability of information and outputs on the two species. Information made available on readily accessible websites and in other forms of media, which are regularly updated. - Reports that evaluate campaign success are produced.	- Countries are interested to promote healthy MS and NG FSAs and to understand their importance for fisheries and livelihoods from both extractive and non-extractive perspectives. - Management measures for FSA are, wherever possible, incorporated into or adapted from current national management plans and environmental planning -Websites utilize the best scientific available information, long with traditional knowledge.

VI. To integrate FSA protection into **broader planning and ecosystem-scale management** initiatives. .	14. Improve understanding of regional larval connectivity patterns.	- Development of connectivity indices for different FSA source areas based on coupled biophysical models and genetics, as applicable. -Conduct regional genetic studies to determine the degree of NG and MS larval connectivity	- Publications that provide new regional and sub-regional connectivity information. -Maps illustrating genetic larval connectivity for NG and MS.	- More funding is available to expand connectivity research efforts.
	15. Identify the possible spatial and/or temporal implications of climate change on the spawning processes of both species.	- Thermal tolerance indices and other measures of climate vulnerability are developed and tested.	- Publications that provide new information on climate vulnerability or modelling on FSAs of NG and MS.	- Scientists are able to combine efforts and resources. - Governments recognize this work as part of the EAF concept and are supportive.

	16. Increase NG and MS FSA protection by improving management of current MPAs or establishment of new MPAs where the conservation of FSAs is included in the objectives.	- Increase in number of existing MPA evaluated with respect to conservation of NG and MS FSA. - At least 5 new MPAs are established across the Caribbean focused on the protection of NG and MS FSAs in the next 10 years.	MPA management plans evaluated and updated to highlight the protection of NG and MS FSAs. -Legal declaration of at least 5 new MPAs established to increase protection of NG and MS FSA.	- Managers and MPA stakeholders understand the importance of protecting NG and MS FSA. MPA stakeholders collaborate in the evaluation and establishment of existing or new MPA management plans.

3.4. Guidance for proposed actions

To foster adaptive management, the 16 proposed actions (Table 3.1) comprising this plan are not organized chronologically or by priority order, and there is inevitably some overlap; many should be initiated soon and run concurrently. They are based on the best scientific information available, are intended to be achievable, consider the EAF approach, and focus on the urgency to protect the FSAs of Nassau grouper and mutton snapper, and by extension, the fisheries that these support. Addressing these issues is also in line with commitments under SDG 14. To better understand the importance and intent of these proposed actions and the need for their effective implementation, each of the 16 actions is given below accompanied by a justification with associated guidance.

1. Generate and compile scientific and traditional information that highlights the importance of healthy NG and MS FSAs for securing the stability and productivity of their populations and the ecosystem services they provide.

Justification: In the Caribbean, decisions regarding fisheries often have insufficient involvement from, and understanding of key issues by, different stakeholders. The participation of and support from diverse stakeholders, especially those directly impacted by declines in fisheries or by their management, is important to achieve practical and acceptable solutions. Even though there is not yet a full understanding of many biological and ecological processes of the two targeted species, and despite remaining information gaps, existing scientific information and management experience in the region is already more than sufficient to improve management actions and to integrate FSA-related issues into multiple agendas. Better understanding of and support for conservation of species reproduction may require the inclusion of traditional information, which calls for active engagement and involvement of fishers and their willingness to share their experience and knowledge about FSAs. Compilation and generation of relevant information is a pre-requisite for understanding complex and vital processes. Hence, the expression of technical documentation, language and concepts in simple words is essential for success.

Guidance: Utilize expertise within the WECAFC FSA Working Group, and beyond, to promote understanding and integration of FSA-relevant issues within existing fisheries and conservation practitioner networks for those who depend on healthy FSAs. Simple and consistent messages based on the best available scientific information and the integration of newly collected traditional information deserve to be disseminated to contribute to improvement in understanding the importance and benefits received from protecting key population key processes, especially reproduction. Educational and outreach specialists, can contribute their support for effective conservation strategies. Dissemination of information can increase public and stakeholder support through access to technical reports, social media, and more inclusive messaging tools. Any information utilized for improving management of NG and MS spawning aggregations needs to be integrated into the recently adopted "Regional Communication Strategy for Fish Spawning Aggregations Conservation and Management".

2. Promote and facilitate fisher participation in traditional information compilation to support regional / sub-regional FSA conservation strategies.

Justification: Fisher's knowledge and experiences in fishing NG and MS FSAs are often key for reconstructing historical trends, understanding the intensity of fishing effort and estimating aggregation captures. Information is also needed from fishers who catch the NG and MS outside of the spawning season (and hence outside of aggregations) to better understand the contribution of healthy spawning aggregations for supplying fisheries more broadly; this is important from an equity perspective and could allow more fishers to have access to these resources year round. Therefore, the active involvement of, and understanding by, fishing communities in all aspects of regional management intended to protect the sacred FSA processes (reproduction) to sustain their fisheries is crucial. While direct users of these resources are particularly important for taking an active role in the regulatory process for FSAs, their support for increasing conservation of population recovery mechanisms, in general, is also vital for integrating ecosystem concepts in the management strategies and for equity considerations, and must be represented.

Guidance: Secure and expand opportunities for deep involvement of fishers in providing information on the fishery history and current status of NG and MS FSAs, participation in data assessment and development of management recommendations. Fishers need to work alongside managers, scientists and NGOs and therefore dedicated training to enable this involvement may be necessary. Acknowledgement of the importance of traditional knowledge and its integration with science and modern resource management concepts, such as EAF, is needed to increase trust among these sectors and ensure effectiveness of management measures (Fischer et al., 2015). Mechanisms for sharing data and experiences should be established from the very beginning of this process and fishers that exploit both species both during and outside of aggregation periods should be engaged.

3. Define criteria to determine sites/countries at high risk of losing their NG and MS FSAs by considering ecosystem, biological, ecological and socio-economic elements and considering current known status of the species. Where no information is available, approach should be precautionary.

Justification: NG and MS spawning aggregations occur throughout much of the Caribbean region and are subjected to varying levels of fishing pressure with some FSAs at higher risk of overfishing than others (this is because of the species, the location, the prevailing fishing pressure or the fishing history). Areas with large shallow coastal platform areas, for example, are likely to hold a larger proportion of total species abundance and, hence, to be particularly important for the management and conservation of both species. To better address risks at the level of the FSA, research is also needed to determine whether there are critical thresholds (i.e. minimum number of fish for sufficient reproduction to maintain populations large enough to support fisheries) for aggregation sizes, as well as understand population structuring, connectivity, and possible species 'responses to changing environments, such as due to climate change. It is also important to determine the indicators of conservation effectiveness of management measures, the extent and role of stakeholders in management and the scope for, and application of, precautionary and adaptive FSA management.

Guidance: To better identify those FSAs in higher risk, a set of criteria should be agreed upon among users, scientists and managers. These criteria need to include not only bio-ecological components, but also geographical and socio-economic elements at the relevant temporal and spatial scales. Inclusion of uncertainty at every step must be considered, such that guidance on how to act with more urgency at some sites than others (for example if a new threat arises or fish numbers in FSAs drop too low) should ultimately become clear and objective. Identification of risk criteria is the joint responsibility of all stakeholders interested in the sustainability of NG and MS fisheries. The production and generation of thematic maps can be great tools for defining the areas at greatest risk, and are thus in more urgent need of action.

4. Map locations and timing of known NG and MS FSAs, pre-spawning migrations routes and determine their population status, using appropriated methods and fisher knowledge.

Justification: The spawning sites and times of NG and MS, as well as migration routes of pre-spawners in some locations are known in parts of the WECAFC region, with those of the NG better understood overall. However, spawning aggregations are dynamic and can vary through time depending on several factors, including FSA status (number of fish present and fishing pressure) and environmental conditions (changes in current patterns, water temperature, etc.). Therefore, improved understanding of locations of aggregations and spawning seasons for both species would help to determine or fine-tune management measures, and to assess the suitability and feasibility of spatial versus temporal protection. For example, temporal protection (usually implemented together with sales/possession bans) is appropriate when individual sites might be too distant from shore and so too difficult to protect on-site. Temporal measures would also help to protect undiscovered aggregations without the need to determine where they are. Often, both temporal and spatial measures might be needed.

Guidance: Sub-regional and regional fisheries management bodies, scientists, fishers, NGOs and other stakeholders can work collaboratively to unite the human, technical and financial resources needed for better understanding of Nassau grouper and mutton snapper spawning aggregation locations and times. The collection of information could be broad and may incorporate different methods and technologies, ranging from semi-structured interviews with fishers to sophisticated instruments and protocols and state-of-the-art technologies. Fishery-independent field studies and desk-top review of existing literature and reports can also contribute important information to further supplement what is known for NG and MS FSA.

Underwater or fishery surveys at reported aggregation sites are particularly needed to validate and update/collect information on the current status of known or reported/suspected sites for management and planning purposes. Deeper sites (beyond diving depth) can be surveyed using remote active or passive technologies.

Mapping efforts and determination of spawning seasons should begin at the national level and be scaled up through regional cooperation mechanisms and collaborations, with all available technologies applied. Special budgets for this work need to be factored into current fisheries and conservation funding plans or achieved through special funding mechanisms. Efforts to locate new FSA locations should not be prioritized, both because undescribed aggregations are currently protected by virtue of being unknown, and because such research has 'provoked spawning aggregation focused fisheries '(van Baren, 2013; Tulloch et al., 2018).[1] Efforts to assess known aggregations must be the top priority. Temporal protection measures can further protect such sites, if any, and are particularly appropriate for FSAs generally because spatial data are not needed for seasonal protection. In this way, mapping becomes an essential tool for communicating NG and MS FSAs, and to demonstrate the usefulness of sharing data.

5. Adopt and progressively implement regional monitoring frameworks to collect fishery dependent and independent data on a standardized, long-term basis.

Justification: Long-term and standardized monitoring data on NG and MS abundances, body sizes, behaviors and movement patterns (i.e. migrations to and from spawning areas) over time are important for understanding population responses to increasing threats leading changes over time and also responses to management. In addition, habitat type and other environmental characteristics associated with spawning areas may be important. However, currently, with a few notable exceptions, these data are absent or lack necessary statistical rigor. In order to have comparable data on a regional scale and in the long-term, it is advisable that protocols are consistent and collected on a regular and standardized basis.

Guidance: The various WECAFC Working Groups including FSA, Fisheries and Resources Monitoring System, IUU Fishing and Demersal Working Groups can work collaboratively to improve and standardize the collection of fishery dependent and independent data. Collection of such data, together with environmental parameters (water temperature, pollution, etc.) can be achieved using existing protocols, integrated into existing national or regional monitoring efforts and by incorporating stakeholder participation. Countries should be encouraged to introduce regular data collection initiatives, where these are currently lacking. Strategies to maintain or increase collaborations and the sharing of data, and regarding agreements on sub-regional guidelines for the development of activities at or around FSA sites, for example tourism infrastructure, should also be considered. Collaboration and integration of work could also increase overall efficiency and make best use of available resources and capacity. Tools to provide

[1] Based on a decision tree by Tulloch et al. (2018) it is considered that the NG and MS are at risk of exploitation due to their economic value, that knowledge of location data could provide fishers with a known fishery target, that conservation/policy mechanisms are not in place in most cases to effectively protect known aggregations, and if in place, are rarely effective currently. Knowledge of a new site (at least in the short term) would not on balance help to protect it in the absence of sufficient management.

guidance in developing protocols have been developed and could be further elaborated to suit national and regional needs[2].

6. Develop effective national/sub-regional/regional alliances and protocols, to collect socio-economic and trade data associated with NG and MS fishing at/during FSA areas/seasons.

Justification: Currently, few data are available to determine the full extent of the food security value and economic importance of NG and MS derived from either (a) fishing at spawning aggregations, and/or on their migrations to spawning sites, or (b) their fisheries outside of the aggregation periods. Of the information that exists, it typically only provides minimal estimates of overall value since much of the volume of these fisheries is not reported to species level, if at all. Understanding economic value is necessary for assessing research and management priorities and for recognizing the socio-economic importance of species, both during and outside of FSAs, and for both commercial and recreational uses. Identification of local communities with high economic dependence from fishing these two species on their aggregations, as well as at other times, and understanding their role in the value trade chain of these species is important for gaining support for conservation and for improving the performance of these fisheries and benefits to fishers.

Because so few economic data are collected on these species in much of the WECAFC region, their value, or potential value if recovered, is not widely recognized, as judged by the lack of commitment in most countries to their management. Historic information indicates that healthy NG and MS fisheries can yield thousands of tons and millions of USD annually, in line with other highly valued resources such as spiny lobster and queen conch. Given the fact that exploitation of the NG and MS spawning aggregations began a long time ago, and that marked declines have occurred in NG in recent decades, it is possible that perspectives of what is a healthy and productive FSA can substantially differ between younger and older generations ('shifting baseline' concept; Pauly, 1995).

Trade in Nassau grouper and mutton snapper is difficult to track for several reasons: a) it not always possible to identify the products in trade, b) it is difficult to determine the legality of origin, c) trade may happen at sea, escaping all controls which operate mostly on land, d) landings at multiple small ports or deliveries directly to hotels/restaurants may circumvent monitoring and reporting, among other reasons, and e) trade chains may be difficult to identify and document. Information is needed on the volumes and commercial values of these commodities at the national level (domestic use) and as exports. As just one example, exports or imports of the

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[2] Manual for studying and conservation for reef fish spawning aggregations developed by Science and Conservation of fish Aggregations
https://www.researchgate.net/publication/228436345_Manual_for_the_Study_and_Conservation_of_Reef_Fish_Spawning_Aggregations or go to SCRFA website (www.SCRFA.org).
Protocol developed by the Belize National Spawning Aggregation Working Group for the Mesoamerican reefs and the Wider Caribbean (http://www.spagbelize.org/).
Sherman K.D. and Dahlgren C.P. 2019.

Nassau grouper and mutton snapper are typically not documented to species level; just labelled as ‘snapper ’or ‘grouper’.

Guidance: Collection of socio-economic data, ranging from fishing communities and all along the trade chain to the retail sector, derived from Nassau grouper and mutton snapper, considering both extractive and non-extractive uses during aggregation and non-aggregation seasons is needed. By working directly with fishing communities, costs/benefits associated with aggregation fishing can be determined and compared to accrued to the wider fishing sectors (i.e. outside of aggregations); in some cases, this will involve the tourism sector. It is recommended that existing national and international organizations dedicate time and effort to support the collection of the necessary data to better understand and appreciate the broad social and economic importance of these species in the region. Once data are available, significant improvements in NG and MS management are possible and expected.

To effectively document trade networks, the active involvement of fishers, business operators, and retailers, and, in some cases, customs and health authorities is needed. Trade networks are often sophisticated and not well-understood, thus requiring special personnel and programs to be in place. Existing examples developed for other marine species can be analyzed, adapted and/or adopted[3]. Some specific measures could be more widely adopted, such as ‘skin-on ’ requirement (in place in Belize and The Bahamas). The role of exports in increasing fishing pressure and the benefits of exports to source countries, using Value Chain Analyses, could also be examined. Hotels and restaurants could be approached to provide data on deliveries of the species that go directly to these outlets, while export companies should be reporting their trade by species. The recreational sector should be included in these analyses since some sports fishers sell their fish.

7. Countries expand commitments to counteract IUU fishing and include strong enforcement of management measures aimed to protect NG and MS FSA.

Justification: Improvement in NG and MS FSA management will be effective only if the region can work collaboratively in overcoming resource limitations and other difficulties associated with enforcement current/future management regulations. Regional and sub-regional initiatives are currently in place aimed at improving the control of IUU fishing. However, there is a need to ensure that the health (functional reproductive status as determined by sufficient adults gathering to spawn annually to maintain fisheries and enable recovery of depleted numbers) of NG and MS FSAs should be included in these initiatives. For that additional work is needed.

[3] examples of VCA fishery analyses
1. Rosales et al., 2017; https://www.sciencedirect.com/science/article/pii/S0308597X17300908
2. DeSilva, 2011
3. Sadovy de Mitcheson et al. 2018
https://www.researchgate.net/publication/328772613_Value_Chain_Analysis_of_the_Fiji_Grouper_Fishery

Guidance: The FSA Working Group should join efforts with other WECAFC Working Groups to work towards the inclusion of more effective control of IUU fishing at FSA areas/seasons in strategies being regionally developed. Such collaborations need to be clearly identified and protocols should be in accordance with existing international legal frameworks. In addition, fisheries managers need to explore various strategies to obtain relevant information and more participation is needed to counteract illegal trade, including that associated with restaurants, consumers, fishers, port authorities, and health inspectors, among other stakeholders. All these aspects require that special revisions are contemplated in existing regional and sub-regional initiatives to counteract IUU fishing, among them the improvement of traceability of NG and MS products in trade as a way to reduce IUU fishing.

At present, WECAFC has developed a "Regional Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated (IUU) fishing (RPOA-IUU)" which was adopted at its 17th Session in July, 2019. This 10-year plan proposed 28 actions to combat IUU fishing in the Caribbean region immersed in four main aspects: (1) policy and legal framework; (2) operations and monitoring, control and surveillance (MCS); (3) regional cooperation and information-sharing; and (4) capacity development. Unfortunately, having majority of the countries with no regulations in place to protect NG and MS FAS, effective actions to counteract IUU fishing at FSA sites need to expand the existing collaboration to tackle specific requirements and demands governing the successful reproductive process of these two species.

8. Promote the establishment of synchronized or harmonized regional closed seasons for commercial and recreational fishing for protecting NG and MS FSAs and safeguard their reproduction. Recommended seasonal closures: four months for NG (1 Dec. to 31 Mar.) and four months for MS (1 Apr to 31 Jul).

Justification: Nassau grouper and mutton snapper spawn over different, two to three month periods, that are species-specific and consistent throughout most of the WECAFC jurisdiction (different between species but consistent within species). Synchronized regional closed seasons to protect the spawning aggregations of these species would significantly contribute to reductions in overall fishing mortality. They would also help to ensure successful reproduction each year for population replenishment or recovery. A synchronized approach would greatly facilitate the planning of monitoring and patrolling needed to counteract illegal fishing (including cross-border) and should lead to increased catches across the region over time by improving overall population resilience and connectivity. In this connection, the WECAFC 17th meeting in 2019 recommended to adopt a regional seasonal closure for all commercial and recreational fishing of Nassau grouper (*Epinephelus striatus*), at least for the period 1 December – 31 March (April where relevant) and for members not to permit export or commercial sale of Nassau grouper or its products (e.g. roe, fillets) for the duration of the seasonal closure. Currently, there is not one regional recommendation in this regard with respect to the MS FSA.

Guidance: The adoption of species-specific closed seasons at regional or sub-regional levels can be achieved through existing fishery regulatory bodies. The seasons can be adjusted in response to improved understanding of variability in spatial/temporal patterns following adoption and implementation of this FMP. A synchronized approach would greatly facilitate the planning of monitoring and patrolling needed to counteract illegal fishing (including cross-border) and should lead to increased catches across the region over time by improving overall population resilience and connectivity. Special protocols should be developed to enforce such regulations among sub-regions. Regulations also need to consider incidental catches of the two focal species by determining acceptable levels of incidental take (i.e. if they are not the target species but can be taken as bycatch). As an example, in the Cayman Is. fishing on protected NG spawning aggregations is permitted but NG must be released. Strategies need to be put in place to mitigate possible impacts. For example, mortality estimates of released fish would be useful to determine the impact of incidental fishing.

Following the Precautionary Principle, for the critically endangered Nassau grouper, a regional seasonal closure for all commercial and recreational fishing activities for the period 1 December – 31 March (April where relevant) is recommended. For the near threatened mutton snapper, a closure for the period 1 April – 31 July as a starting point for the most overfished aggregation areas, is also recommended. Such closed periods could also aid protection of migrating pre-spawning fishes which can be heavily fished and removed before they even reach the spawning site. The specific dates (and areas for the mutton snapper) can be adjusted in the future as additional data become available. Commercial trade of these species during closed seasons should be banned to assist enforcement.

Considering the need for stronger action to recover and safeguard NG natural populations, it is also recommended that those countries at higher risk (suspected or documented poor condition of NG populations) consider to voluntarily advance a complete moratorium of its NG fishery, until recovery can be confirmed.

9. Countries develop and implement national plans to protect FSAs and aggregating species starting with NG and MS.

Justification: To implement this FSA regional fisheries and conservation plans for Nassau grouper and mutton snapper effectively, fisheries authorities and other relevant stakeholders must develop national management plans, which include strategies for ministerial endorsement, and implementation and enforcement of the proposed management actions by fisheries departments and other authorities. To increase buy-in by stakeholders at national levels, the planning process should be comprehensive and include not only conservation strategies, but also recommendations regarding non-destructive fishing gears and methods during non-spawning seasons/sites.

Guidance: National plans complement actions at the regional level and are required to guide resource management and users towards sustainability among countries with different regulatory frameworks but which are linked by shared fish stocks. Regional and national plans shall have joint goals, measures, and application of an Ecosystem Approach to Fisheries, to create buy-in and ownership and to ensure implementation after the planning phase. National management plans will benefit from guidelines given in this regional FSA Fisheries Management and Conservation Plan. Fisheries managers at national level would benefit from guidance by various WECAFC Working Groups, including for instance the FSA, Fisheries and Resources Monitoring System, Demersal Fisheries, and IUU Fishing WGs. In this way, it is expected that planning at the national level is comprehensive, utilizes existing data, and applies precautionary and EAF approaches to fisheries.

10. **Evaluate the effectiveness, applicability and benefits of current NG and MS fisheries management and the degree of protection their FSAs are receiving.**

Justification: Caribbean fisheries are being regulated by many different bodies and instruments and sometimes this can lead to confusion, or to regulations that are inapplicable or that do not result in the sustainability of the target exploited resource. Because relatively few data are available on the outcomes of protection for NG and MS aggregations it is difficult to determine the effectiveness of current regulations in maintaining their populations (although for exceptions see Table 4.1), and there are many places that lack regulations entirely. Consequently, scientists and managers are often unable to consider the impact of fishing on spawning aggregations of snappers or groupers when establishing management regulations. Available statistics on aggregation status, catch data, national and international trade, if available, are of poor species resolution for the grouper-snapper complex in general, and so determination of the sustainability of the two target species is associated with a high degree of uncertainty. Nonetheless, despite lack of data in many places, it is well-established that overfishing quickly depletes spawning aggregations, will compromise the fishery, and must be avoided.

Guidance: Newly developed regulations are needed for many NG and MS FSAs and should be based on a better understanding of their populations, with specific attention paid to reproductive potential (i.e. the capacity to produce viable offspring as determined by number of spawners, sex ratio, and age at maturity, fecundity related to body size, etc.) in targeted populations. Case studies (Table 4.1) clearly indicate factors that can increase and have increases the chance for successful management and can be used for management guidance. Additional legal support may be required to address special topics within countries and at the regional level. Quantitative evaluations of existing or new regulations need to be conducted utilizing quantitative metrics and indices to reduce subjectivity and achieve the needed protection of the FSA aggregations for NG and MS.

11. **Identify and implement viable alternative livelihood options for small scale fishers seriously affected by protecting NG and MS FSA, with priorities on countries with higher risks of losing FSAs.**

Justification: Identification of alternative livelihoods is necessary for those communities traditionally fishing for snappers and groupers as their main source of family income. A viable livelihood alternative should consider the cultural aspects of those communities, maintain linkages with the ocean and active involvement with the conservation strategies to promote the species recovery. Currently, most alternative livelihoods in the region depend on specific projects that are short-term or apply only to limited geographic areas. Hence an increase in livelihood options acceptable to fishers is needed with a long-term commitment.

Guidance: Analyze the costs/benefits of alternative livelihoods in the region and ensure that future initiatives specifically address affected traditional fishers. Additional financial resources for developing viable and acceptable livelihoods may require the integration of initiatives within and between countries as well as innovative approaches for income generation in the long-term, as well as risk reduction. Political will at national and regional levels for the development and implementation of new alternative livelihood options and the active engagement of affected traditional fishers should begin early in the process. Alternative livelihoods should look at fishery-dependent activities first and then at fishery-independent ones, in-keeping with cultural values and experiences, while generating sound sources of family income. Priority should be given to those countries with FSAs at higher risks and hence in greater need of management as well as to local communities that would be seriously affected by an increase in conservation measures.

12. Establish regional guidelines for conducting non-extractive use of NG and MS FSAs (tourism, research, education).

Justification: With increasing tourism, both local and foreign, into the marine environment across the Wider Caribbean Region, the potential for gaining benefits from non-extractive use of NG and MS FSAs is promising. However, even non-extractive activities would need to be controlled because they could potentially disturb successful reproduction, the main purpose of protection. It would therefore be necessary to consider the promotion of non-extractive uses of Nassau grouper and mutton snapper FSAs, if applicable, in parallel with the development of protocols/guidelines to ensure that reproduction is not affected. Also, attention should be paid to ensuring that business / education / research initiatives consider and strive to guarantee equitable distribution of benefits. Safety considerations should be part of the protocols with experiences from aggregation-tourism outside the WECAFC region being used as guidance.

Guidance: A multidisciplinary team can be established to work on adapting existing guidelines for nature observers who visit FSAs and which can also be applied in remote and offshore places where FSA sites are located, thus offering an opportunity for increasing income, research, and community participation in conservation and tourism, as well as considering safety issues. Such guidelines should clearly consider aspects of carrying capacity of visitors/researchers/educators, safety at sea, and data registry.

13. **Develop marketing and awareness regional/sub-regional strategies/campaigns for the general public on the importance of healthy aggregations to maintain ecosystem services and socio-economic benefits, initially focused on NG and MS and in support of the FSA Working Group regional communication strategies.**

Justification: For successful management of fisheries and, in particular, for safeguarding spawning aggregations, a key factor is wide support for and understanding of their importance to society. Such understanding is important not only for those who fish them but also for the wider public to highlight the need for legislation and protection. However, despite several excellent national-level education initiatives already in place for Nassau grouper, including several widely distributed films, there remains much need within the region to create public awareness about both NG and MS, their aggregations, their fisheries, and related environmental and conservation issues. Experience to date with other aggregating species, both within and outside the region, has shown that education/outreach can be a key factor in the success or failure of conservation and/or management efforts. Regional initiatives in this regard are now being drafted. Thus, management planning and communication initiatives need to be integrated to the greatest possible extent. In addition, there are national communication strategies/campaigns that can perhaps provide additional elements and perspectives/approaches to better meet the fisheries management and conservation goals applicable to NG and MS FSA.

Guidance: FSA Working Group will support a five-year tri-lingual strategy regional Communication Strategy for Fish Spawning Aggregations Conservation and Management in the Wider Caribbean named "Recovering Big Fish". It is recommended this strategy contains the following aspects: 1) technical information to increase understanding of the importance of safeguarding the spawning aggregations of Nassau grouper and mutton snapper for long-term food and income benefits from the fishery as a whole (i.e. not just from fish caught at aggregations but including the young produced by healthy aggregations and that supply fisheries outside of spawning periods); 2) highlight the importance of data collection, scientific analysis, research, training, and capacity-building; 3) explain to inspectors/enumerators the purpose for and use of the data collected and why data must be accurate, standardized and collected long-term; 4) increase awareness among fishers and processors around the roles of Nassau grouper and mutton snapper in the ecosystem and the impact of fishing and market demand on their sustainability; 5) teach law enforcement officers and judiciary of the importance of compliance and legal fishing for fishery sustainability and the threats from IUU; 6) explain the importance of preserving 'megaspawners '(particularly large females that produce a disproportionately large number of eggs), and 7) teach school children and the general public about the need for protection and conservation of marine resources and the particular importance of spawning aggregations for sustaining populations. A ListServe or other dedicated online platform for information exchange would be valuable for making data and educational materials readily and widely available.

In addition to the regional and sub-regional existing web-pages that can support any awareness activities, other national and international initiatives can offer support in this regard, including the following interdisciplinary groups/web pages:

- Science and Conservation of Fish Aggregation through https://www.scrfa.org/
- Belize National Spawning Aggregation Working Group through http://www.spagbelize.org/
- Fish Spawning Aggregations in the Gulf of Mexico through https://geo.gcoos.org/restore/
- FishSpawn list-serve through FISHSPAWN-L@LISTSERV.GCFI.ORG available at www.gcfi.org
- Lenfest Ocean Program, Protecting Nassau Grouper Spawning Sites Project through https://www.lenfestocean.org/en/research-projects/protecting-nassau-grouper-spawning-sites
- Grouper Moon Project of the Reef Environmental Educational Foundation available at https://www.reef.org/programs/grouper-moon-project-protecting-caribbean-icon
- Beluga Smile Productions, through
- https://www.facebook.com/BelugaSmile/videos/484812248726185/
- The Fin Foundation through https://thefinfoundation.org/critter-corner/nassau-grouper
- The Perry Institute through http://www.perryinstitute.org/what-we-do/fishery-research-and-conservation/

14. Improve understanding of regional connectivity patterns

Justification: Given the broad distribution of Nassau grouper and mutton snapper and the existence of multiple FSA sites in various countries, the potential for transboundary connectivity of adults at FSAs and early larval stages of these species is high, and remains poorly understood. Processes happening in one country can have a direct impact on neighboring ones, and so affect the entire fishery of specific stocks or sub-populations. There is need to study in greater detail these connectivity patterns at broad geographic scales and their relationship(s) with adult abundance dynamics over time to adjust management strategies accordingly. Changing environments (climate change, pollution, etc.) can result in unexpected variations in connectivity patterns (sites/seasons) that need to be addressed adaptively. Variations can be experienced even within a country or territory, supplementing sites that can be several tens of kilometers apart (Esteves Amador, 2005).

Guidance: Scientists in the region can develop and implement a dedicated project looking at improving understanding of the connectivity patterns at regional scales needed for providing technical advice on FSA conservation and fishery management. Up-to-date genetic, ecological and oceanographic techniques and tools can be utilized to fulfill these objectives. This work demands coordination and collaboration of scientists, managers and fishers across the Caribbean region.

15. Identify the possible spatial and/or temporal implications of climate change on the spawning processes of both species.

Justification: Climate change can directly impact the physiology, growth, reproduction, behavior and survival of marine organisms, and consequently increase threats to already decimated populations. Reproductive seasons could be particularly susceptible to warming ocean waters, and may result in shifting spawning sites/seasons, alter sensory systems of pelagic larvae, or affect food supplies, increasing uncertainty in conservation and fisheries management approaches. Similar results may come from an increase in hurricane intensity and frequency that climate change is already likely causing in the Caribbean. Dedicated research and adapting management strategies shall be considered.

Guidance: Regional organizations need to join efforts to implement a special project aimed at considering and accommodating possible impacts of climate change on Nassau grouper and mutton snapper FSAs, create opportunities where scientists, resource managers and fishers can work collaboratively and help in sourcing the financial resources needed to accomplish these objectives. More integration of dispersed resources, allocated to better understand the impacts of climate change on FSAs, is also urgently needed.

16. Increase NG and MS FSA protection by improving management of current MPAs or establishment of new MPA where the conservation of FSAs is included in the objectives.

Justification: MPAs can contribute to the improvement of conservation of Nassau grouper and mutton snapper FSAs, thus it is worthwhile to assess whether existing protected areas are already providing benefits. Unfortunately, not all MPAs have been effective in protecting FSAs of Nassau grouper and mutton snapper because they are either not adequately enforced, not specifically for no-take, or do not incorporate enough habitats for securing functional bio-ecological processes (Appeldoorn and Lindeman, 2003; Schärer-Umpierre et al., 2014). Thus, measurable goals and metrics are needed to better determine MPA effectiveness in fulfilling the conservation goals for which they were declared. Despite of the high variability of MPA effectiveness in conservation, there are positive examples where fishermen perceive MPAs to have reversed negative fish abundance trends, as in the case of Puerto Rico (Griffith et al., 2007).

Guidance: It is recommended to call attention to the UN Environment – CEP and the SPAW Protocol Secretariat to prompt them to lead an evaluation of the existing conservation instruments and strategies in relation to their effectiveness for achieving protection of the NG and MS FSAs. Special attention must be paid to the NG as a critically endangered species included on the SPAW protocol. These bodies can also promote the inclusion of FSAs as a relevant criterion when planning for the establishment of new MPAs, or when considering the extension/adjustment of existing ones. In addition, experiences of management at the national level, as gained by The Bahamas, Belize, Mexico and the US, can be utilized to improve management planning and the establishment of new MPAs and to find ways to secure the necessary funding for these activities. The elaboration of specific guidelines to evaluate the performance of existing or new MPAs in conserving FSA of Nassau grouper and mutton snapper is highly recommended.

Chapter 4: Adoption and Implementation Strategy

The Regional Fish Spawning Aggregation Fishery Management and Conservation Plan presented here summarizes the rationale and proposes 16 specific actions within 6 objectives to protect Nassau grouper and mutton snapper spawning aggregations in the Wider Caribbean region.

4.1 Implementation strategies and monitoring

Strategic considerations for implementation of each of the 16 proposed management actions comprising this FMP are summarized in Table 4.1 and Figure 4.1.

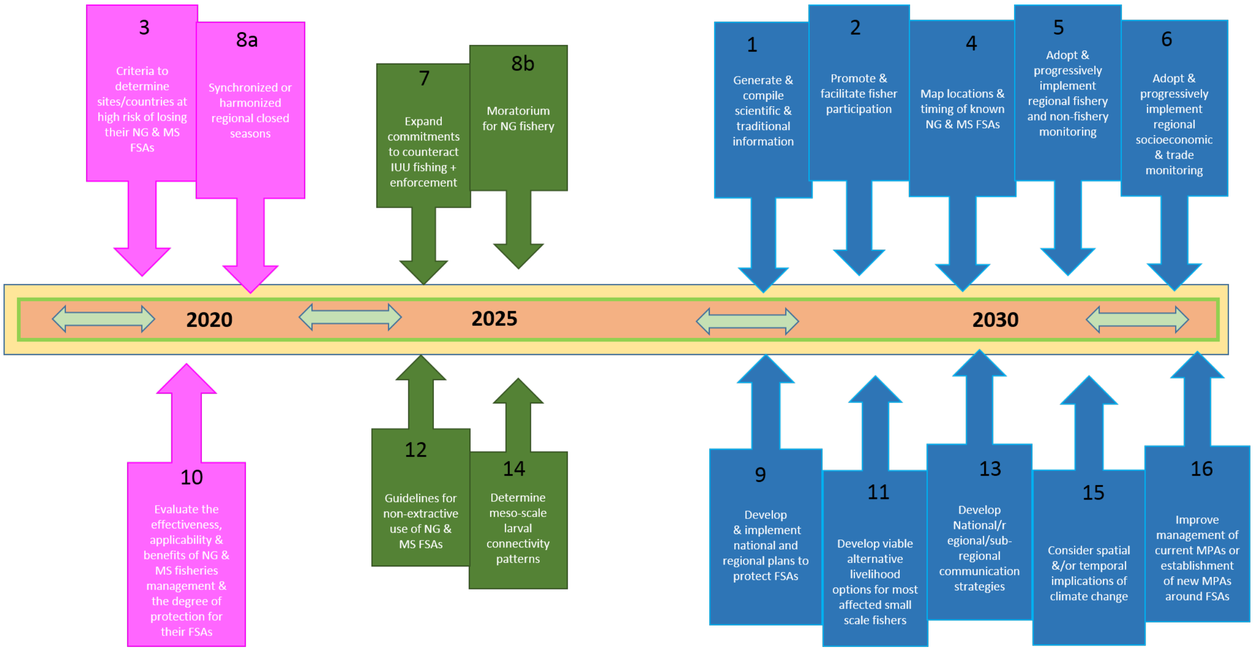

Figure 4.1. Timeline of proposed actions to protect Nassau grouper and mutton snapper spawning aggregations.

Table 4.1. Strategy for implementation of the Regional FSA Fisheries Management and Conservation Plan

Objective	**Management action**	**Expected outputs**	**Current state**	**Responsible**	**Execution period years**
I Increase the availability of information for and **understanding** of NG and MS population status **to build support** for FSA protection.	1. Generate and compile scientific and traditional information that highlights the importance of healthy NG and MS FSAs for securing the stability and productivity of their populations and the ecosystem services they provide.	- Compilation of simple and consistent messages, dissemination of scientific research and analysis of case studies documenting depletion, stabilization or recovery of NG and MS FSA. - Documentation generated will be provided to the Communication FSA Working Group Communication Sub-Committee for further use.	Deficient	- FSA Working Group and sub-regional organizations (Table 2.2) assisted by educational and outreach specialists.	1-10
	2. Promote and facilitate fisher participation in traditional information compilation to support regional / sub-regional FSA conservation strategies.	- Trained fishers support FSA conservation strategies based on data generated by scientists and fishers.	Incipient	- FSA working Group, sub-regional organizations, other NGOs, scientists and government fisheries and conservation managers.	1-10

II. To **determine the current status, abundances and location/timing of** known FSAs and identify those in most need of protection.	3. Define criteria to determine sites/countries at high risk of losing their NG and MS FSAs by applying EAF and considering current known status of the species. Where no information is available, approach should be precautionary.	-Set of criteria to determine degree of FSA risk based on bio-ecological, geographical, socio-economic, bathymetric and habitat components. Criteria need to encompass processes at temporal and spatial scales. Inclusion of uncertainty at every step must be considered.	Non-existing	- FSA working Group, sub-regional organizations, other scientists, fisheries and conservation managers, and NGOs. - GIS specialists and promotion of free GIS software are encouraged.	1-3
	4. Map locations and timing of known NG and MS FSAs, pre-spawning migrations routes and determine their population status, using proper methods and fisher knowledge.	- Thematic maps (where, when, how many) on NG and MS FSAs are available based on best quality information available and following agreed protocols for information dissemination. -Updated maps resulting from integration of new information on NG and MS FSAs.	Incipient		1-10

III. To develop regionally consistent/harmonized **monitoring frameworks and protocols** to collect key biological, trade and other socio-economic information associated with NG and MS and NG, both during and outside of FSA seasons/areas.	5. Adopt and progressively implement regional monitoring frameworks to collect fishery dependent and independent data.	- Updated FSA monitoring protocols to collect information on fishery dependent and independent data on NG and MS FSAs (based on existing protocols) will be adopted at regional and sub-regional levels. -Databases containing results of implementation of fishery dependent and independent monitoring will be set up.	Deficient	- FAO FSA, Fisheries data and Statistics, and Demersal Working Groups, along with FAO Fisheries and Resources Monitoring System will collaborate with sub-regional organizations and government fisheries and conservation agencies. - Implementation of protocols will need participation of FSA fishers and fisherfolk organizations.	1-10
	6. Develop effective national/sub-regional/regional alliances and protocols, to collect socio-economic and trade data associated with NG and MS fishing at/during FSA areas/seasons.	- Dedicated databases of socio-economic information on NG and MS FSAs, including trade networks, during aggregation and non-aggregation seasons.	Non-existing	- FSA Working Group, port, customs, health and tourism authorities, fishing communities, consumers and restaurants and other business operators, fisheries and conservation managers, and NGOs.	1-10

	7. Countries expand commitments to counteract IUU fishing to include strong enforcement of management measures aimed to protect NG and MS FSA.	- Special personnel and programs in place aimed to improve knowledge of trade networks and documentation of NG and MS commodities in trade during spawning and non-spawning seasons.	Incipient	FSA, IUU fishing Working Groups, sub-regional organizations along with port, customs, health and maritime and other enforcement authorities, fishing communities, consumers and restaurants and other business operators, fisheries and conservation managers, and NGOs.	1-5
IV. To **establish coordinated mechanisms** for **effective protection** of FSAs from extractive use across the Caribbean region.	8. Promote the establishment of synchronized or harmonized regional closed seasons for commercial and recreational fishing for protecting NG and MS FSAs and safeguarding their reproduction. Recommended seasonal closures: four months for NG (1 Dec. to 31 Mar.) and four months for MS (1 Apr to 31 Jul).	- A regional seasonal closure for all commercial and recreational fishing activities for the period 1 December – 31 March for NS (April where relevant) and for the period 1 April – 31 July for MS. - Additional moratorium of NG fishery (during non-spawning sites / locations), until recovery can be confirmed.	Deficient Deficient	- FSA, Fisheries data and Statistics and IUU fishing Working Groups, sub-regional organizations along with port, customs, health and maritime and other enforcement authorities, fishing communities, consumers and restaurants and other business operators, fisheries and conservation managers, and NGOs.	1-3 1-5

	9. Promote the development and implementation of national plans to protect FSAs and aggregating species starting with NG and MS.	National plans to increase protection of NG and MS FSA sites and seasons, complementing actions adopted at the regional level.	Deficient	- FSA Working Group, sub-regional organizations along with port, customs, health and maritime and other enforcement authorities, fishing communities, consumers and restaurants and other business operators, fisheries and conservation managers, and NGOs.	1-10
	10. Evaluate the effectiveness, applicability and benefits of current NG and MS fisheries management and the degree of protection their FSAs are receiving.	- Increased number of technical reports aimed to better analyze the effectiveness of existing NG and MS regulations and measures in protecting their spawning aggregations. Specific recommendation for regulation amendments are included.	Non-existing	- FSA Working Group, sub-regional organizations, academia, legal departments of fisheries and conservation managers, Foreign Affairs agencies	1-3
	11. Identify and implement viable alternative livelihood options for small scale fishers seriously affected by protecting NG and MS FSA, with priorities on countries with higher risks of losing FSAs.	- Identification and development of viable and acceptable livelihoods, including innovative initiatives in place. Countries in greater risk of FSA depletion prioritized. Funding mechanisms for long-term support identified.	Incipient	- FSA Working Group, sub-regional organizations, fishing communities, consumers and restaurants and other business operators, fisheries and conservation managers, and NGOs.	1-10

	12. Establish regional guidelines for conducting non-extractive use of NG and MS FSAs (tourism, research, education).	- Develop/adapt guidelines for nature observers that can also be applied in remote and places (including remote) where FSAs are located, thus offering an opportunity for increasing income, research, and community participation in conservation and tourism.	Non-existing	- FSA Working Group, sub-regional organizations, fishing communities, tour operators, diving industry, fisheries and conservation managers, and NGOs.	1-5
V. To significantly increase **awareness and engagement** among key stakeholders to enhance support for the protection of FSAs, with special attention to equitable benefits for local communities.	13. Develop marketing and awareness regional/sub-regional strategies/campaigns for the general public on the importance of healthy aggregations to maintain ecosystem services and socio-economic benefits, initially focused on NG and MS, in support to the FSA Working Group regional communication strategies.	- Dedicated education and outreach programs in place in support of, or maintaining, healthy NS and MS FSA, integrated into the regional communication strategies.	Incipient	- FSA Working Group, sub-regional organizations, fishing communities, tour operators, diving industry, fisheries and conservation managers, and NGOs. Need to integrate education and communication specialists.	1-10

VI. To integrate FSA protection into **broader planning and ecosystem-scale management** initiatives.	14. Improve understanding of regional larval connectivity patterns.	- Dedicated project looking at improving understanding of the connectivity patterns at regional scales needed for providing technical advice on FSA conservation and fishery management.	Deficient	- FSA Working Group, academia, sub-regional organizations, fisheries and conservation managers fishing communities, fisherfolk organizations.	1-5
	15. Identify the possible spatial and/or temporal implications of climate change on the spawning processes of both species.	- Strengthen ongoing or new projects aimed at addressing impacts of climate change on Nassau grouper and mutton snapper FSAs.	Incipient	- FSA Working Group, academia, fisheries and conservation managers fishing communities, fisherfolk organizations.	1-10
	16. Increase NG and MS FSA protection by improving management of current MPAs or establishment of new MPAs where the conservation of FSAs is included in the objectives.	- Evaluation of effectiveness of existing conservation instruments/strategies to protect NG and MS FSA completed, and recommendations being applied. - New MPAs integrate FSAs as a priority criterion for establishment.	Incipient	- FSA Working Group, academia, fisheries and conservation managers fishing communities, fisherfolk organizations, UN Environment – CEP.	1-10

Monitoring of the outcomes of FSAMP can be conducted by regular meetings of the FSA Working Group, usually timed biannually, as well as through inter-sessional communications. This Working Group can also perform a mid-term evaluation and proceed with necessary updates, as needed. Therefore, the plan is proposing the use of new and existing mechanisms for actions as follows:

Establishing a coordination group: Given the high degree of regional collaboration and participation of several stakeholders contemplated in this regional plan, there is need to establish a coordinating group that helps to ensure and enhance the well-integrated work. The need for such a coordination mechanism has been also envisioned by CLME+ project in order to improve ocean governance in the Wider Caribbean, thus through the Resolution WECAFC/17/2019/20 an Interim Coordination Mechanism has been established. As such, the WECAFC secretariat is expected to continue coordinating actions on fisheries related issues among WECAFC, OSPESCA and CRFM members. Indeed, at their meeting on 2 October, 2019, these organizations agreed to work together in addressing topics related to IUU fishing, management of spiny lobster and migratory fish resources, explore new alternatives for aquaculture and address relevant impacts of disaster risk management and climate change.

Unfortunately, currently, topics directed to protect FSA were not included in the coordination mechanism priority agenda, thus additional efforts need to be taken to address the 16 recommended actions of this plan. In the meantime, the FSA Working Group is urged to create a sub-committee that would concentrate on coordinating the progressive implementation of the plan measures. In particular, this committee needs to coordinate with other WECAFC Working Groups including the IUU Fishing, Demersal Fisheries, Shrimp and Ground Fisheries, and Recreational Fisheries Working Groups. The work of this committee is essential considering that many of significant country producers of groupers and snappers are not OSPESCA or CRFM members.

Topics for this coordination can be developed from the logical framework in Chapter 3 and Table 4.1, including work for securing and updating existing bilateral and multilateral agreements to incorporate issues related to spawning aggregations of Nassau grouper and mutton snapper, poaching at national, regional and international levels, and protocols to develop linkages between, and among, enforcement, customs, fisheries and port authorities. This sub-committee can organize dedicated regional workshops to allow and enable the fulfilment of the FSAMP objectives.

Better and more effective coordination is also required between and among country representatives of international organizations and their national fisheries and conservation managers. Only under collaborative initiatives would it be possible to:

- share technical information and receive feedback from various stakeholders;

- promote collaboration to improve data collection, analysis, participation in monitoring and research, and mapping of fish spawning aggregations,
- support enforcement and surveillance mechanisms; and
- create the necessary mechanisms to empower fisher organizations, and foster/enable their participation in fisheries management.

One of the most urgent activities identified in the management plan is the implementation of harmonized closed seasons for NG and MS. In the case of the NG, additional restrictions are likely to be necessary on fishing during non-spawning and seasons and outside of aggregations, such as a voluntarily moratorium until recovery of natural populations is confirmed. Based on available biological information, temporal harmonization of closed seasons would best run from December through March (April where relevant) inclusive for NG, and April through July for MS. Based on genetic and modelling data, spatial harmonization may best be considered to include two main regions: all countries in central to northern South America and the north central to northwestern Caribbean Sea.

Another urgent need is to introduce the collection of socio-economic data derived from Nassau grouper and mutton snapper fisheries. Species-specific information should be collected for these species during both aggregation and non-aggregation seasons, including from trade networks and in relation to other non-extractive business generated by NG and MS FSAs. Such data are also needed for identification of viable alternative livelihoods for small fishing communities that may be affected by conservation strategies. Coordination on how to advance in this regard should also be a priority.

Establishing an education and outreach group: A regional communication strategy for fish spawning aggregation conservation and management has been developed [4] and formally adopted by the FSA Working Group. This five-year tri-lingual strategy aims to: a) unite audiences around a common vision and story related to the value of FSAs; and b) use communication to leverage the power of a growing constituency to inform public opinion, facilitate stakeholders' information exchange, and influence management policy of FSAs. The following topics are proposed in this strategy:

- to identify target audiences;
- to define main themes;
- to develop mock-ups highlighting results, and discussion of key findings from scientific research and the ongoing work of the FSA Working Group;
- to develop a database containing an inventory of existing FSA communications materials, and
- to establish organizational structure and strategy for building momentum regionally and beyond around the need for FSA protection in relation to fisheries and biodiversity.

[4] Beluga Smile Productions, LLC. 2019. Recovering big fish: A Communication Strategy for Fish Spawning Aggregations Conservation and Management in the Wider Caribbean. Washington, D.C. Unpublished document. 56 p.

As the regional communication initiative develops, a specialized group of stakeholders should establish its capacities to generate broad support for stronger FSA protection, as envisioned in this FSAMP. Therefore, the FSA Working Group needs to verify that the following concepts are included in education and outreach planning and progressive implementation:

a) the need for broad inclusion of stakeholders for achieving conservation and sustainability objectives;
b) increasing awareness around the roles of NG and MS in the ecosystem, their potential fishery value outside of aggregation periods and locations when populations are restored and the impact of fishing and market demand on their sustainability;
c) the importance of safeguarding the NG and MS FSAs for long-term food and income benefits;
d) the importance of having 'megaspawners 'and healthy/viable aggregations (see Glossary) for productive NG and MS populations;
e) the importance of data collection, scientific analysis, research, training, and capacity-building;
f) an understanding of the need for data and why it must be accurate, standardized and with a historical perspective;
g) the importance of compliance of fishing regulations and the need to counteract IUU fishing; and
h) the need for protection and conservation of marine resources, and in particular of FSAs.

Establishing a technical advisory group: The FSA Working Group can create another sub-committee to provide technical guidance to countries in developing their FSA management actions including national plans to complement actions at the regional level. The technical group can also provide guidance to national resource managers on topics related to determination of sustainable harvestable quotas of NG and MS outside their reproductive seasons, using stock assessments, and methods that apply an Ecosystem Approach to Fisheries.

Technical advisory is needed in addressing issues such as: a) identification of indicators that can be utilized to determine the degree of risk for NG and MS FSAs; b) regional technical reference points or thresholds for these fisheries; c) management targets for species 'fishery and conservation status by FSA and country; d) research agendas that include the role of these species as parts of the ecosystem, the effects of climate change, and patterns of larval transport and genetic connectivity; and e) funding for projects that support regional/sub-regional needs.

Expert support will be needed to identify studies among multiple countries which are benefiting from shared populations of the two priority species, incorporating regionally defined priorities in research, monitoring and the collection of time-series data. In addition, advice is required on socio-economic research analyzing the role of exports in increasing fishing pressure and the benefits of exports to source countries using value chain analyses, cultural aspects and/or considering the cost/benefits received from the protection of NS and MS FSAs. For example, developing guidelines for observers that are applicable in remote and offshore places where FSA sites are located could offer an opportunity for increasing income, research, and community participation in conservation and tourism.

Establishing a legal support group: Dedicated legal advice would help evaluate the feasibility of projected regulations, as well as conduct effectiveness evaluation and/or applicability analysis of existing regulations affecting FSAs across the Wider Caribbean region. Such advice would also be important for addressing implementation of legal procedures across maritime borders aimed to counteract IUU fishing. The establishment of sharing data policies, respect of community traditional rights and duties, promotion of safety at sea, black-listing of violators, and other governmental initiatives may also require legal advice prior to full implementation. Legal advice group can be integrated by selected members of the FSA Working Group and legal advisors from OSPESCA and its GTPESCA (Fishing Technical Group, in Spanish), and other legal departments from WECAFC member states.

The advance of the FSAMP requires securing funds to ensure that proposed activities are developed. Attention to fund-raising and appropriate allocation, prioritized as needed, is urged. Regional coordination and collaboration are strongly encouraged to advance management by introducing proposed actions into the agendas of existing regional alliances and mechanisms. This is also important for promoting and securing the necessary political will to achieve the recommendations outlined in the management plan. Priority should be given to building efforts for harmonized and efficient regulations, preparation of appropriately targeted research proposals, development and implementation of viable and culture-friendly alternative livelihoods, development of effective FSA Working Group communications and workshops, and planning for mid-term plan evaluations. National funding for those countries at greater risks or where actions are particularly important for the two focal species, would add considerable value to regional efforts. The identification of funding alternatives for this plan could be enhanced through dedicated efforts of the FSA Working Group and could come from existing national fishery management budgets, NGOs and donors, intergovernmental organizations and funding sources for scientific research.

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ANNEX 1: Glossary

Adaptive management: is a structured, iterative process of robust decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring.

Allee Effect: is a phenomenon in biology characterized by a correlation between population size or density and the mean individual fitness (often measured as per capita population growth rate) of a population or species.

Anthropogenic impact: Human impact on the environment, or anthropogenic impact on the environment, includes impacts on biophysical environments, biodiversity, and other resources. The term anthropogenic designates an effect or object resulting from human activity.

Biodiversity: is the variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable.

Climate change: is a change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

Connectivity: exchange of individuals among geographically separated subpopulations.

Ecosystem Approach to Fisheries: involves planning, development and management of fisheries in a manner that addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystems.

Enforcement: encompasses the personnel and institutional mechanism(s) available to ensure the compliance with fishery regulations. It involves a broad suite of stakeholders, including administrative personnel, the judiciary and the armed forces.

Fisheries management: The integrated process of information gathering, analysis, planning, consultation, decision-making, resource allocation, formulation and implementation, followed by the enforcement of rules that govern all fisheries activities in order to ensure the continued productivity of the resources.

Harvest strategy: suite of management actions needed to achieve biological or economic objectives for a single stock or group of stocks. These include the use of control rules that regulate the level of fishing activity, monitoring and assessment procedures to inform both the setting and progress of the harvest strategy objectives.

Healthy/viable aggregations: refers to a situation whereby fish populations are able to reproduce (in their aggregations) at rates (*per capita*) such that population replacement is possible under the level of fishing being imposed on the species. In the case of depleted populations fishing/management should be adjusted to allow them to recover to their former known or likely fish abundances (usually several to many thousands of adults per aggregation based on available information) and no to be at risk of further decline.

Hyperstability: occurs when a fishery's catch rate, in the context of this FMP referring to catch from spawning aggregations, stays stable while the actual fish population declines drastically. The reason this occurs in spawning aggregations is that fish will continue to aggregate to spawn, and provide high catches, even if their overall population declines. This situation might make it very difficult to understand population status if only aggregation catches are used for monitoring.

Illegal, Unreported and Unregulated fishing: is conducted within areas under national jurisdiction or on the high seas, which poses a direct and significant threat to effective conservation, the management of exploited stocks, and undermines their economic and social benefits. IUU fishing tends to promote further IUU fishing, creating a downward cycle of management failure.

Incidental catches: in commercial fisheries, incidental catches are understood as those catches of no targeted species that may have nor not have commercial value.

Maximum Sustainable Yield: the size of a natural population at which it produces a maximum rate of increase (and hence produced the highest landings in a fishery); typically at half the carrying capacity.

Megaspawner: is a highly fecund, older female fish.

Monitoring system: refers to the effective supervision of fishing activities and the collection, measurement and analysis of data on fishing-related activities – including, but not limited to: catch volumes, species composition, fishing effort, bycatch, gears, discards, area of operations, etc.

No-take Area/Marine Reserve: Are those areas protected areas where is totally prohibited the extraction or significant destruction of natural or cultural resources. They are considered the stronger protection areas and are believed to be effective in restoring and preserving biodiversity, and in enhancing ecosystem resilience.

Overfishing: is the removal of a species of fish (either directly or indirectly as from bycatch) at a rate that the species cannot replenish its populations to compensate for removals, resulting in those species either becoming depleted or very underpopulated in that given area.

Precautionary principle: is a general term that refers to a set of agreed cost-effective measures and actions, including future courses of action, which ensures prudent foresight and reduces or avoids risk to the resources, the environment and the people to the extent possible. The principle explicitly takes into account existing uncertainties and the potential consequences of being wrong. The Fishery Manager's Guidebook issued by FAO in 2009 advises that the precautionary approach or principle should be applied when ecosystem resilience and human impact (including reversibility) are difficult to forecast, and hard to distinguish from natural changes. The precautionary principle suggests that when an action risks harm, it should not be proceeded with until it can be scientifically proven to be safe.

Recruitment overfishing: is a type of overfishing whereby the rate of fishing above which the recruitment (addition of new young) to the exploitable stock becomes significantly reduced. This is characterized by a greatly reduced spawning stock (adults), a decreasing proportion of older fish in the catch, and generally very low recruitment year after year.

Regional (in the FMP context): refers to the Wider Caribbean region, which consists of the insular and coastal states and territories that boarder the Caribbean Sea, the Gulf of Mexico, and the Western Central Atlantic Ocean and that have, have had or potentially could have natural populations of the targeted species.

Resident spawning aggregations: are formed by fish that travel short distances from their home reefs or shelters to the aggregation sites and assemble on a regular basis, sometimes almost daily and usually over extended periods. Such species are generally small to medium in size.

Spawning Aggregation: is a gathering of animals, at densities higher than during the non-spawning period, in locations and at times solely for the purpose of spawning.

Sub-regional (in the FMP context): refers to a set of countries, typically contiguous, within the Wider Caribbean Region, selected on the basis of shared criteria; these could be based, on governance for example, or cultural, biological or physical oceanographic characteristics, e.g. Central America, Lesser Antilles.

Surveillance: involves the regulation and supervision of fishing activities to ensure that national legislation and terms, conditions of access, and management measures are observed. Surveillance is critical to ensure that resources are not overexploited, poaching is minimized and management arrangements are implemented.

Sustainable development: refers to the management and conservation of the natural resource base, as well as the orientation of technological and institutional changes, in such a way as to ensure the continued satisfaction of human needs for present and future generations. Such sustainable development conserves land, water, plants and animals and genetic resources, and is environmentally non-degrading, technologically appropriate, economically viable and socially acceptable.

Sustainable fishing: is the rate of harvest that does not result in a decline in the natural population over time due to fishing practices. Sustainability in fisheries combines theoretical concepts of population dynamics – such as maximum sustainable yield or spawning potential ratio – with practical fishery regulations that control fishing effort to avoid overfishing.

Traceability: is a record-keeping system designed to track the flow of product through the production process or supply chain. ... And yet others hold that traceability must provide access to essential information about how fishing takes place.

Trade network: it refers to the trade of fish products or commodities by wholesalers, processors, distributors and retailers in several different countries before final consumption, utilizing different marketing channels.

Transient spawning aggregations: are formed by larger species physically able to travel greater distances (can be tens to hundreds of km). Transient aggregations usually form for one to many, often for a week or two at a time and usually around the times of the full or new moon lunar phases. As a general rule, transient aggregations are less common and of shorter duration than resident aggregations.

Value chain analysis: in the present context describes the activities that take place in fisheries to describe the change in value of a fishery commodity along the value/trade chain from fisher through to consumer. It helps to identify how the value is distributed and provides opportunities to identify strategic windows and possible imbalances/inequities along the length of the chain.

Verify status. To understand the current status or condition of a spawning aggregation by confirming the time and place of aggregation and the assembly of numbers of fish several times higher than levels outside of the aggregation period. Should include an estimate of numbers of fish present, for example using underwater visual census or remote observational (visual auditory) technologies.

Vessel Monitoring System: is a satellite-based surveillance system primarily used to monitor the location and movement of commercial fishing vessels.

Viable Aggregations (see Healthy)

ANNEX 2. Governance Frameworks

Governance in the Wider Caribbean region is complex and challenging (Chakalall et al., 2007; Salas et al., 2011). The complexity includes the lack of international waters, the existence of several disputed national maritime boundaries, and several bi-national treaties and agreements related to shared marine natural resources. This semi-enclosed ocean basin encompassing an area of 2,515,900 km^2 (Kjerve, 1999), more than 40 small island states, European overseas territories and larger independent republics, is home to more than 43 million people[5] of multiple cultures that speak more than 11 languages[6]. The region is recognized as a preferred tourism destination that supported more than 57 million visitors in 2018 (30 million stayover visitors and 27 million cruise passengers) contributing more than $US 37 billion to the region's economy (Caribbean Tourism Organization 2018[7]). The Wider Caribbean region also encompasses the geographic ranges of Nassau grouper and mutton snapper, making activities in the region critically important for both species (Figure 2.1).

WECAFC is one of the few fishery management umbrellas that cover the entire Caribbean and adjacent areas, and, given the geo-political complexities of the region, high levels of collaboration and coordination in governance are necessary for effective implementation of this FSAMP. On the other hand, WECAFC countries are already committed to the Sustainable Development Goals (SDGs) of the United Nations, of direct relevance to this FMP, including SDG 14: **Conserve and sustainably use the oceans, seas and marine resources for sustainable development**[8] SDG 14 goals include targets that specifically address regulation of harvesting and ending overfishing and IUU fishing, and conserving at least 10% of coastal and marine areas, using science-based management plans. In particular, there is an emphasis on Least Developed Countries and Small Island Developing States. Also highlighted are the needs to increase scientific knowledge, develop research capacities, transfer marine technology to improve ocean health, and to enhance the contributions of marine biodiversity. The Commission is transitioning from the status of a Regional Fishery Advisory Body to a new Regional Fishery Management entity/arrangement.

WECAFC would need to work along with sub-regional organizations to facilitate the approval and enforcement of actions shared by countries with similar regulatory regimes and shared problems (Tables 2.1 & 2.2). In particular cases, and depending on the issue, fisheries management will require the direct intervention of, or involvement by, particular countries or regions, organizations, conventions or management instruments.

Few countries in the WECAFC region specifically regulate either the Nassau grouper or the mutton snapper. It is estimated that Caribbean countries (28 out of 38) do not have any regulation in place to protect Nassau grouper or its spawning aggregations (Table 2.3). Temporal closed seasons exist to protect spawning aggregations in The Bahamas, Belize, Cayman Islands, Cuba, Mexico, and Turks and Caicos, and permanent closures of the entire fishery exist in Bermuda, Puerto Rico, US Virgin Islands and the United States. Other regulations can include restrictions on the use of fishing traps and spear guns at spawning aggregation sites. We estimate that 6 of 38 countries have regulations and management measures specifically for the protection of mutton snapper spawning aggregations (Table 2.4), including spatial closures, seasonal closures, and seasonal sales controls. In addition, marine protected areas (spatial closures) may directly or indirectly protect (depending on their location and enforcement effectiveness) these spawning aggregations or other life history stages (e.g., The Bahamas, Belize, Cuba, Honduras, Mexico, United States, and Turks and Caicos). Complementary measure such as 'skin-on' carcass requirements in some countries can be important for trade controls, in addition to other, conventional, management measures such as minimum sizes and quotas.

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[5] https://www.worldometers.info/world-population/caribbean-population/
[6] https://adventugo.com/11-caribbean-languages-organized-by-country/
[7] https://www.caribjournal.com/2018/02/18/30-million-people-visited-caribbean-last-year/
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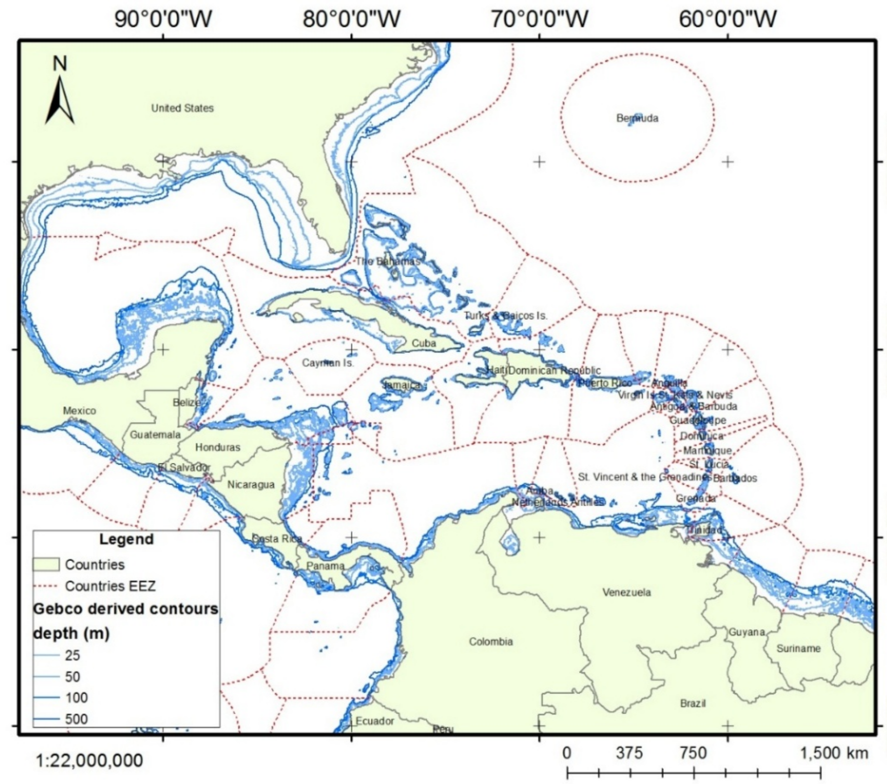

Figure 2.1. Caribbean map denoting the 2011 EEZ (red) and the first 500 m of the ocean basin (blue) expected to serve and the Nassau grouper and mutton snapper range.

Country boundaries are from World ArcGIS ESRI base maps,
EEZ were taken from World Maritime Boundaries downloaded from Marine Regions Geodatabase (http://www.marineregions.org/downloads.php)
bathymetric contours were derived from open sea map using GEBCO 2014 grid, from 30-arc seconds data set and taken from Opendem (https://www.opendem.info/download_bathymetry.html)

Table 2.1. Membership of regional and sub-regional organizations.

No.	Country/Overseas territory	FAO-WECAFC	UN-SPAW	OECS	CRFM	OSPESCA	CFMC
1	Antigua and Barbuda	X	X	X	X		
2	The Bahamas	X	X		X		
3	Barbados	X			X		
4	Belize	X	X		X	X	
5	Bermuda	X					
6	Brazil (Northern)	X					
7	British overseas territory (Anguilla)	X	X	X	X		
8	British overseas territory (Montserrat)	X	X	X	X		
9	British overseas territory (Virgin Islands)	X	X	X			
10	Cayman islands	X					
11	Colombia	X	X				
12	Costa Rica	X				X	
13	Cuba	X	X				
14	Curacao	X					
15	Dominica	X		X	X		
16	Dominican Republic	X	X			X	
17	France (French Guiana)	X	X				
18	France (Guadeloupe)	X	X	X			
19	France (Martinique)	X	X	X			
20	France (Saint Martin)	X	X				
21	Grenada	X	X	X	X		
22	Guatemala	X				X	
23	Guyana	X	X		X		
24	Haiti	X	X		X		
25	Honduras	X	X			X	

26	Jamaica	X			X		
27	Kingdom of the Netherlands (Aruba and Bonaire)	X	X				
28	Kingdom of the Netherlands (Saint Maarten)	X	X				
29	Kingdom of the Netherlands (Saba)	X	X				
30	Kingdom of the Netherlands (Sint Eustatius)	x	X				
31	Mexico	X	X				
32	Nicaragua	X	X			X	
33	Panama	X	X			X	
34	Puerto Rico	X	X				X
35	Saint Lucia	X	X	X	X		
36	Saint Kitts and Nevis	X	X	X	X		
37	Saint Vincent and the Grenadines	X	X	X	X		
38	Suriname	X			X		
39	Trinidad and Tobago	X	X		X		
40	Turks & Caicos	X	X		X		
41	U.S. Virgin Islands	X	X				X
42	United States (South Atlantic coast* and Gulf of Mexico**)	X	X				
43	Venezuela	X	X				
	Total	42	34	11	17	7	2

*= North Carolina, South Carolina, Georgia, E Florida; **= W Florida, Alabama, Mississippi, Louisiana, Texas

Table 2.3. Summary of existing fisheries regulations that can directly or indirectly apply to the conservation of Nassau grouper spawning aggregations in the Wider Caribbean region (see Table 3.1).

No.	Country/ Overseas Territory (OT)	Moratorium	Temporal closure	Size limit (minimum or slot)/ quota	Scuba ban	Spear gun ban	Other controls
1	Anguilla						
2	Antigua and Barbuda		Jan 1-March 31				No selling, purchasing or possession in closed season
3	The Bahamas		Dec 1-Feb 28	1.36 kg Bag limits for foreign fishers		Spear gun fishing restricted in some areas	No commercial exports; no fresh fish sale in closed season when all groupers landed intact and with skin on fillets. Not illegal to 'possess' NG during closed season .
4	Barbados						
5	Belize		Dec 1- Mar 31	For fish 50.8 – 76.2 cm there is quota or limited take	X	No spear guns on compressed air	No trawling or compressed air to catch grouper; fish landed whole for inspection; skin patch on fillet. Illegal to buy/sell/possess during closed season. Export requires permit. Fisher must have license to take NG at spawning aggregation.
6	Bermuda	X					
7	British Virgin Islands						
8	Cayman islands		Dec 1-April 30	During open season fish of 40.6-61 cm can be taken of 5 ind/vessel/day	X	No spear guns	No commercial fishing for NG; no export; no possession, no purchase, receiving, permitting of take
9	Colombia				X		
10	Costa Rica						

11	Cuba			Minimum size 45 cm TL/1600 g; some effort controls during spawning periods; bag limits for recreational fishery	X		Ban on set nets April 1-Aug 31; minimum mesh size (30 mm) for traps and trawls; Ban on trawl nets bag limits recreational fishers;; land whole fish;
12	Curacao						
13	Dominica						
14	Dominican Republic						
15	French Guiana						
16	Grenada						
17	Guadeloupe				X		
18	Guatemala		Dec 1-Mar 31	Slot size 51-76 cm			Prohibited from market in closed season; trade prohibited
19	Haiti				X		
20	Honduras		Dec-Mar NG FSAs protected				
21	Jamaica						
22	Martinique						
23	Mexico		Feb 1-Mar 30 for all groupers (target species is *E. morio*) (first part of NG season not covered).			No spear gun use in closed season	No gillnet use at FSAs
24	Netherland Antilles (Curaçao)						

25	Netherlands (Aruba and Bonaire)						
26	Nicaragua			45 cm			
27	Panama						
28	Puerto Rico	X					Gear restrictions, at least 4 MPA with NG FSA with additional fishing restrictions and closures variously lasting 2-6 months depending on location
29	Saint Lucia						
30	Saint Kitts & Nevis						
31	Saint Maarten						
32	Saint Martin						
33	Saint Vincent and the Grenadines						
34	Suriname						
35	Trinidad and Tobago				No less than 30.5 cm in length		
36	Turks & Caicos		Dec 1-Feb 28	Slot size 53.4-89 cm (note that commercial minimum at 43.2 cm in; not formalized but policed as if in place)		No use of compressed air for fishing	No fishing, selling or possession in closed season. In addition one MPA focused on protected NG FSA
37	US Virgin Islands	X					Gear restrictions, at least one MPA with NG FSA with additional fishing restrictions. Seasonal reef fish closures (Dec-Mar and 1 Feb – 30 April (EEZ)

38	United States (mainland)	X					
39	Venezuela						

Table 2.4. Summary of existing fisheries regulations that can directly or indirectly apply to the conservation of mutton snapper spawning aggregations in the Wider Caribbean region (see Table 3.2).

No.	**Country/Overseas territory (OT)**	**Unregulated**	**Permanent closure**	**Temporal closure**	**Size limit (minimum or slot)/ quota**	**Spear gun ban**	**Other gear controls**
1	Anguilla	X					
2	Antigua and Barbuda	X					
3	The Bahamas				Bag limits for foreign sport fishers for demersal fish	Spear gun fishing restricted in some areas	Restrictions on fishing with spear guns in certain areas
4	Barbados	X					
5	Belize					No spear gun on compressed air or for commercial use	Limited access to FSA; snappers landed with skin-on
6	Bermuda	X					
7	Brazil	X					
8	British Virgin Islands	X					
9	Cayman islands	X			No take of marine life on SCUBA	No speargun	
10	Colombia	X					
11	Costa Rica	X					
12	Cuba				25 cm FL , commercial.		Some FSAs in no-take zones, gillnet ban
13	Curacao	X					

14	Dominica	X					
15	Dominican Republic	X					
16	French Guiana	X					
17	Grenada	X					
18	Guadeloupe	X					
19	Guatemala	X					
20	Haiti	X					
21	Honduras	X					
22	Jamaica	X					
23	Martinique	X					
24	Mexico	X					Some FSA in biosphere reserve and MPAs
25	Netherland Antilles (Curazao)	X					
26	Netherlands (Aruba and Bonaire)	X					
27	Nicaragua				30 cm TL		
28	Panama	X					
29	Puerto Rico			State closure 1-Apr to 31 May, EEZ closed season 1-Apr to 30-Jun			No sale in season unless imported
30	Saint Lucia	X					

31	Saint Kitts and Nevis	X					
32	Saint Maarten	X					
33	Saint Martin	X					
34	Saint Vincent and the Grenadines	X					
35	Suriname	X					
36	Trinidad and Tobago	X			No Less than 12 inches in length		
37	Turks & Caicos	X			Minimum size of 7 inches for snappers	No use of compressed air for fishing	
38	US Virgin Islands			EEZ and USVI waters 1 Aprl-30 Jun; One FSA 1 Mar-30			Delimited area in St. Croix (USVI) closed season no-take from 1-Mar to 30 Jun. No sale in season unless imported
39	United States				18 inch TL & bag limit Quota of 5 fish per person per day or per trip during the April through June Up to 500 pounds whole weight during January through March and July through December		Must be landed with head and fins; One FSA in an MPA
40	Venezuela	X					

2.1. International legal instruments, calls to action and initiatives to safeguard FSAs

The protection of fish spawning aggregations is addressed in multiple international legal instruments:

Code of Conduct for Responsible Fisheries (FAO): The Code was adopted on 31 October 1995, and is a voluntary effort to ensure sustainable exploitation of aquatic living resources in harmony with the environment. Of direct relevance to this FSAMP, Article 6.8 calls for critical fisheries habitats in marine and freshwater ecosystems, including nursery and spawning areas, to be protected and rehabilitated as far as possible and where necessary. Particular effort should be made to protect such habitats from destruction, degradation, pollution and other significant impacts resulting from human activities that threaten the health and viability of the fishery resources.

Voluntary Guidelines for Securing Sustainable Small Scale Fisheries in the context of Food Security and Poverty Eradication (FAO): A non-binding agreement that address policies, strategies and legal frameworks concerning small-scale fisheries, but also other matters affecting lives and livelihoods in fishing communities. The sustainable resource management guidelines consider human well-being and ecosystem health, participatory management of fisheries, aquatic ecosystems and biodiversity, and stress that the right to use a resource and the responsibility to manage it responsibly come together. Guidelines also provide guidance on the need for sustainable fishing practices that do the least harm to the environment and the fish. States are encouraged to prevent and stop all illegal and destructive fishing practices, avoid overfishing, and put in place systems for monitoring, control and surveillance. Small-scale fishers are, in turn, encouraged to support and uphold these systems.

Protocol Concerning Specially Protected Areas and Wildlife (SPAW): A regional legally binding agreement for the protection and sustainable use of coastal and marine biodiversity in the Wider Caribbean Region. The SPAW Protocol works towards the improvement of protected areas management, the conservation of threatened and endangered species listed on Annexes I, II and III, and assisting with the implementation of other regional and global bio-diversity agreements and commitments. Nassau grouper is listed on Annex III (as of 2018), which calls for Parties to implement strategies for the sustainable use and conservation of the species.

United Nations Convention on Biological Diversity (CBD): The global agreement to conserve biological diversity, the sustainable use of this diversity and the fair and equitable sharing of the benefits arising from the utilization of genetic resources. CBD has a dedicated Marine and Coastal Biodiversity Programme focused on integrated marine and coastal area management, marine and coastal living resources, marine and coastal protected areas, mariculture, and invasive alien species. There have been calls to recognize spawning aggregations as Ecologically and Biologically Significant Areas under the CBD, because they fulfil all essential criteria: uniqueness or rarity, importance for life history stages, importance for declining species or habitats, biological productivity, biological diversity and naturalness (Erisman et al., 2015).

United Nations Convention for the Law of the Sea (UNCLOS): The global binding agreement that defines regional and international regimes for the conservation and sustainable use of oceans and their resources. UNCLOS established an obligatory mechanism for the settlement of disputes for Parties to the Convention. This law created the concept of Exclusive Economic Zone (EEZ) and became the management authority for exploitation of seabed resources beyond the limits of national jurisdictions, as well as calling for all States that are Party to the agreement to protect and preserve the marine environment, among other topics.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): An international agreement among governments aimed at ensuring that the international trade in listed animals and plants does not threaten their survival in the wild. Neither the Nassau grouper nor the mutton snapper is currently listed in the Convention. However, CITES has proven helpful in the management of other Caribbean marine resources, such as the queen conch, and a commercially important reef fish in the Indo-Pacific, the Napoleon wrasse (Vincent et al., 2013; Prada et al., 2017 [https://www.cites.org/eng/prog/queen_conch]) and could be of conservation value for other threatened species traded internationally in the region, including Nassau grouper and mutton snapper.

In addition, recognition of the need to conserve fish spawning aggregations has been growing and is reflected in multiple calls to action and other initiatives that have emerged over almost two decades:

2000-present: Science and Conservation of Reef Fish Aggregations (SCRFA): A global initiative by an international NGO to promote and foster the protection and management of fish spawning aggregations, to support and foster the scientific study of aggregations, and to raise awareness of the problems of aggregation-fishing, and possible approaches to management (www.SCRFA.org/database/). Has been involved in multiple management actions and provides materials on spawning aggregations, their management and research (www.scrfa.org).

2002-present: The Belize National Spawning Aggregation Working Group: A coalition of seven NGOs that worked successfully to initially protect 11 of the Nassau grouper spawning sites, and to introduce a four-month closed season. Since early 2003, the Working Group was revitalized and has been meeting regularly on a quarterly basis to share data and develop management strategies. The coalition is comprised by 13 organizations: Belize Audubon Society, Belize Fishermen Co-operative Association, Belize Fisheries Department, Coastal Zone Management Authority and Institute, Green Reef Environmental Institute, Hopkins Fishermen Association, Placencia Fishermen Co-operative, Southern Environmental Association, The Nature Conservancy, Toledo Institute for Development and Environment, University of Belize, Wildlife Conservation Society, and World Wildlife Fund (http://www.spagbelize.org/).

2003: International Tropical Marine Ecosystems Management Symposium 2: At its second meeting the following statement was made: recognizing that spawning aggregations need protection, a key recommendation was that fish spawning aggregations should be conserved, through robust management strategies. Whenever possible this should include complete or managed protection to ensure persistence of the populations that form aggregations, the integrity of reef ecosystems and the livelihoods and food supply of communities that depend on aggregating species. Specifically, fishing of aggregations should be avoided unless part of important local traditional or subsistence fisheries; if spawning aggregations are fished for subsistence, they should be closely monitored and carefully managed; fishing of spawning aggregations should not be permitted for export/commercial markets; spawning aggregations should be included routinely in fishery management plans and marine protected area design; the potential impacts on and benefits of tourism on fish aggregations should be evaluated, especially to determine the possible disturbance caused by tourism activities; education is needed to increase understanding of the biological and fishery importance of spawning aggregations and their vulnerability to fishing, and extreme caution should be exercised not to make public information on the specific locations of aggregation sites that cannot be adequately protected from exploitation.

2004: The IUCN World Conservation Congress: At its 3rd Session held in Bangkok, Thailand, 17–25 November 2004 (Rec 3.100, p.115 Reef Fish Spawning Aggregations) the forum made the following two recommendations: 1) urges governments to establish sustainable management programs for sustaining and protecting reef fish and their spawning aggregations, including a range of spatial and seasonal measures that can be adapted to local needs and circumstances; and 2) requests international and regional fisheries management organizations as well as non-governmental organizations to take action to promote and facilitate the conservation and management of fish spawning aggregations, including by raising awareness of the long-term ecological, economical and societal values of spawning aggregations. The IUCN has also included spawning aggregations of areas in need of protective action in the form of 'Key Biodiversity Areas'

2006: International Coral Reef Initiative (ICRI): The ICRI meeting in Mexico urged governments to establish management programs for sustaining and protecting reef fish and their spawning aggregations, including a range of spatial and seasonal measures that can be adapted to local needs and circumstances. Further, the recommendation requests international and regional fisheries management organizations as well as non-governmental organizations to take action to promote and facilitate the conservation and management of fish spawning aggregations, including by raising awareness of the long term ecological, economical and societal values of spawning aggregations and in respect of their high vulnerability to uncontrolled fishing.

2015 - 2018: Gulf-wide conservation and monitoring program focused on fish spawning aggregations: This project compiled existing biological and fisheries information for Gulf of Mexico species known or likely to form spawning aggregations and identified existing datasets and monitoring programs in the Gulf of Mexico that could inform regional monitoring of spawning aggregations. Available documentation can be freely accessed online (Kobara et al., 2017: http://geo.gcoos.org/restore/).

2009-2020: Caribbean Large Marine Ecosystem (CLME): A regional project funded by the Global Environment Facility aimed to adopt a 10-year Strategic Action Program (SAP) for the sustainable management of shared Living Marine Resources in the Caribbean and North Brazil Shelf Large Marine Ecosystems. By June 3, 2019, the CLME+ SAP had been politically endorsed by 35 Ministers representing 25 countries and 6 overseas territories. Although fish spawning aggregation were not prioritized in the SAP directly, indirectly some of the identified actions can contribute, to the protection of aggregations:

- S2. Enhance regional governance arrangements for sustainable fisheries (in collaboration with FAO- WECAFC, CRFM, OSPESCA and OECS);
- 2.10. Establish and/or enhance the capacity to manage knowledge and to mainstream findings from monitoring, science & research in regional, sub-regional and national decision-making and policy development for sustainable fisheries;
- 2.13. Establish and/or enhance the data and information quality and collection and management capacity of the regional, sub-regional and national fisheries governance arrangements, including through the establishment of public-private partnerships;

5.2. Establish, strengthen and harmonize, as feasible, (sub-)regional and/or fisheries-specific initiatives to combat IUU by combining compliance measures (Monitoring Control and Surveillance plus awareness-building among consumers and producers) with the provision of alternative livelihoods.

ANNEX 3: Brief Summary of Life History of Nassau Grouper and Mutton Snapper

Nassau grouper: distribution, population structure, ecosystem role

Nassau grouper is found across the WECAFC region, from southeast Florida to northern South America, in a range of different habitat types throughout all developmental stages. It is predominantly associated with areas where there are coral reefs. The distribution of Nassau grouper within the range varies based on habitat and depth. Some areas do not provide appropriate nearshore nursery habitats or extensive coral reefs; however, adults may occupy adjacent offshore hard bottom areas and larvae may travel long distances across the region (e.g. east Florida, Stephania Bolden, pers. comm. 2019). The absence of physical barriers to dispersal and the potential for long distance dispersal of larvae has evidently not resulted in genetic homogeneity of Nassau grouper throughout the Caribbean Sea (Jackson et al., 2014). These authors suggested that oceanography likely plays an important role in retaining larvae close to spawning sites at both local and regional spatial scales. Similarly, evidence of population sub-structuring for this species was demonstrated across The Bahamas (Sherman et al., 2020).

During the spawning season, adult Nassau grouper can move long distances (up to several hundred km) to spawning sites (Carter et al., 1994; Bolden, 2000; Dahlgren et al., 2016), across waters shallower than about 400 m. Males and females travel from their home reefs to aggregation sites, sometimes showing strong site fidelity year after year, although home ranges may shift over time (Starr et al., 2007; Blincow et al., 2021) to find mates and spawn. Within the spawning aggregation, fish in high density groupings exhibit characteristic color changes (Sadovy and Eklund, 1999; Archer et al., 2012).

Spawning aggregations are typically located near significant geomorphological features, such as the ends of islands or projections (promontories) of the outer reef edge and close to drop-off areas adjacent to the open ocean (Colin et al., 1987, Heyman and Kjerfve, 2008). With the exception of Bermuda where the species is largely extirpated, the spawning season in the Caribbean falls within the period of December to March (Table 3.1).

Following spawning, eggs and larvae go through a planktonic phase of several weeks, moving short or long distances from the point of release, and settling in nursery habitats, often inshore. Juveniles migrate out from seagrass or mangrove areas as they develop and grow, to shallow and deep reefs. Local retention and long-distance larval transport are indicated for both species (Colin 1992; Heppell et al. 2010). The adult depth range for Nassau grouper has been documented to at least 255 m (Starr et al., 2007). Population sub-structuring is suggested across parts of the Caribbean by genetic and modelling studies, including across The Bahamas (Jackson et al., 2014; Sherman et al., 2017; Martinez et al., 2019; Sherman et al., 2020). Results of these studies indicate some instances of genetic differentiation, but not a high degree of population structuring across the range. Population biology needs to be integrated into the management planning of this species (Sherman et al., 2016; Sherman et al., 2020).

Nassau grouper is an apex predator, and like other larger groupers, plays an important functional role on reefs (Bellwood et al., 2004). This species, and other groupers, could be instrumental in the biocontrol of invasive species (red lionfish *Pterois volitans*), but there is concern this role may be reduced due to overfishing (Maljkovic et al., 2008; Mumby et al., 2011). A study modelling aggregating Nassau grouper suggested that these supply up to an order-of-magnitude more nitrogen and phosphorus to the ecosystem than is provided without aggregating fish on coral reefs (Archer et al., 2014).

Nassau grouper: life cycle

Nassau grouper has a bipartite life cycle that consists of egg and larval phases in the plankton, and juveniles and adults that live in reef and adjacent habitats. The life cycle begins with the mating of mature adults in spawning aggregations. The fertilized eggs hatch within about 24 hours and the larvae remain in the plankton for 35 to 40 days before settling in juvenile habitat, often beds of macroalgae and inshore reefs (Colin, 1992; Shenker et al., 1993; Eggleston, 1995; Dahlgren and Eggleston 2001; Camp et al., 2013). The species eats mainly fish and crustaceans, depending partly on life-history stage (Randall, 1965; Eggleston et al., 1998). Larger females produce exponentially more eggs than smaller ones and, hence, these so-called 'megaspawners' are particularly important for reproduction; sexual maturity is reached at between 400 and 450 mm SL (440 and 504 mm TL) and about 4-5 years of age, and sex ratios are close to parity although these can vary with location and fishery status (Bush et al., 1996, Sadovy and Eklund, 1999; Sullivan-Sealey et al., 2002). The maximum age recorded is 29 years from the Cayman Islands (Bush et al., 1996, 2006) and the maximum known size exceeds 1 m. Generation time is about 17 years.

A deepening understanding of movement patterns highlights the importance of seasonal variability, body size as well as spatial protection for this species. For example, a study conducted by tagging and tracking nineteen Nassau grouper over two spawning seasons showed that individuals of 54 cm TL made spawning migrations of 70 km to over 200 km, and that tagged fish were at spawning sites for 1-2 days and away from their home ranges 12-30 days on average (Dahlgren et al., 2016). The results from the Bahamas study suggested that current site protection may be insufficient to protect fish undergoing such extensive movements and that a complete ban on fishing for Nassau grouper in the country should be considered during the entire time that fish may be migrating to and from spawning sites (Dahlgren et al., 2016). In the Cayman isalnds acoustic tagging revealed movement patterns between aggregation areas and home reefs and that larger fish were generally found in deeper waters (Blincow et al., 2020).

Mutton snapper: distribution, population structure, ecosystem role

Mutton snapper is found across the WECAFC region, from the southeast U.S. to Brazil, in a range of different habitats throughout its life history. Following adult spawning in aggregations, eggs and larvae disperse and develop, settling in shallow nursery habitats. Young mutton snappers are found predominantly in areas with grass beds; older stages are found on coral reefs. The adult depth range for mutton snapper is approximately 95 m (Thompson and Munro, 1974; Allen, 1985).

There is some indication of regional population structure. Analysis of mutton snapper sampled off the USVI, Puerto Rico, and the Dry Tortugas in Florida suggest the presence of different demographic stocks (Carson et al., 2011). A decade-scale biophysical modeling study of snapper larval transport from Cuban aggregation sites suggests that larval dispersal patterns are very site-dependent (Kough et al., 2016). Larvae from sites in northern Cuba supply many larvae to The Bahamas and the Turks and Caicos, as well as considerable self-recruitment within Cuba. Larvae from sites on the south coast of Cuba showed even higher self-recruitment and also supplied larvae to Hispaniola, the Cayman Islands, Jamaica and other countries. In Puerto Rico, large numbers of fertilized snapper eggs, as well as early stage pre-flexion larvae, dispersed offshore possibly because bathymetry favors advection. Water flowed parallel to the sharply breaking contour at the outer shelf edge with possible recruitment destinations tens of kilometers apart situated northwards on an extensive insular platform (Esteves-Amador, 2005). Simulation studies of larval movements across the Mesoamerican Barrier Reef suggest potential for widespread connectivity of mutton snapper in the region that would call for regional, as well as national management (Martinez et al., 2019; Claro et al., 2019).

In one example of an ecosystem role for mutton snapper FSAs, spawning adults at Gladden Spit, Belize, release large clouds of eggs that can be preyed upon by whale sharks (Heyman et al., 2001). These sharks may time their movements to take advantage of these large and predictable pulses of protein (eggs) and regularly gather at known spawning aggregation sites (Graham and Castellanos, 2012).

Mutton snapper: life cycle

The species has a bipartite life cycle that consists of planktonic egg and larval stages, and demersal juvenile and adult life stages. The larvae are estimated to be in the plankton for approximately 25-37 days before settling in seagrass beds and associated shallow habitats (Lindeman et al., 2000; 2005). The species feeds mainly on crustaceans, fishes and mollusks (Randall, 1967; Anderson, 2003).

The species is relatively long-lived with individuals reaching estimated sexual maturity at four years and about 40-50 cm FL in Cuba (Claro, 1981). Maximum total length can exceed 90 cm TL and the species is commonly taken to 50-70 cm (Anderson, 2003; Castro-Perez et al., 2018). Maximum age is variable but typically less than 20 years, although maximum reported age was 29 years in Florida (Claro, 1981; Burton, 2002).

A relatively solitary species, mutton snapper occurs in small groups outside the spawning season and do not typically form the large resting schools known for many other snapper species (Randall, 1967). The species forms annual spawning aggregations of short duration, about a week, around the full moon period, typically peaking in May and June (Table 3.2). However, spawning can vary as in Cuba where peaks occur in May or June depending on the location, within an overall spawning range of April to September (Claro and Lindeman, 2003). Pre-spawning movements to spawning sites are important, involving large shifts in fish biomass across multiple shelf habitats (Bustamante et al., 2001; García-Cagide et al., 2001; Nemeth, 2012). In Cuba, such pre-spawning migrations often involve considerable fishing mortality before reaching the spawning site (Claro et al., 2009). Aggregation sites have sandy, rocky or coral habitat and occur on or adjacent to shelf breaks, with most recorded sites at 20-40 m (e.g., Gladden Spit in Belize, Heyman and Kjerfve, 2008). Available information suggests that mutton snapper typically spawn in subgroups within larger aggregations.

In the Dry Tortugas, Florida, individual mutton snapper showed migrations to spawning grounds over minimum linear distances of up to 35km (up to 5 trips/fish/yr) (Feeley et al., 2018). Migrations occurred from April to August, depending on lunar cycles and an increase in water temperature from 25-30°C. Fish arrived at Riley's Hump on the full moon and stayed for 7 ± 2 d. The minimum catchment area of the population studied in the Dry Tortugas was estimated at 291 km^2 (Feeley et al., 2018).

ANNEX 4: Management Challenges and Case Studies

4.1 Introduction

Despite data shortages, knowledgeable experts and experienced fishers and fishery managers agree that regional declines in numbers of fishes that aggregate to spawn are associated with declines in their overall fisheries; Nassau grouper and mutton snapper are no exception. This FMP is built on the weight of these opinions (FAO, 2018b) and recognizes the urgency to act, especially in the case of the threatened Nassau grouper.

The management agenda for protecting remaining populations, to allow diminished ones to recover and aggregations to be restored should consider all implications of their exploitation, whether by extractive (commercial, recreational fisheries and incidental catches) or non-extractive activities (tourism on FSAs), as well as the possible implications of other environmental factors such as climate change. (Section 4.2, 4.3). Guidance to better apply EAF can be obtained from lessons learned elsewhere and summarized in Section 4.4.

For those traditional fishers who heavily depend on fishing FSAs for their food or livelihoods and are directly impacted from conservation measures, viable alternative livelihoods, that take account of and respect cultural values, must be identified (Heyman et al., 2011). Such livelihood alternatives need long-term funding, the active participation of regional organizations to determine their cost/benefits, and the dedicated involvement of affected stakeholders. Livelihood alternatives are particularly needed in the principal (current or former) producer countries for these two species, Mexico, Belize, Cuba, Brazil, Honduras and The Bahamas where there are already promising opportunities associated with dive tourism, education and research. while tourism operations may derive benefits from divers observing aggregated fish of a range of species (Sala et al., 2001; Heyman et al., 2011; Shideler and Pierce, 2016), special guidelines to minimize disturbance to courting and spawning fish may also need to be developed and integrated into management planning (Heyman et al., 2011).
To increase effectiveness of conservation strategies, additional fishery management for exploitation taking place outside of NG and MS spawning aggregations sites may also need to be planned. Because both species are also taken outside of spawning times and locations. For example, fishing outside of aggregations could remove 14% of the Nassau grouper adult population from a given area in Belize (estimated for 2001 by Sala et al., 2001), while in Cuba a significant proportion of annual catches of mutton snapper came from outside of FSAs (Claro et al., 2009; Fig. 4).

For the majority of countries in the region, and despite a number of noteworthy exceptions, an understanding of current conditions and historical perspectives on landings, fishing effort, socioeconomics and population abundances of Nassau grouper and mutton snapper are largely incomplete, not only at the national level but also for individual FSA sites. In addition, an understanding of the trade networks of the two focal species is typically unavailable. Such information is needed to track trade flows, increase traceability and transparency, ensure fair economic benefits to fishers and traders, maximize economic benefits to source countries, and to improve management and enforcement. Data gaps associated with Nassau grouper and mutton snapper fisheries almost certainly undervalue these resources and their importance to users and source countries. This reality is nested within the larger void of socio-economic information on the larger fisheries and management tools themselves beyond only FSAs (McConney and Pena, 2012).

NEED FOR ACTION NOW

Nonetheless, and notwithstanding data gaps, there is sufficient information available to plan for or improve management. Moreover, it is indisputable that improved management of FSAs of these two species should not wait for more information to be completed or for yet more research. Many FSAs are already much reduced in size and likely will become harder to recover if they decline further. Sufficient information is already available, ranging from scientific studies to management experiences to date, to make informed decisions for management action. Top priorities for immediate action need to emphasize the need for counteract the reduction or elimination of aggregation-fisheries and to develop alternative livelihoods for fishers most affected.

4.2 Related fishery management issues

There is undeniably an urgent need for FSA conservation and management measures that consider, address and advance a range of international, national and regional commitments, initiatives, challenges, actions and cooperation (see Section 2). Most challenges are also relevant to the management of shared marine resources in the region, as reflected in recent plans for spiny lobster and queen conch (CSLFRMP, 2019; Prada et al., 2017), in particular those related to IUU, and to data collection and analysis. Progress towards addressing the challenges, therefore, could benefit multiple resources. There are opportunities arising from technical innovations (from vessel tracking, to mobile phones to tagging, acoustic devices, molecular techniques, remote observation vehicles, other robotics etc.) and through international and national collaborations and well as from synergies with other important species being managed.

- **International cooperation/collaboration**: Given the transboundary nature of many coastal fisheries (as a result of mobile adults or dispersive egg and larval phases) and the highly international nature of seafood trade, considerable political will, engagement and commitment are essential for ensuring cooperative conservation actions in transboundary species. This will become ever more necessary as pressure to export seafood grows, and is especially constrained among countries with disputed maritime boundaries. The costs of failure will be high for those producing countries that fail to work collaboratively, while rewards could be considerable for those that are successful and maintain healthy stocks of valuable species. Collaborative work should include dedicated educational and outreach programs to catalyze broad support for FSA protection.

- **Information sharing:** With a growing need for fishery and trade monitoring, improved traceability of seafood products and better understanding of the value chain and socio-economic importance of coastal fisheries, information collection, access and sharing is increasingly called-for and there is much opportunity for improvement. However, initiatives are often under-resourced. This is despite the large amount of research in the region, a broad and growing consensus on the need to manage monitor coastal fisheries, including FSAs, and a increased interest by the general public to take a more active role in resource management. Communication technologies now readily allow for widespread data collection and sharing and could easily be adapted for use by producers, users and managers of reef resources.

- **IUU challenges**: Illegal fishing is common due to many factors, including the lack of national regulations, poor country capabilities to ensure high seas presence, and challenges to control illegal trade or enforce existing laws. IUU fishing at FSA sites and during spawning in situations when the aggregations are located far offshore, or are close to national boundaries, or peak during difficult oceanographic conditions may demand special enforcement strategies, resources and working platforms not usually available to fisheries managers. On the other hand, modern tracking technologies are becoming cheaper, more readily available and can be relatively easily applied thereby offering new opportunities to improve enforcement. Particular issues to be addressed to better tackle IUU include:

- data acquired through Vessel Monitoring Systems (VMS), when available, are not always shared among relevant national fisheries and maritime authorities making difficult the enforcement of existing regulations (as an interesting example outside the region, Indonesia has now made its vessel tracking data publicly available which opens many opportunities to improve vessel oversight). Currently, small fishing boats are not required to have any satellite tracking system, which makes management harder to enforce as many small vessels are involved in these fisheries. However, the use of simple and available Global Positional System (GPS) technology could easily be explored for use on smaller vessels.
- patrolling/customs personnel are not always able to identify exploited resources at the species level after being familiarized may be regularly replaced by rotation schemes. Training strategies to keep the knowledge of enforcement officials up to date need to be attended to.
- many aspects of the fishery and trade in the two species remain unregulated in many places (e.g. fish fillets without skin on, possession or sale controls during protected seasons, etc.), thus making difficult the assessment of product legality or species identity. The skin-on requirements, sales bans and DNA testing might be feasible for targeted species.
- fisheries regulations often have inappropriate penalties for violations (too low or too high) and negatively affect fishers 'compliance, thereby undermining the effectiveness of the legislation. Penalties should be balanced to improve deterrence.
- political interference may result in illegal fishers not being arrested, charged or prosecuted in a court of law. Corruption can be part of this process and has a serious negative impact on attempts to manage (Sumaila et al., 2017).
- magistrates and judges in judicial systems need to be educated on fisheries regulations impacts and implications of illegal fishing in order to deliver better judgements on cases before the courts and treat violations more seriously; this would provide important incentives to law enforcement officers and increase the chance of prosecutions.
- where fishing violations involve people of different nationalities, the procedures and involvement of foreign affairs ministries, health departments and immigration authorities are necessary, but their role is not always considered. Attention could be paid to this issue.
- special legal procedures or protocols may be needed to control both fisheries and trade internationally, and these may be difficult to develop or enforce.

- **Fundraising for management, outreach and alternative livelihoods:** Management requires sufficient funding and is needed for key areas, in particular for targeted projects in countries, on transboundary issues, to tackle IUU, for education, information sharing and monitoring, for outreach and to develop livelihood alternatives.

4.3. Management Implications of fishing or disturbing spawning aggregations

- **FSA Management-too little could be too late**: Delaying management until aggregations become severely reduced can compromise their recovery ability. In the Cayman Islands, for example, one Nassau grouper aggregation is recovering following years of protection with a more than tripling of fish numbers over 15 years, while a smaller one appears to be taking longer to recover (Waterhouse et al., 2017, 2020; Shouse et al., 2018; Stock et al., 2021). In Belize, despite enforcement and protection of aggregations, monitoring suggests stabilization but there is little sign of increase in aggregation numbers despite many years of protection (Belize National Spawning Aggregation Working Group; Burns Perez and Tewfick, 2016). One possible explanation is that there is a critical threshold of fish numbers in an FSA, below which reproduction and hence recovery becomes compromised, or takes longer if aggregation sizes are allowed to drop too low. This effect has already been documented for queen conch, for which the need for ensuring a minimum aggregation density (Allee effect) is well-known (Stoner et al., 2012), and the effect cannot be dismissed for fishes (Semmens et al., 2008; Hutchings, 2015; Perälä and Kuparinen, 2017). However, in Belize there has also been poaching on protected aggregations, while there is some evidence that even extirpated aggregation site might be able to recover if protected (Chollett et al., 2020).

- **Non-extractive benefits – dive tourism:** As dive tourism develops, the economic benefits of natural spectacles like spawning aggregations, are becoming increasingly recognized appreciated. Sala et al. (2001) calculated significant economic benefits from non-extractive use of a Nassau grouper aggregation from diving to be more than 20 times the short-term, extractive, benefits of fishing activities. While it is possible that diver presence can impact spawning behaviour, dive tourism may, nonetheless, be more beneficial than extractive use in some locations, and could be managed with appropriate guidelines (Heyman et al., 2011). With evidence that divers can negatively affect fish behaviour (Emslie et al., 2018) and that gears can affect spawning behaviour (Sadovy de Mitcheson, 2016); such guidelines should be routinely developed as aggregation dive tourism grows.

- **Ecosystem effects:** A possible ecosystem role for spawning aggregations involves the major mobilization of energetic resources over many biological scales, across broad distances and among multiple habitats, which can also involve interactions with other species. In a review of ecosystem-scale issues involving spawning aggregations, Nemeth (2012) emphasized the energy transfer associated with feeding, excretion, and propagule release across a wide array of benthic and pelagic habitats. These issues can be further examined at the scale of catchment areas, staging areas, and courtship arenas (Nemeth, 2012) but highlight the relevance of aggregations in ecosystems and hence the importance of applying EAF to FSA management.

4.4 Climate change and implications for spawning aggregations

FSAs are likely to be directly and indirectly affected by climate change due to alterations in physical and chemical conditions of the environmental, including temperature, winds, vertical mixing, salinity, oxygen and pH (associated with acidification). Direct effects act on the physiology, development rates, reproduction, behavior and survival of organisms, while indirect effects act via ecosystem processes that affect productivity, and changes in the production of food or abundance of competitors, predators and pathogens (Daw et al, 2009; Portner and Peck 2010; Pinsky et al. 2013; Mellin et al., 2016).

Climate change effects may exacerbate population declines in highly fished populations and constrain management efforts in multiplicative manners (Daw et al, 2009). Modelling suggests that fisheries production in tropical reef systems, like WECAFC, are susceptible to substantial declines under different climate change scenarios (compared to temperate regions) though adaptive management can help to reduce and mitigate impacts (Cheung et al., 2010, 2018). Of particular importance to tropical reef fishes like Nassau grouper and mutton snapper are the potential impacts on reproduction. This can occur on the reproductive events and on pelagic larvae, particularly in relation to larval sensory system development under ocean acidification (Pankhurst and Munday 2011). Larval dispersal could also be influenced by changing seasonal current patterns (Liu et al. 2012) which could affect survivorship and distribution. Reef fishes (like many aggregation-spawners) that spawn intensively and for limited periods in the year could be particularly susceptible to warming ocean waters.

Using the Nassau grouper as a model, Asch and Erisman (2018) calculated the thermal niche and ecological niche breadth of both non-spawning and spawning adults. The thermal niche of spawners was narrower, probably associated with a rather restricted temperature range in which the species spawns (25-26 degrees). This suggests that the spawning life stage may be a bottleneck constraining adaptation options to warming ocean temperatures. The authors concluded that Nassau grouper conservation should include consideration that these possible impacts of climate effects may amplify population declines and reduce or otherwise alter the impacts of conservation measures. To maintain preferred temperatures, fish may possibly shift the timing of their spawning seasons or move to deeper (cooler) waters. So, while the mutton snapper spawns at 26-28 degrees (at least in Cuba) and could perhaps shift to an earlier time of year to accommodate ocean warming if necessary, the Nassau grouper may have little option for maintaining its current temperature range in warmer tropics because it is already a winter (cold water) spawner. As a specific example that such changes can occur, fishers have anecdotal information that during prolonged periods of warm sea temperatures lobster stocks seek deeper waters with lower temperatures (CSLFRMP, 2019).

4.5 Lessons learned from case studies

Management efforts have been carried out over multiple decades in several countries on Nassau grouper and mutton snapper FSAs. These efforts are of much value for understanding and identifying key factors associated with management successes or failures. Table 4.1 presents case studies and identifies some of the key lessons learned. Additional lessons are available regarding management experience with another grouper, the red hind, *E. guttatus* aggregations (Nemeth et al., 2006, Kadison et al., 2017), and from aggregating groupers in the Indo-Pacific Ocean (Sadovy de Mitcheson et al., 2008, Grüss et al., 2014; Erisman et al., 2015; Sadovy de Mitcheson et al., 2020). All these lessons have been considered in the formulation of this FSAMP.

Briefly, guidance gathered from the case studies indicate the following:

- fisher involvement and regular data gathering are very important and should be fostered and actively encouraged early on in the management planning process. This can be part of multi-stakeholder initiative that brings key parties together to the table, including scientists working on aggregations, to develop plans and initiatives that achieve high consensus, are practical, based on the best available science and are clearly understood. Both recreational and commercial fishers need to be part of stakeholder groups;
- long-term commitment and support from government as well as the application of scientific knowledge is essential to ensure that management is fit for purpose for the species and circumstances, and in place long enough to be effective. For example, consistent, unambiguous and precautionary legislation on spatial and/or seasonal management is needed, involving clear management objectives and standardized and regular monitoring;
- the importance of education and outreach is paramount to ensure public support and understanding, with messaging targeted at different interest groups, including schoolchildren, and ongoing education programs to continually update and refresh understanding of key issues;
- regular monitoring of aggregations to enable assessment of outcomes of management, allow for adaptive management and demonstrate success. Decisions should be made in advance regarding whether closed aggregations should be reopened after recovery, or ultimately whether these should best be maintained as a source of the wider fishery rather than opened to fishing, as well as how much recovery is considered acceptable or indicated as the target management outcome;
- effective enforcement is essential for successful FSA protection and is one of the most challenging aspects of their management. It will become increasingly important for a wide range of valued marine species, as pressures, both domestic and international, to increase fishing intensity and exports grows.

Table 4.1. Summary of management lessons from case studies. For the rows, the key factors are represented by indices of 0-2 (0: none/little, 1: intermediate, 2: high). Information was also provided in communication by: Rodolfo Claro (Cuba), Croy McCoy, Scott Heppell, Bradley Johnson (Cayman Islands), Will Heyman, James Azueta (Belize), Krista Sherman (The Bahamas), Stuart Fulton and Alfonso Aguilar-Perera (Mexico) and Alejandro Acosta, Don DeMaria (United States). The authors for this FMP are responsible for allocating the indices 0-2. For major sources see: Bush et al., 2006; Garcia-Moliner and Sadovy, 2008; Heyman, 2011; Heppell et al., 2012; Bush 2013; Sherman et al., 2016; Burns Perez and Tewfik 2016; Agar et al., 2019; Claro et al., 2019; Waterhouse et al., 2017; 2020 and websites[4].

Key factors	**Nassau grouper**					**Mutton snapper**		**Lessons learned**
	Cuba[1]	**Cayman Islands**[2]	**Belize**	**The Bahamas**	**Mexico Caribbean**	**Mexico Caribbean**	**USA**[3]	
Fisher involvement in planning & monitoring	0	2	2	1	1	1	1	Essential and must be actively encouraged and enabled
Fisher acceptance of management	1	2	2	1	1	2	1	Commercial sector may be more accepting than recreational sector; acceptance higher when the need for management is understood, and/or positive outcomes seen

Management measures appropriate to FSAs	1	2	2	2	0	1	1	Measures need to be clear and practical and use information on aggregation condition for planning; should be precautionary and apply multiple and complementary approaches (spatial/temporal and sales bans)
Management effectiveness for the species according to fishery status/surveys	0	2	1	1	?	?	1	Baseline surveys and follow-up monitoring important; assessment of aggregation status needed to demonstrate outcomes of management
Enforcement capacity and effectiveness	1	2	1	1	?	1	0	A major challenge; needs government/community involvement and prevention of IUU fishing
Compliance with regulations	1	2	1	1	?	1	2	IUU fishing and poaching can be serious problems
Extent of cross-stakeholder collaborations	1	2	2	1	1	1	1	A key to success and progress is management planning and development
Communication, outreach	0	2	2	2	1	0	1	Outreach tailored to different stakeholders is essential and needs to be sustained i.e. repeated regularly to reinforce/remind about messages

Availability of relevant FSA science and fishery data	1	2	2	1	1	1	1	Important for management planning, adaptive management and to assess outcomes
Political will	1	2	2	1	1	1	1	Essential and needs to be long-term and with clear management objectives
TOTALS	**7**	**20**	**17**	**12**	**6**	**9**	**10**	

FOOTNOTES:

1. In the case of Cuba the NG fishery collapsed in the 1970s to such an extent that there appeared to be little interest or incentive thereafter to manage the species; hence the early management measures do not reflect more recent perspectives on the species.

2. In the case of the Cayman Is. there was an intense and consistent focus over many years on a few key aggregations which built on a growing understanding, over recent few decades, of the threatened status of the species and benefited from modern diving capabilities.
3. In the case of the Florida Keys, the index is generated, as for the other studies, across more than one aggregation; in the United States case the two locations, Riley's Hump and Western Dry Rock would individually get very different assessments.

4. https://www.reef.org/programs/grouper-moon-project-protecting-caribbean-icon;
https://breef.org/wp-content/uploads/2015/03/Breef-NGrouperGuideforSchools.pdf
http://www.spagbelize.org/

ANNEX 5. Application of FSAMP to Other aggregating species

Overview

The need to protect or manage the spawning aggregations of reef fishes that are fished on their aggregations is widely recognized and promoted globally. The issue has been addressed in multiple calls to action and expressions of concern over almost two decades, and is strongly supported by science. Spawning aggregations are now recognized as Key Biodiversity Areas by the IUCN, and as Ecologically or Biologically Significant Areas, and are flagged for protection in the FAO's Code of Conduct for Responsible Fisheries. They are also directly relevant to several of the Sustainable Development Goals of the United Nations.

Healthy spawning aggregations are essential for replenishing fisheries and could be affected beyond extractive activities, such as from temperature changes caused by climate change (narrow temperature ranges are often closely associated with spawning processes). A growing number of countries, over the past two decades, have begun to protect spawning aggregations of reef-associated fishes which are important for their nations' fisheries and biodiversity.

In the Wider Caribbean region, in addition to the focal Nassau grouper and mutton snapper species of this FSAMP, several other medium to large size reef species form spawning aggregations which may be similarly vulnerable to fishing pressure, environmental degradation or to other progressive environmental changes. These species include several snappers and groupers, a few parrotfish and mullet, tarpon and bonefish which live near reefs and adjacent habitats (see Table). Several of these species are already considered threatened, at least partly due to aggregation-fishing (Sadovy de Mitcheson, 2020), thus measures proposed in this plan may be applicable to other fisheries that experience declines. Some of the species already receive some protection in a few locations (e.g., red hind, goliath grouper, gag grouper) with a particularly successful example in the case of the red hind (Nemeth, 2005). While the availability of scientific information on the location, status and dynamics of spawning aggregations in many countries is limited, management activities can be developed depending on the species and on national capabilities until the fishery is better understood. For most species, the spawning seasons are known which can be an excellent starting point for protection.

There is a need to regularly monitor species that aggregate to spawn, but also concerns about reliability of the data if information is only available from aggregation catches. This is because of **hyperstability**, a condition whereby catches experienced by fishers can remain stable (giving the illusion of stable population levels) while masking a collapse in the fishery. This phenomenon can occur because catch per unit of effort at aggregations will stay stable (in the short term) even if the underlying population is declining (Erisman et al., 2011). This is because adults will keep aggregating to spawn even as their populations dwindle in number. Because of hyperstability, exploited populations should also be monitored at non-aggregation times, if possible, to obtain a better understanding of trends in the population.

Table. Biological information of exploited reef fish that aggregate to spawn in the Wider Caribbean region. Information taken from www.fishbase.org and www.iucnredlist.org.

Scientific name	English* common name	Spanish * common name	French* common name	Max. TL (cm)	Maturity (Lm) cm	IUCN Red List Status	Spa m
Mugil cephalus	Gray mullet	Lisa rayada	Mulet cabot		35	LC	Clear s
Megalops atlanticus	Tarpon	Sábalo	Grand-écaille		160	VU	Clear s

Note:
TL= total length.
Lm= length at sexual maturity.
IUCN Red List categories: VU=vulnerable; NT=near-threatened; LC=least concern; DD= data deficient.
*= Each species may have more than one common name depending on the country

General Recommendations:

Recognizing their susceptibility to overfishing, fisheries that target species that aggregate to spawn should be managed conservatively and monitored regularly to ensure that population sizes can support the fishery. It is clear that the approach to the management of aggregating species should be precautionary. Therefore, the following actions are recommended:

- Increase monitoring at the species-level to determine trends in numbers and sizes of all fish removed (i.e. commercial, subsistence, recreational) during spawning aggregations over time. Fishing should cease if catches decline for 2 years or more consecutively. If possible, the fishery should also be monitored outside of the aggregation location and season (due to possible hyperstability).
- Give priority for monitoring to those species that could potentially be of value for non-extractive uses (e.g. recreational diving), those considered to be endangered, threatened or near-threatened (IUCN Red List), and those that are not understood well enough to be assessed (DD in the above table).
- Evaluate whether current fishery management measures are adequate and compliance acceptable, and assess the need to establish additional measures (e.g. as for the red hind, gag and goliath grouper) or improve enforcement.
- Improve educational programs to increase understanding of the biological and fishery importance of spawning aggregations of all coastal fishes, their high vulnerability to fishing and the importance of functional (i.e. viable/healthy-see Glossary) aggregations for sustaining fisheries. Encourage community ownership of natural resources.