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WESTERN CENTRAL ATLANTIC FISHERY COMMISSION (WECAFC)

Project GCP/SLC/223/EC – *Improving ecosystem approach to fisheries by advancing fish spawning aggregation information gathering and increase of public engagement in the WECAFC region*

Pilot Implementation of WECAFC Regional Fish Spawning Aggregation Management Plan: Report from Belize submitted by Myles Phillips of Wildlife Conservation Society (WCS) for WECAFC

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Improving ecosystem approach to fisheries by advancing fish spawning aggregation information gathering and increase of public engagement in the WECAFC region

Pilot Implementation of WECAFC Regional Fish Spawning Aggregation Management Plan: Report from Belize

Prepared for WECAFC by:

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Submitted on: 30 August 2024

Wildlife Conservation Society

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Abbreviations

BAS	Belize Audubon Society
BCMR	Bacalar Chico Marine Reserve
BFD	Belize Fisheries Department
CCU	Conservation and Compliance Unit of the Belize Fisheries Department
GOB	Government of Belize
GSSCMR	Gladden Spit and Silk Cayes Marine Reserve
GRMR	Glover's Reef Marine Reserve
MBRS	Manual of Methods for the Mesoamerican Barrier Reef System
MPA	Marine Protected Area
NPAS	National Protected Areas System
RFSAMP	Regional Fish Spawning Aggregation Management Plan
SEA	Southern Environmental Association
TAMR	Turneffe Atoll Marine Reserve
TASA	Turneffe Atoll Sustainability Association
UBERI	University of Belize Environmental Research Institute
WCS	Wildlife Conservation Society – Belize Programme
WECAFC	Western Central Atlantic Fishery Commission

Project Summary

Implementing Agency: United Nations Food and Agriculture Organization of the United Nations (FAO) – Western Central Atlantic Fishery (WECAFC)

Funded by: European Commission's Directorate-General for Maritime Affairs and Fisheries (EU-DG-MARE)

Service Provider: Wildlife Conservation Society

Implementation Timeline: July 2023 – October 2024

Two of the most economically valuable and highly considered groups of fish in small-scale coral reef fisheries of the WECAFC region are the groupers (Family Epinephelidae) and the snappers (Family Lutjanidae). These species bring massive benefits to economies, food supply, and eco-tourism and are also important top-level predators in coral reef ecosystems of the region. Declines in several of the medium- to large-sized grouper and snapper species, however, are reason for much concern, and two species in particular are considered to be in immediate need of local and regional management action. These are the endangered Nassau grouper, *Epinephelus striatus*, and the near-threatened mutton snapper, Lutjanus analis, which are the focal species of a novel fishery management plan.

As a result of a highly consultative process, the WECAFC Working Group on Fish Spawning Aggregations (FSA) has developed the "Regional Fish Spawning Aggregation Fishery Management Plan (RFSAMP): Focus on Nassau Grouper and Mutton Snapper" (RFSAMP). The RFSAMP was endorsed at the 18th session of WECAFC in 2022 and is the outcome of a decade of dedicated work that acknowledged the particular vulnerability of these species to fishing during their brief annual spawning events and seeks to stop and reverse declines at their spawning aggregation. Given the transboundary nature of both the spawning adults and the planktonic larvae of these two species, a collaborative regional approach is essential to stop the uncontrolled exploitation of vulnerable fish spawning aggregations. While the FSAMP focuses on two species, it was also designed as a template for managing other aggregating species and is the first ever regional instrument to focus specifically on spawning aggregation management.

This project represents the pilot effort for operationalization of the RFSAMP. Belize, Cuba and the Bahamas have been strategically selected as pilot countries according to a set of criteria, including their: (1) importance for conservation of Nassau grouper and mutton snapper, (2) representativeness of different management paradigms and challenges (small islands to continental environments across socioeconomic circumstances), and (3) potential as models for successful implementation of the RFSAMP.

The project will be jointly coordinated and receive technical oversight as a collaborative effort between task forces from the WECAFC Fish Spawning Aggregation Working Group (SAWG) and the Fisheries Data and Statistics Working Group (FDSWG). The Wildlife Conservation Society is the service provider for this FAO-WECAFC project, and their staff will perform the role of in country focal points for the project in Belize and Cuba. The project has employed an in-country focal point to lead data collection in the Commonwealth of the Bahamas.

Project Objectives

1. Compile/update/collect scientific and traditional information on Nassau grouper and mutton snapper spawning aggregations, and other complementary fishery-dependent and -independent information to improve our understanding of the species' current status and to provide recommendations to improve their fishery management and conservation strategies in key selected countries within the WECAFC region.

2. Review and streamline existing protocols aimed at collecting fishery-dependent and -independent data on aggregation spawning, especially snappers and groupers, with a view to improvement in regional standardisation and establishment of long-term databases of Nassau grouper and mutton snapper spawning aggregations, part of WECAFIS system to the extent possible, otherwise linked in.

3. Strengthen partnerships and collaboration between and among individuals, organizations (e.g., civil society, administrations, research community etc) working to sustainably manage fish spawning aggregations in the Wider Caribbean through the establishment of a specialized digital platform (Hub) to serve as the main tool for the implementation of the already adopted Communication Strategy "Recovering Big Fish". To facilitate fundraising from private donors, the digital hub is conceived as an independent, stand-alone digital platform accessible to all SAWG institutional partners and target audiences, including fishers, managers, decision-makers and the public.

Introduction

Belize is a small developing country located in Central America. It is one of four countries whose marine domains include portions of the Mesoamerican Barrier Reef, the largest barrier reef system in the western hemisphere. Belize claims a significant portion of this reef, including three atolls and a ~300 km expanse of barrier reef and lagoon which extends from its northern boundary with Mexico to its southern boundaries with Guatemala and Honduras.

Belize was selected as a pilot country for the implementation of the Western Central Atlantic Fisheries Commission (WECAFC) Regional Fish Spawning Aggregation Management Plan (FSAMP) because of the relatively advanced state of management measures in place for the Nassau grouper (*Epinephelus striatus*) and its fish spawning aggregations.

FSA management is implemented within the context of Belize's National Protected Areas System (NPAS), which includes several marine protected areas (MPAs) designated as either marine reserves, national parks or natural monuments with varying spatial, temporal and gear restrictions on user activities. Comanagement is a prominent feature of marine governance, with responsibility for an increasing number of protected areas delegated from the Belize Fisheries Department to non-governmental organizations. Belize has achieved 20.5 percent total MPA coverage in its EEZ, 11.65 percent of which consists of "replenishment zones" where commercial fishing is prohibited (Blue Bond & Finance Permanence Unit, 2024). The system of protected areas is overlaid by a system of Territorial Use Rights for Fishing areas (TURFs; known locally as Managed Access Areas) which attempts to manage fishing pressure while promoting engagement and stewardship of resources by fishers (Bowman et al., 2021).

Management effectiveness in the NPAS is evaluated on a five-year cycle, with the last evaluation having taken place in 2019 (Walker, 2020). Protected area advisory councils comprising representatives of major stakeholder groups promote equity and inclusion, convening regularly to share information and to facilitate adaptive management, while protected area management plans include information on the status of associated FSA zones and propose strategies for their ongoing monitoring and management (Wildtracks Belize, 2019).

The Government of Belize has shown ongoing support for resource intensive FSA monitoring and enforcement, implementing FSA-specific regulations and a range of management measures which generally align with best practice guidelines. These regulations (S.I. 161 of 2003, S.I. 162 of 2003 & S.I. 49 of 2009) mandate the following (Phillips et al., 2024):

- seasonal closure of Nassau grouper fishery from 1 December – 31 March;

- establishment of thirteen year-round no-take FSA zones. Most of these zones protect multispecies FSA sites which were known to feature prominent Nassau grouper FSAs, and are associated with larger marine reserves;
- minimum size limit of 20 inches/50.8 cm based on known L_{50} (total length at which Nassau grouper have 50 percent probability of sexual maturity);
- maximum size limit of 30 inches/76.2 cm to protect mega spawners/big old fat fecund female fish (Froese, 2004; Hixon et al., 2014);
- requirement for Nassau grouper to be landed whole to allow confirmation of legal size; and
- requirement for all fish fillets to be landed with a skin patch to allow species identification.

Belize has also strongly benefitted from the establishment of a National Spawning Aggregation Working Group in 2001 (Gibson et al., 2007). This working group is a coalition of stakeholders and rights-holders who have worked assiduously to maintain research, enforcement, monitoring activities at eight of the protected sites and engage with the Fisheries Department on a quarterly basis to inform management and provide mutual support (Burns Perez & Tewfik, 2016). The BFD's Conservation & Compliance Unit (CCU) and protected area comanagers have conducted special patrols at protected FSA zones during the closed season for Nassau grouper to discourage illegal exploitation of the aggregating fish.

New developments have occurred within the last five years with respect to the management of FSAs. The Fisheries Resources Act of 2020 serves as the new overarching legal instrument for fisheries management in Belize and has increased the penalties associated with fishing infractions. The specific regulations for Nassau grouper render fines which can exceed BZD 1 000 per fish depending on the charges. Other finfish benefit from protections under the Fisheries Resources Act (UNCTAD, 2022) (UNCTAD, 2022):

- Under the Fisheries Resources Act of 2020 (Part XIX, section 88(1)),10, the following species are fully protected:
  - parrotfish (Scaridae, all species);
  - surgeon fish (Family: Acanthuridae, all species);
  - angel fish (Family: Pomacanthidae, all species);
  - triggerfishes (Family: Balistidae, all species);
  - whale shark (Rhincodon typus);
  - nurse shark (Ginglymostoma cirratum);
  - sawfish (Pristis perotteti and Pristis pectinate); and
  - rays (all species of rays of the superorder Batoidea).

- Tarpon, bonefish and permit are permitted for catch and release sportfishing only. Possession/landing of these species is illegal.

Finally, in recognition of their mandate to establish management plans for commercial fisheries under the new Act, the Belize Fisheries Department collaborated with the Environmental Defense Fund and the United Nations Conference on Trade and Development (UNCTAD) to propose a multispecies finfish management plan in 2022 (UNCTAD, 2022). The proposed management plan gives Nassau grouper and mutton snapper special consideration, grouping mutton snapper with red hind as the two species are often targeted at the same time. However, this proposed plan has not yet translated to a new legal instrument for fin-fishery management, monitoring and evaluation.

This document synthesizes and summarizes:

- the status of FSA management in Belize (and its effectiveness);
- the status of FSA populations in Belize;
- the availability and accessibility of data relevant to FSA management;
- opportunities for regional support from WECAFC; and
- data gaps and next steps for RFSAMP implementation in-country.

Methodology

Stakeholders were engaged in a series of meetings and workshops between December 2023 and May 2024 to sensitize them about the RFSAMP, the project and its objectives. These engagements also served as opportunities to populate a list of literature for review, a repository of metadata and a SWOT Analysis.

The metadata repository was an excel spreadsheet used in all three pilot countries to capture information related to the management, status, monitoring, enforcement and trade of Nassau grouper, mutton snapper and other FSA related species. This spreadsheet was populated and verified during meetings with the Belize Fisheries Department in December 2023 and with the Belize Spawning Aggregation Working Group in January 2024 (Appendix 1).

Data and literature relevant to fish spawning aggregations in Belize were requested from local and regional stakeholders, and gaps in data availability and accessibility were identified and assessed. Initial interpretations of this information were validated and updated as needed by a cross-section of stakeholders representing the Government of Belize, NGO and fisher representatives at a workshop held in May 2024 (Appendix 2). Findings were incorporated into a final report, and presented to the Government of Belize, the national Spawning Aggregation Working group prior to submission. Findings were also

presented to six traditional fishing communities in July 2024: Sarteneja, Belize City, Hopkins, Dangriga, Riversdale and Placencia.

Nassau grouper management and conservation

Nassau grouper seems to have incurred the greatest benefit from national FSA management efforts in Belize, with its dramatic declines serving as the canary in the coalmine for the plight of these crucial ecological phenomena.

A major fishery for Nassau Grouper has existed since as early as the 1920s, when Belize was still known as British Honduras. Small sailing boats of Cuban origin became available to local fishermen and allowed small crews to transport enough equipment and supplies to conduct extended stays at remote FSA locations (Craig, 1966, 1969). During the 1950s and 1960s, as many as 300 boats were observed to converge on a single FSA known as Caye Glory, and so many groupers were harvested in Belize that fisheries records indicate Nassau Grouper to have been the most caught fish in the country. Jacques Cousteau visited the Caye Glory FSA in the early 1970s, and described an aggregation of “many, many thousands” of individual (Burns Perez & Tewfik, 2016). An earlier account reported groupers at the same site in “countless numbers”, so numerous as to obscure the sandy bottom (Graham et al., 2008; Thompson, 1945).

Populations of this species are presumed to have experienced notable decline in Belize by the 1970s, attributed to heavy fishing pressure and the introduction of the spear gun in the 1960s (Burns Perez & Tewfik, 2016). Annual grouper catch fell from over 45 359 kg annually in the 1950s to less than 13 607 kg in 1986 (Carter & Marrow, 1991).

Recognition of the declines in catch of Nassau Grouper were met with early efforts to manage fishing pressure in the 1980s and 1990s. These included a ban on fish traps inside spawning aggregation areas (Belize Statutory Instrument #17 of 1982), a draft national management plan for Nassau Grouper (Carter & Marrow, 1991) and the establishment of several marine reserves. Population assessments at the turn of the century indicated that the once numerous fish could only be found in numbers exceeding one thousand at two of nine traditionally recognised spawning sites. Nassau Grouper were low in number or completely absent from many others, including the once renowned Caye Glory (Sala et al., 2001). In the present day, Nassau grouper is the only finfish species in Belize to benefit from specific regulations which do not constitute a complete fishery closure.

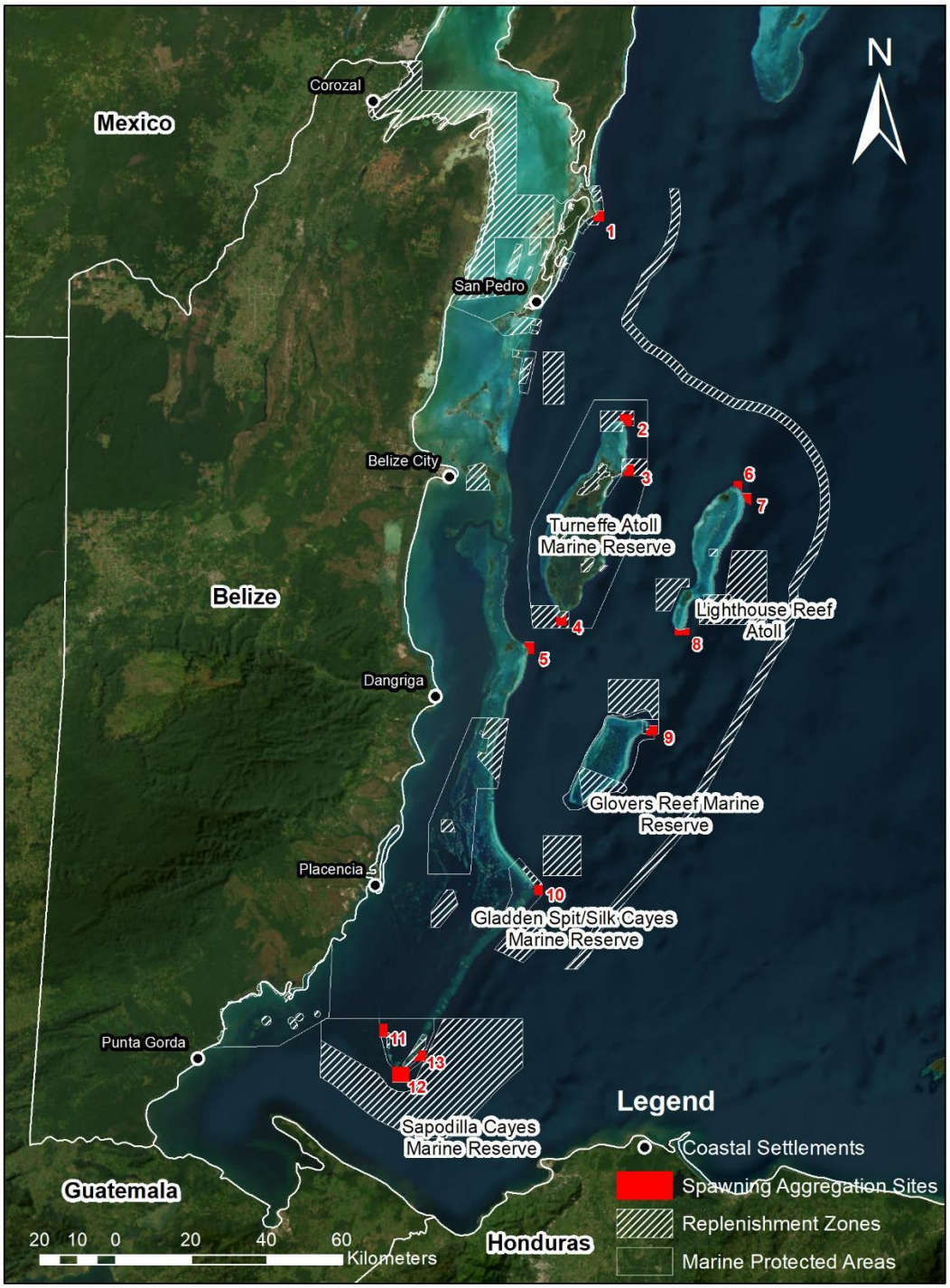

Figure 1: Marine protected areas in Belize, with legislated multispecies FSA protection zones highlighted in red. 1 = Rocky Point; 2 = Maugre Caye; 3 = Dog Flea Caye; 4 = Southern Point TAMR; 5 = Emily/Caye Glory; 6 = Northern Two Cayes; 7 = Sandbore; 8 = Southern Point LHRA; 9 = Northeast Point GRMR; 10 = Gladden Spit; 11 = Seal Caye; 12 = Nicholas Caye; 13 =Rise and Fall Bank

Mutton snapper management and conservation

Mutton snapper retains much of its commercial importance in Belize and is prized as a commercial and recreational target species. Its population is considered to be in better condition than that of Nassau grouper, but has experienced notable declines nonetheless (UNCTAD, 2022). The Gladden Spit FSA, a traditionally fished aggregation of mutton snapper, has declined to the point where the cost of fishing has been said to outweigh the benefits for most fishermen. A 2008 study indicates that traditional boat captains from nearby communities unanimously reported decline in catch and fish size at that site within the preceding decade (Graham et al., 2008).

There are no specific national regulations for mutton snapper at present, and it is only regulated at the Gladden Spit & Silk Cayes Marine Reserve under the regulations which governed its establishment (Gladden Spit & Silk Cayes Marine Reserve Regulations; SI no. 95 of 2003). A special traditional fishing license has been required by the comanager for fishing at this FSA since 2006, and fishing is permitted two weeks of each month from March to June (Granados-Dieseldorff, 2013).

Under the proposed multispecies fishery management plan, mutton snapper is listed as a high priority species and are grouped into a proposed management "basket" with the red hind as these species are often targeted at the same time. Stakeholders proposed the implementation of a bag limit, size limits and a closed season for mutton snapper as measures to be enshrined in law in future (UNCTAD, 2022).

Mutton snapper is known to aggregate at five of the legally protected FSA sites:

- Rocky Point, Bacalar Chico Marine Reserve (BCMR);
- Gladden Spit, Gladden Spit & Silk Cayes Marine Reserve (GSSCMR);
- Caye Bokel, Turneffe Atoll Marine Reserve (TAMR);
- Seal Caye (SCMR); and
- Rise and Fall Bank (SCMR).

… while the following are documented as site names yielded by traditional users (Granados-Dieseldorff, 2013; Paz, 2002):

- Long Caye, Glovers Reef Atoll;
- Mata (M&Ms);
- Tres Cocos;
- Wacatunich; and
- English Caye.

However, this species is believed to aggregate at several other undocumented FSAs across the Belize Barrier Reef system. Fisher representatives corroborated the existence of undocumented FSAs, stating that these locations constitute valued fishing grounds even in the present day (Phillips, 2024).

FSA management effectiveness

Monitoring and evaluation framework

Adaptive management follows a generally cyclic path through monitoring, evaluation and adaptation over time. Prior to the commencement of this cycle, a rubric must be created against which changes in management effectiveness can be measured. This rubric can be considered to consist of a theory of change, with targets, indicators, assumptions, and outcomes which can be used to assess the state of the resource and the mechanisms which manage it.

Definition of a monitoring and evaluation framework aligns with the short term proposed actions under the RFSAMP. Language under proposed action #3 (Define criteria to determine sites/countries at high risk of losing their FSAs) suggests the following:

> *"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* (Sadovy et al., 2022)."

Theory of Change

Belize was not found to have a specific or formal monitoring and evaluation framework for FSAs which is applied across its management efforts. While a multispecies finfish management plan has been proposed, it has not been operationalized as a legal instrument. However, it does include considerations for Nassau grouper, mutton snapper and other commercially important FSA species under an "Adaptive Management Framework" previously used in the design of national management plans for queen conch and lobster, including indicators and benchmarks. The following excerpt describes the vision for Belize's finfish management strategy (UNCTAD, 2022): **"… to maintain a sustainable and viable multispecies finfish fishery that will continue to provide benefits to Belizeans and the national economy."**

For the purposes of this report, we propose a *de facto* theory of change or *modus operandi* followed by the past two decades of FSA management efforts against which they may be examined. This ad hoc theory of change is informed by the following observations about the FSA regulations:

- year-round (temporal) protection of thirteen specific FSAs year-round, with special fishing licenses required for some locations;
- seasonal protection of Nassau grouper during the spawning season (December-March);
- subadult and mega-spawner Nassau grouper are protected;
- fishers must be able to prove that filleted fishes are not Nassau grouper;
- heavy penalties exist for infractions; and
- Gladden Spit, the most commercially important FSA in Belize since the decline of Caye Glory, is managed by a comanager who issues permits to fishermen to exploit the snapper FSAs.

It can be assumed, therefore, that the Government of Belize anticipated that these measures would result in **"the stabilization or increase of populations of Nassau grouper through the regulation of commercial fishing pressure"**. A similar assumption can be made regarding the regulation of fishing for snappers at the Gladden Spit FSA.

Goals, Targets and Indicators

The following may be posited as anticipated outcomes (after Phillips et al., 2024):

1. Nassau grouper and mutton snapper at the FSAs should exhibit a pattern of stabilization or increase.
2. There should be concurrent increase in the number of protected mega-spawner Nassau grouper over time due to maximum size limits.
3. An increase in abundance and size at the FSA sites should be reflected in populations at nursery (i.e. patch reefs) and adult (fore-reef and deep fore-reef) habitats which eventually join the FSA.
4. Concurrently, Nassau grouper should increase in frequency and mean size in fisher catch as more large fish become more common on fishing grounds.

However, these outcomes rest on several assumptions, including:

1. Recruitment and survival rates are sufficiently high relative to fishing and natural mortality that eradicating or minimizing fishing mortality during the spawning period alone would allow populations to increase.
2. The ontogenetic (life history related) habitats of this species are of adequate quality to enable population recovery.
3. Resource users are supportive of regulations.
4. Enforcement resources are adequate to deter illegal, unregulated and unreported (IUU) fishing.

In addition, it is fair to assume that the year-round regulation of commercial fishing at these FSA sites, many of which are multispecies, was meant to confer benefits upon other, less protected, commercially important species which use them either concurrently with Nassau grouper or throughout the year.

These outcomes and assumptions suggest areas which should be assessed during the monitoring and evaluation cycle using measurable targets and indicators.

The proposed multispecies fishery management plan suggests a limited number of fishery dependent and independent performance indicators for assessment of finfish management, along with targets and proposed streams of data and limit reference points which would trigger management action (Table 1).

Table 1: Performance indicators, reference points (i.e. target and limit) and data streams identified by Belizean finfish stakeholders for managing each fish basket (after UNCTAD, 2022)

Performance Indicator	Target Reference Point	Limit Reference Point	Data Stream
fishery-dependent estimate of average length	Running 5-year average of the representative species	Minus 10%	Landings at fish markets countrywide
fishery-independent abundance estimates	Running 5-year average of the representative species	Minus 10%	Underwater visual survey
previous season total landings	Running 10-year average of the representative species	Minus 20%	Landings at designated landing sites

However, as the assumptions and expected outcomes suggest, it may be necessary to consider a broader spectrum of life history- and habitat-related, enforcement, participation and outreach indicators to make a holistic assessment of FSA management effectiveness for adaptive management. This was corroborated by stakeholders during the validation workshop (See Appendix 2).

In addition, there is, at present, no consistent source of the landings data upon which the two fishery dependent performance indicators would rely.

Existing monitoring data streams

Fishery independent methods

Underwater Visual Census

Standard protocols for collection of FSA related data have been used across Belize since 2004[1]. The manual which describes these protocols includes methods for locating, describing, mapping and monitoring of FSAs, *inter alia*. The primary FSA monitoring methodology is known as the underwater visual census and allows the collection of visual estimate data on the abundance, size composition and behaviours of species at the FSA, along with a myriad of metadata on the environmental conditions. Typically, the peak abundance at each spawning site is considered equivalent to the highest count recorded by the survey team during that year. Eight of the thirteen protected FSAs have been regularly monitored over the past two decades. Raw UVC data can be obtained on request from individual organizations in Microsoft Excel format; however, the data is often incomplete, inconsistent in archival format and/or riddled with data entry errors. The National Spawning Aggregation Working Group established a central database in ~2005 which has most recently been housed by the University of Belize Environmental Research Institute. Unfortunately, due to staff turnover and loss of funding, the database has become defunct. In the past year, efforts have been made to recover the archive, but it was found to have been corrupted, and much of the data was lost. The database is slated to be redesigned and relaunched in the near future.

Laser Caliper Method

Another method used at the FSAs for assessment of size composition at the FSA. This method involved the attachment of parallel lasers to an underwater camera tray, and the use of the known distance between the laser points to estimate the total length of individual fish. Laser calipers allow more accurate measurements but are only considered accurate within ~5 m/15 ft and only yield measurements of a sample population of fish. It is important to ensure that the sample size collected is as large as possible.

Sources of raw data are available from three organizations:

- Wildlife Conservation Society (WCS) – Glover's Reef Marine Reserve (Nassau grouper and tiger grouper *Mycteroperca tigris*)
- Belize Audubon Society (BAS) – Lighthouse Reef Atoll (Nassau grouper)

[1] Heyman, W., Azueta, J., Lara, O., Majil, I., Neal, D., Luckhurst, B., Paz, M., Morrison, I., Rhodes, K. L., Kjerve, B., Wade, B., & Requena, N. (2004). Spawning Aggregation Monitoring Protocol for the Meso-American Reef and the Wider Caribbean. Version 2.0.

- University of Belize (UBERI)/Turneffe Atoll Sustainability Association (TASA) – Turneffe Atoll Marine Reserve (Nassau grouper & Mutton snapper)

Passive Acoustic Monitoring Data

These methods involve the use of recording devices known as "hydrophones" to record ambient underwater sound. They can be used to record the courtship associated sounds of spawning fish, which allows researchers to identify presence, absence, and patterns of behaviour over periods spanning days or months. Only two organizations collect this type of data locally, and only limited amounts of passive acoustic is presently available from each:

- WCS Belize
    - Northeast Point, GRMR (2022)
    - Southwest Caye/Tiger Bank, GRMR (2017-2021)
- TASA
    - Mauger Caye, TAMR (2023)
    - Dog Flea Caye, TAMR (2023)
    - Caye Bokel, TAMR (2023)

Reef Survey Data

Reef Surveys have been widely conducted across Belize for more than two decades using two methodologies – the Manual of Methods for the Mesoamerican Barrier Reef System (MBRS), and the Atlantic and Gulf Rapid Reef Assessment (AGRRA) protocols. This survey data serves as a repository of information on the density and size of fish in various reef habitats and management zones and can be used to observe ontogenetic patterns of habitat use. However, it must be noted that adult and mega spawner populations may not be well represented in fish survey data captured by SCUBA (>15 m), as Nassau grouper inhabit deeper areas as they grow older (Harms-Tuohy et al., 2022).

MBRS and AGRRA data are available from most of the conservation NGOs with marine interests. However, these records are often inconsistent or incomplete due to staff turnover, loss of institutional memory and direct submission of raw data to regional repositories. A time series (2006–2021) of AGRRA data from across Belize is available from the Healthy Reefs Initiative for groupers, snappers and other fish species.

Fishery Dependent Methods

Fishery dependent data on finfish is not widely available in Belize. While efforts have been made by the GOB to implement mandatory catch logbooks as a prerequisite for license renewal within the past few years, the quality of the submitted data has been called into question.

Primary sources of raw fishery dependent data in Belize come from studies conducted by NGOs. These datasets facilitate analyses of catch composition, individual length data, individual weight data, catch per unit effort, depth of fishing grounds and characteristics of fishing gear *inter alia*.

Historical landings data are preserved and/or reconstructed in peer reviewed articles, *inter alia* (W. Heyman & Wade, 2007; Zeller et al., 2011).

Catch data from fishing grounds

Two organizations have conducted surveys of fisher catch by intercepting vessels during fishing trips and offering incentives in exchange for data. WCS has collected this type of data from Glovers Reef Marine Reserve from 2004 to 2019 and has published analyses of this dataset over time which consider Nassau grouper as a focal species (Babcock et al., 2018; Tewfik et al., 2017, 2022). TASA began data collection at Turneffe Atoll Marine Reserve in 2023 and has stated intent to continue these efforts indefinitely.

National Landing Site Surveys

From 2017 to 2020, WCS conducted surveys of landings of lobster, conch and finfish in five (5) traditional fishing communities: Corozal, Caye Caulker, Belize City, Dangriga, Placencia. Data from Punta Gorda was contributed by the Toledo Institute for Development and Environment (TIDE). Analyses of data from these six communities were reported to donors and GOB (Tewfik et al., 2020) and eventually published in a peer-reviewed article (Tewfik et al., 2022).

Evaluation and reporting paradigms

Evaluation naturally follows monitoring in the adaptive management cycle, to the point where they are often mentioned simultaneously. However, the degree to which data streams are utilized/analysed and interpreted can vary greatly, as can the breadth of distribution of the findings. These factors influence the academic rigour, accessibility, and utility of such products for assessment of management effectiveness.

In Belize, reports relevant to FSAs can be considered to fall into four categories:

- **Intra-organizational reports** – where monitoring teams report on individual monitoring events or annual findings within their organization. These reports are generated by most organizations and tend to include highly detailed accounts of the surveys which provide valuable context for interpretation of data trends over time. Unfortunately, they are largely inaccessible to actors outside of the organization and are often lost from institutional memory when staff turnover occurs. Further, they do

not always compile data from previous years, nor provide a long-term interpretation of any trends in the observed variables.

- **Interorganizational reports** – where monitoring teams report findings to donors, expert working groups or GOB. This category of reports has the same challenges with respect to accessibility as intra-organizational reports. However, the Belize Spawning Aggregation Working Group synthesizes this information to produce annual/biannual reports which are moderately accessible upon request from the executive members.
- **Institutional publications** – products which synthesize large amounts of data and information to provide context and recommendations for strategic action at the national or regional level. Access to these documents is largely reliant on institutional knowledge – many of them are "open-access" and available online, but one must be aware of their existence. Recently, the National Spawning Aggregation Working Group has uploaded several of the publications to their website www.spagbelize.org.
- **Peer-reviewed publications** – the most accessible form of report, and the most effective at preserving information in posterity. Several relevant articles were produced in the period 1999–2009 during a surge of interest in Belizean FSAs and Nassau grouper conservation. However, publication of studies has been infrequent in the past decade.

Information Baselines

Belize can be considered to have strong baselines of information regarding fish spawning aggregations.

The earliest documentation comes from descriptions of the fisheries of British Honduras in the 1940s and late 1960s (Craig, 1966, 1969; Thompson, 1945). These documents largely describe the vibrant fishery at Caye Glory, believed to have hosted an aggregation of over 100 000 fish. In 1969, Craig cautioned that the aggregation already showed signs of decline due to heavy annual fishing.

By the 1980s, ongoing concerns about declining catch led to the earliest management efforts, a draft management plan and descriptions of other spawning aggregations and their associated fisheries (Carter et al., 1994; Carter & Marrow, 1991; Carter & Perrine, 1994).

During the period 2000–2010, there was a monumental swell in research and management interest surrounding fish spawning aggregations. The apparent disappearance of the Caye Glory FSA and the decline of many others led to works which described known and historic FSAs, landings, trade and socioeconomic information and the traditional knowledge of FSA fishers by The Nature Conservancy, Green Reef Environmental Institute and others (Gibson et al., 2007; Graham et al., 2008; W. Heyman & Requena, 2002; E. Paz & Grimshaw, 2001; G.

E. Paz & Grimshaw, 2001). During this period, annual monitoring of eight of the 13 fully protected FSAs began, yielding multi-decadal time series in the present.

Most recently, in 2022, three new FSA sites were confirmed at the very south of the Belize Barrier Reef in the Sapodilla Cayes Marine Reserve.

Enforcement and outreach

In Belize, most finfish species do not benefit from specific regulations, and most commercial catches from the artisanal fishery remain unreported or misreported. In addition, the impact of unregulated consumption by recreational fishers (i.e. tour boats, charter fisheries, individuals) on Belize's fin-fisheries has not been assessed.

With respect to illegal fishing, the Conservation Compliance Unit is the primary agency responsible for enforcement of fishery regulations in Belize. FSA related infractions by locals are considered rare, though enforcement officials note that night-time incursions by foreign vessels from Guatemala and Honduras occur with some regularity, especially at Glover's Reef and Gladden Spit. This transboundary fishing is believed to be driven by illegal markets for FSA finfish products in their home countries. The CCU and MPA comanagers have made significant efforts to mitigate this threat through enforcement presence, particularly at distant FSA sites, but are consistently challenged by the fuel requirements for patrolling these areas. In some cases, partner organizations (e.g. WCS) have supplemented the fuel allocation to the CCU to facilitate their work during the Nassau grouper closed season.

Local stakeholders are highly sensitized regarding existing regulations, fines and penalties around FSAs and the Nassau grouper. The BFD and the National Fish Spawning Aggregation Working Group have conducted education and outreach activities over the past two decades with communities and fishers using several modalities, including:

- outreach to fishers during their fishing trips ("Boat to Boat Outreach");
- MPA advisory councils;
- community meetings;
- television and radio;
- social media content; and
- posters & infographics.

The most recent outreach video can be viewed via this link: 2022 PSA - Nassau Grouper in Belize - Story of Carlton Young.

Adaptive management actions

In terms of adaptations to date, there have been no changes to FSA-specific regulations nor governance since 2009. This is, in part, a credit to the fact that Belize's marine governance systems already encapsulate most of the regulatory best practices specifically for Nassau grouper to date. The changes to the fee and penalty structures included in the Fisheries Act of 2020 also impact FSA-related infractions under the existing regulations.

It could be argued that the ad hoc adoptions of new technologies (e.g. laser callipers, passive acoustic monitoring, fish finders) by individual organizations to enhance monitoring activities can be considered adaptations. However, there has been no tangible systematic adaptation of FSA-specific governance based on monitoring and evaluation in over a decade, with most activities at the national scale upholding the status quo of annual monitoring and archival with no formal evaluation and response mechanism.

Status of FSAs

For the purposes of this report, it is assumed that there exist four distinct subpopulations of *E. striatus* in Belize: one on each of the three atolls, and one which extends across the main barrier reef system (and possibly across geopolitical boundaries into neighbouring Mexico and Guatemala. It was noted in a 2007 tagging study of Nassau grouper at Glover's Reef Marine reserve that these fish do not usually swim across deep, open water, and require contiguous expanses of reef for migration. The outcomes of the tagging study supported this – adult *E. striatus* tagged at the Northeast point FSA were not found to leave the atoll even to travel to the South Water Caye Marine Reserve, the nearest section of the main barrier reef system (Starr et al., 2007).

Key resources which summarize the monitoring and status of these FSAs in greater detail are listed below:

- Burns Perez, V., & Tewfik, A. (2016). Brief History of Management and Conservation of Nassau grouper and their Spawning Aggregations in Belize: A Collaborative Approach. *68th Gulf and Caribbean Fisheries Institute*.
- Fulton, S., Acevedo, A., Estrada, J., & Caamal, J. (2020). *Status Report on Fish Spawning Aggregations in the Mesoamerican Reef 2020*.

Glover's Reef Atoll FSA sites

Northeast Point

A well-studied multispecies FSA site noted for its prominent aggregation of Nassau grouper, as well as black, yellowfin and tiger groupers (Kobara & Heyman, 2010; Sala et al., 2001; Starr et al., 2007). This is the only legally protected FSA site on the atoll. Fishing at this aggregation began in the early 1970s and was estimated to host over 15 000 Nassau groupers during the spawning season in this era (Sala et al., 2001).

Monitoring at this site is led by WCS Belize, and the available data comprises:

- Underwater Visual Census (2004–2023);
- Laser calliper size data (2017–2023);
- Reef survey data (2004–2023);
- Catch and effort data (2004–2019); and
- Passive acoustic data (2022)

This FSA is considered to exhibit statistically significant patterns of decline over the past 20 years despite national regulations and a gentleman's agreement between the fishery advisory council and the BFD which establish an informal moratorium on Nassau grouper fishing at GRMR (Phillips et al., 2024). The last survey during the spawning season in 2023 reported only 463 fish.

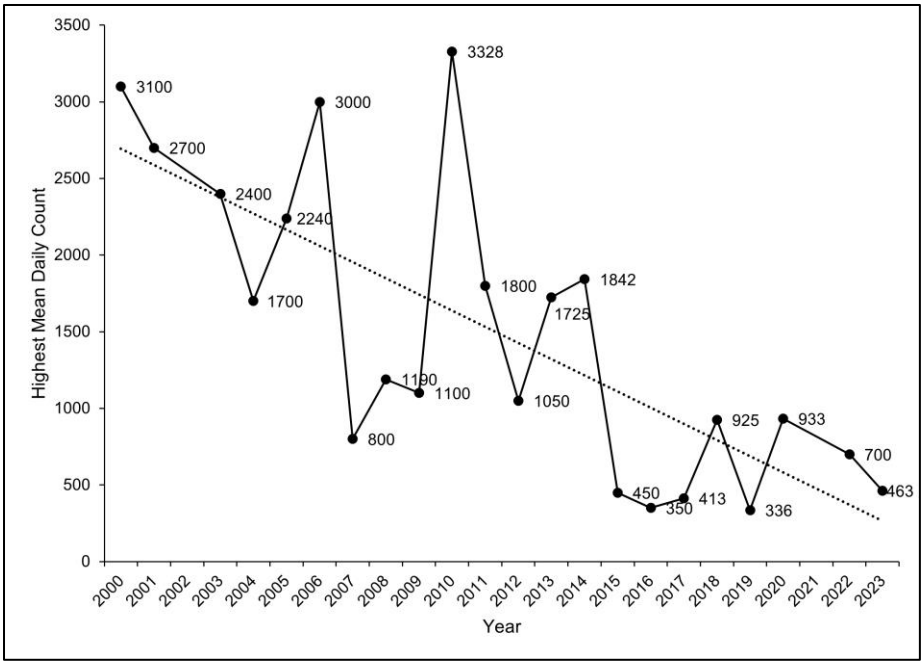

Figure 2: Maximum mean daily counts of Nassau grouper recorded at Northeast Point, Glover's Reef Marine Reserve during the 2000–2023 spawning events. No data was collected in 2021. Linear regression trendline: y = 105.56 * x + 213813.4. Multiple r2 = 0.531. p-value = (> 0.001). After Phillips et al (2024).

Southwest Caye/Tiger Bank

This site featured a tiger grouper FSA of 30-50 individuals (Starr et al., 2018). This aggregation has since been extirpated, supposedly by fishing pressure during the 2020–2021 COVID-19 pandemic. WCS Belize collected short time series of underwater visual census and laser caliper (2017–2022) and passive acoustic data (2019–2021) from this site. The data remains unpublished.

Long Caye/Middle Caye

This site is a known historic mutton snapper site (Graham et al., 2008; Paz, 2002). The existence of this site was corroborated by fishers during the validation session for this project, but the site has not been visited for assessment in many years.

Turneffe Atoll FSA sites

There are three protected multispecies aggregation sites at Turneffe Atoll, which are described below. Other aggregation sites have been documented to exist at Soldier Caye and Crawl Caye, *inter alia* (Paz, 2002).

Mauger Caye & Dog Flea Caye

These FSAs are well documented as historic multispecies FSAs. A relatively large aggregation of 2300 *E. striatus* was unexpectedly encountered at Mauger Caye in 2023 after many years of significantly lower numbers. The opposite scenario occurs at Dog Flea Caye; an *E. striatus* FSA of was encountered once in 2003 and has not been seen again since.

In addition to underwater visual census data, laser calliper data exists for Mauger Caye (2017–2023). Passive acoustic data has been collected from both sites in 2023 and will be collected each year on an ongoing basis.

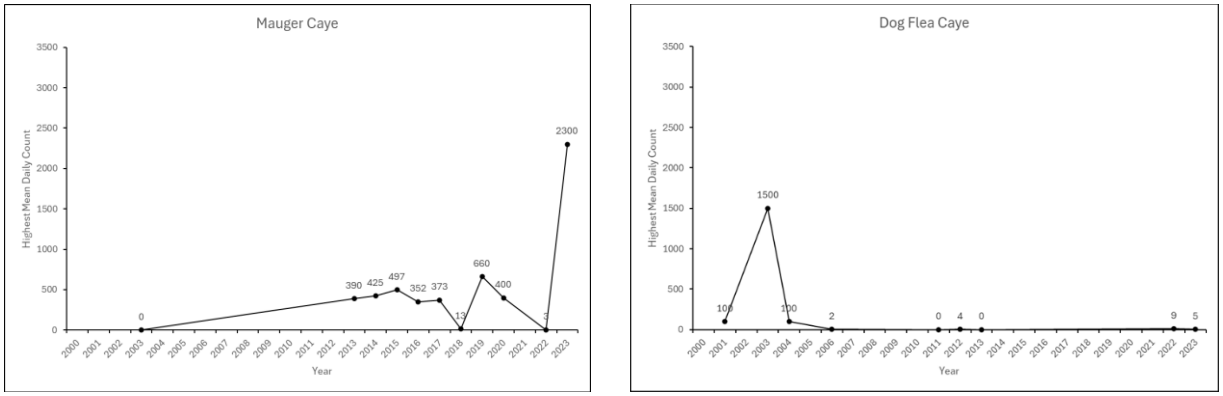

Figure 3: Annual time series of Highest Mean Daily Count of Nassau grouper at Mauger Caye and Dog Flea Caye, TAMR

Caye Bokel

Caye Bokel is a multispecies FSA which was historically known to host an *E. striatus* aggregation. The *E. striatus* aggregation has either been lost or extirpated; as such, the site is now chiefly monitored (underwater visual census) for *L. analis* and other snapper species. Three hundred mutton snapper were counted at the site in 2023.

Lighthouse Reef Atoll FSA sites

Sandbore, Northern Two Cayes & South Point

Lighthouse Reef Atoll (LHRA) is not encompassed by a marine reserve. However, it is managed and patrolled by the Belize Audubon Society (BAS) and features the largest extant Nassau grouper FSA in Belize: Sandbore. Though at least five FSA sites have been documented on LHRA (W. Heyman & Requena, 2002; Paz, 2002), only three are protected by the legislation: Sandbore, Northern Two Cayes and South Point. Of these three, only Sandbore is regularly monitored by BAS. A time series of underwater visual census data (2001–2022) exists for this FSA site, as well as laser caliper data from 2021 to 2022. Survey

teams noted difficulties with locating the FSA in 2020 and 2021. The use of a fish finder allowed them to locate the main group of 4 000 fish in 2022.

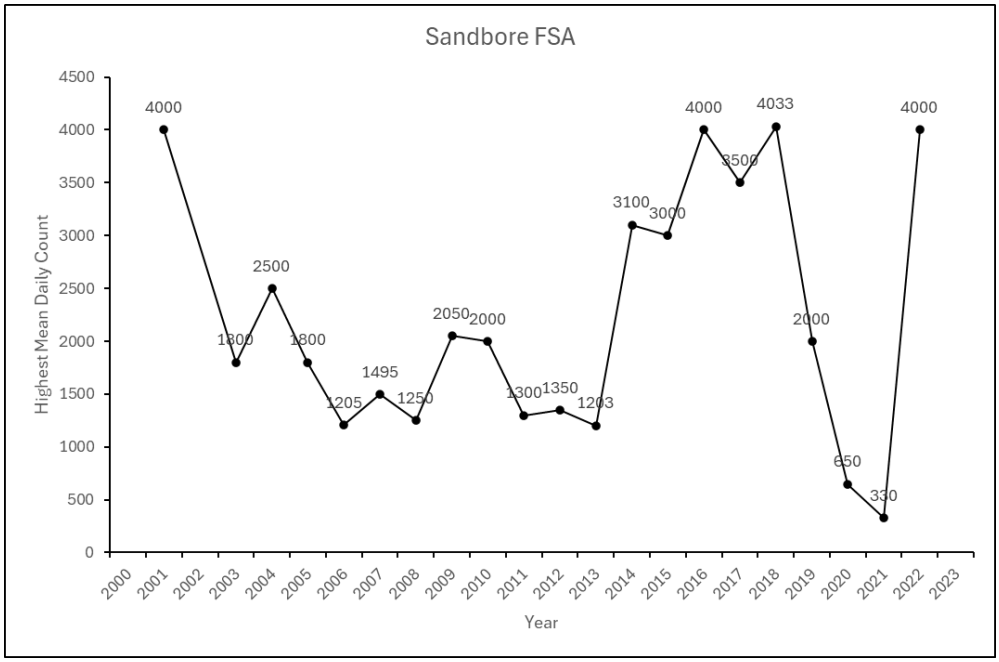

Figure 4: Annual time series of Highest Mean Daily Count of Nassau grouper at Sandbore, LHRA

Main Barrier Reef FSAs

Rocky Point

This multispecies FSA site is encompassed by the Bacalar Chico Marine Reserve off the coast of San Pedro, and its Nassau grouper FSA is believed to have been extirpated. Two hundred E. striatus were documented in 2004 and 2005, and an FSA has never been seen at the site since. Now, it is known for FSAs of jacks, grunts and permits. It is monitored by the Belize Fisheries Department via the Hol Chan Trust.

Emily/Caye Glory

Once the largest FSA site in Belize, with over 100 000 fish in the mid-1900s, this FSA site was believed to have been extirpated during assessments in 2001 (Burns Perez & Tewfik, 2016; Craig, 1966, 1969; Fulton, Acevedo, et al., 2020; Fulton, José González-Bernat, et al., 2020). However, adopting a transect style survey to search for the FSA across the breadth of the general area in which it is known to occur, survey teams have managed, on a few occasions, to encounter a relatively large aggregation of 1 000-3 000 fish at this site.

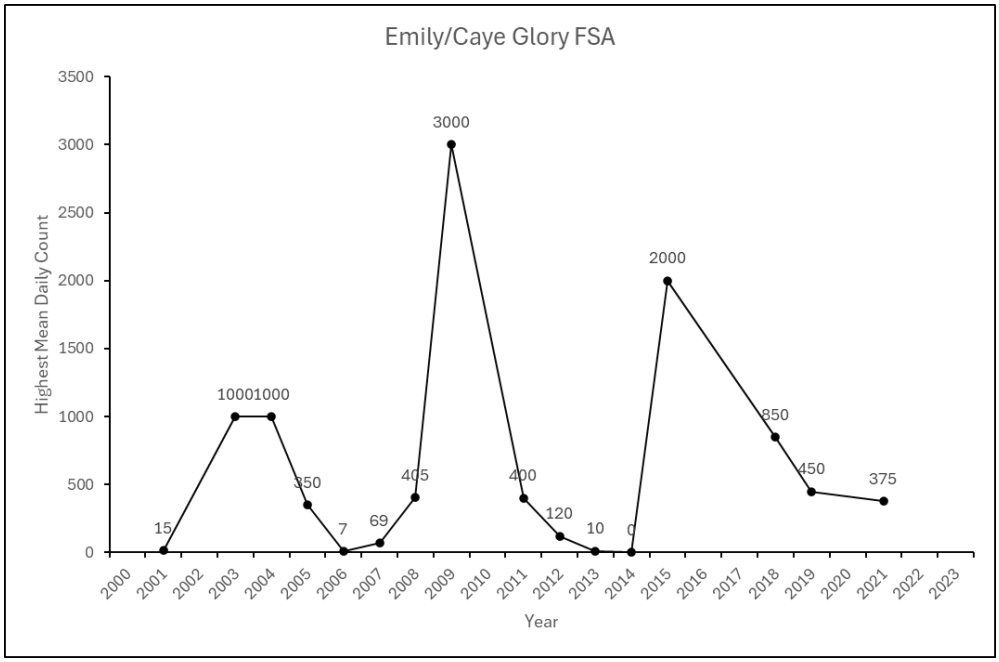

Figure 5: Annual time series of Highest Mean Daily Count of Nassau grouper at Caye Glory FSA

Gladden Spit

The Gladden Spit multispecies FSA is one of the best studied FSAs in Belize and has importance both as a traditional/commercial fishing site and as a destination for whale shark and FSA dive tourism (Graham et al., 2008; Graham & Castellanos, 2012; Granados-Dieseldorff, 2013; W. D. Heyman et al., 2010). The site is managed and monitored by the Southern Environmental Association, which conducts underwater visual surveys at the site. The Nassau grouper FSA is believed to have been extirpated from this site. However, aggregations of mutton, cubera and dog snapper are consistently reported to number well over 10 000 fish.

Nicholas Caye, Seal Caye & Rise & Fall Bank

These three legally protected FSAs are encompassed by the Sapodilla Cayes Marine Reserve. Of the three, only Nicholas Caye is monitored. Teams conducting underwater visual surveys have consistently reported a very small number of fish at the site.

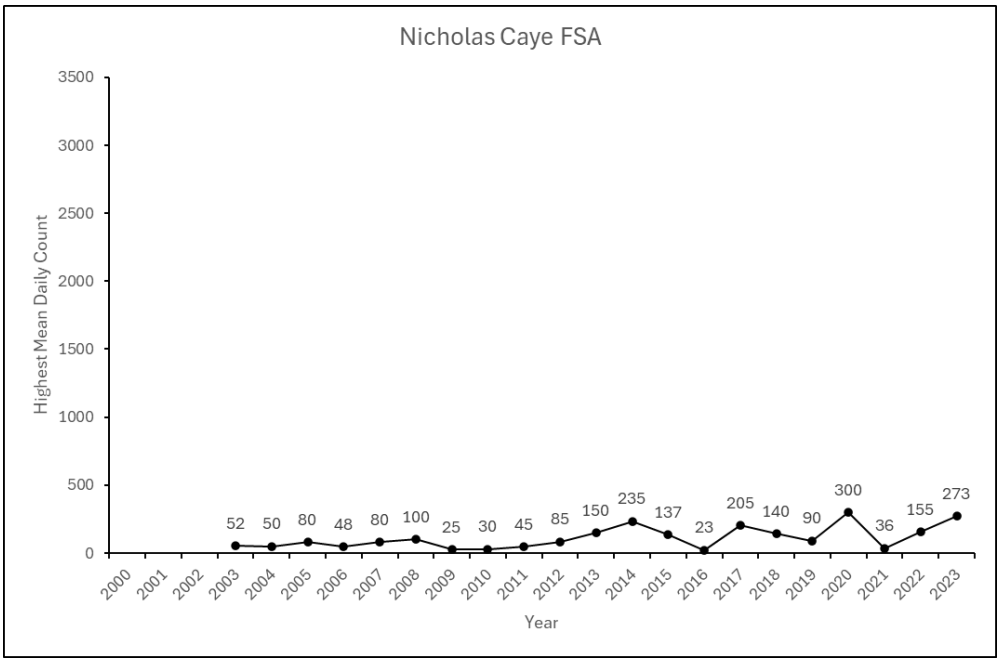

Figure 6: Annual time series of Highest Mean Daily Count of Nassau grouper at Nicholas Caye FSA

The Sapodilla Cayes Marine Reserve has been expanded to encompass this region all the way to the maritime boundary with Guatemala, and the Belize Fisheries Department relinquished responsibility for management and monitoring to TIDE as a comanagement organization in 2022. TIDE has recently confirmed the existence of three additional FSA sites south of Rise and Fall Bank in the Cayman Crown complex of reefs.

SWOT Analysis for FSA Management in Belize

Strengths	Weaknesses
- Ongoing collaborative efforts between BFD & NGOs; provides additional support which is necessary for consistent monitoring i.e. human, financial resources. - Advancements in technology used for monitoring at some sites (e.g. hydrophones, laser callipers, etc) - Political will to support FSA conservation. - Regulations are quite advanced, and include most of the accepted best practices for conservation of Nassau Grouper - SPAGS still exist in Belize despite extirpation in other countries. - There is active management and enforcement, especially by comanagers of MPAs. - Very active working group ensures continuity of management. - Data collection on FSAs in Belize spans over two decades; a significant time series of information with strong baselines. - Ongoing investment in continued capacity building and training (i.e. methodology refresher courses, etc). - Annual/Biannual national reports continue to be produced. - Positive outlook by fishing community on regulations yields both compliance and support for FSA conservation. - Fishers generally avoid landing Nassau grouper to avoid penalties. - Existence of the Belize MPA network with SPAG as priority. - 25 years of published spawning aggregation work (better than most countries). - Strong public knowledge, lots of outreach and PSAs. - Documentaries on Nat Geo, BBC, PBS feature Belize's FSAs. - Standardised monitoring methodologies across Mesoamerican countries via MARFish project promote subregional cross compatibility. - Engagement of fishing sector – feedback, participation in monitoring, fisheries landing data. - Many FSAs have been identified, legally protected and recognised by management and fishers. - Under the Blue Bond commitment, an expansion of national protected area coverage gave a bigger no-take buffer around some legally protected FSAs	- Gaps in time-series of data, usually caused by lack of finances or manpower to survey. - Strong variability in the accessibility of data. - BFD not in possession of complete/up-to date national datasets. - The SPAG Working Group has a database, but it has been defunct for many years. - Gaps in enforcement are caused by lack of consistent funding. - Regular staff turnover: people stay within country but change jobs. Institutional memory leaves organizations on a regular basis. - Organizations not adequately staffed to independently conduct monitoring activities - Limited number of qualified freelance surveyors to supplement in-house monitoring staff. - Capacity within organizations to write peer-reviewed papers and conduct statistical analysis is uncommon. - Raw data collected by organizations are not always translated to outreach/publications/easily accessible reports. - No long-term strategy to overcome systemic logistical challenges with respect to monitoring spawning aggregations e.g. biannual monitoring to decrease annual resource needs/facilitate resource sharing - No clear monitoring, evaluation and adaptation framework for FSA management. - Limited feedback from monitoring to facilitate strategizing for adaptive management. - Limited availability of fishery dependent data. - Catch trends not routinely reviewed to detect growth/recruitment overfishing. - Shifting baseline for FSA species populations among stakeholders; healthy populations last seen 50 years ago. - No specific regulations for mutton snapper nor other commercially important FSA species. - Relevant management plans have been proposed but have no legal basis.

Opportunities	Threats
- Alignment with Code of Conduct for Sustainable Small-scale Fisheries - Use of the RFSAMP as a reference for generating national strategic policies - Adherence to the precautionary principle in the development of national FSA policies - Closed seasons during the spawning season of other vulnerable species could protect undocumented FSAs - Greater engagement with Big Fish Initiative for community outreach and regional collaborations - Community outreach on topics including life-history of key species and catch data analysis may allow fishers to modify fishing practices to increase the sustainability of their livelihood - Community outreach effort should be monitored, evaluated and adapt regularly. - Fishers are still repositories of traditional knowledge and can indicate observed changes since baseline. - Continuation of efforts to promote self-organization of community and stakeholder groups. - Engagement/facilitation of fishers in reporting illegal fishing and design of enforcement strategies. - Leveraging regional networks for funding/technical support e.g. MARFish, WECAFC, OSPESCA, SPAW-RAC. - Mitigate resource scarcity by staggering FSA monitoring to biannual. - Interagency collaboration to enhance monitoring and enforcement. - User friendly national data platform, with ongoing training for use and a streamlined flow of information to BFD. - Protected Areas Conservation Trust (PACT) funding. - Belize Fund for a Sustainable Future (BFSF) funding. - Scientific review of past 2 decades of FSA monitoring to inform adaptive management. - Formulation of long-term strategy & monitoring framework with clear benchmarks and indicators - Explore measures to minimise impacts to Nassau grouper outside of spawning season & no take areas - Increasing comanagement to relieve resource burden on GOB - Passive monitoring techniques e.g. passive acoustics - Use of fish finders to locate roving FSAs	- Ongoing population/aggregation declines - Effects of changing climate on ecology and life history of FSA species poorly understood - Effects of transition of reef systems from coral dominated to algae dominated systems on ecology of FSA species poorly understood - Lack of consistent, long-term access to funding - Reliance on grant funding has far reaching consequences - Ongoing evidence of illegal fishing from neighbouring countries - **Growth overfishing** - **Recruitment overfishing** - Weather patterns can prohibit consistent monitoring - Variability in location, depth and timing of spawning aggregations is poorly understood - Variability in location, depth and timing of FSAs makes visual monitoring of FSAs more difficult - “Trust issues” between fishers and Belize Fisheries Department - Corruption within enforcement agencies - Narrative choices for communication with fishers and the community which alienate stakeholder groups - Selection of ineffective/inappropriate indicators for monitoring and evaluating management effectiveness

- Collaborations for publication/management planning
- Proposed national multispecies finfish management plan (2022)
- MARFish proposed national and regional recommendations in 2020
  o Status report on FSAs in MAR
  o Policy Brief on FSAs in MAR	

Belize Fisheries Department – Remarks on RFSAMP

The metadata repository includes a country profile which includes a self-assessment of regulations and management effectiveness with respect to FSAs. The BFD indicated that they consider Belize to have achieved moderate FSA management effectiveness, with implementation of regulations somewhat effective, minimal resource needs for management action met, spawning population stable, and stakeholders somewhat compliant.

While the BFD officers present had not read the entire RFSAMP, they had read the executive summary. While the main body of the text was described as lengthy, they were impressed by the level of detail and expressed intent to use it as a reference on a case-by-case basis. They also did not foresee any obstacles which might delay or interfere with progressive implementation of the RFSAMP in-country.

In terms of significant national initiatives which might benefit FSA management, the officers made reference to Belize's commitments to increase the percentage of highly protected areas in its' marine space, and the advent of marine spatial planning (Blue Bond & Finance Permanence Unit, 2024). When asked for recommendations to improve FSA management in their subregion (i.e. Mesoamerica), BFD proposed that The Organization of Fishing and Aquaculture in Central America (OSPESCA) has mandated harmonised regulations for the spiny lobster fishery in the past and might be the most effective avenue for exploration of harmonised subregional regulations for Nassau grouper and mutton snapper. This would go a long way towards mitigating the threat of illegal fishing driven by markets for these species in neighbouring countries.

The articles below describe their responses to the 16 individual actions described under the RFSAMP.

Short-term actions (Within three years)

3. Define criteria to prioritise sites/countries

BFD: Belize has had harmonised national methodologies for exploration, identification and monitoring of FSAs since 2004. These methodologies provide the criteria and data streams necessary for assessment and prioritisation of FSAs in-country and may serve as an example of methodologies which can be applied in other nations.

8a. Promote synchronised regional closed season for Nassau grouper from 1 December – 31 March and for mutton snapper from 1 April to 31 July

BFD: Belize has already implemented a closed season for the Nassau grouper fishery which aligns with the regional recommendation. In contrast, mutton snapper is only regulated at

the Gladden Spit FSA, which is the most commercially significant site for its fishery. Fishing at this site has been limited to specially licensed traditional fishers who are only allowed to fish for two weeks of each month from March to June. A national closed season for mutton snapper will require further consultation with the administration for an assessment of feasibility in the national context.

10. Evaluate the effectiveness of current Nassau grouper and mutton snapper Fisheries Management

BFD: Subsequent review of available information will allow an appropriate answer to this question.

Medium-term actions (Within five years)

7. Countries expand commitments to counteract IUU fishing

BFD: Belize has an IUU fishing plan in place, implementation of which is spearheaded by the Conservation Compliance Unit of the BFD.

CCU: The GOB recognizes the threats posed to FSAs by transboundary incursions, and hopes to procure larger, faster patrol vessels to enhance their operations. The best way to counteract these threats is to be found in collaborations between national and international agencies. The BFD is currently exploring collaboration with US enforcement agencies and neighbouring countries.

8b. Complete moratorium on Nassau grouper fishery

BFD: This will require further consultation with the administration for an assessment of feasibility.

12. Establish regional guidelines for conducting non-extractive use of Nassau grouper and mutton snapper FSAs (tourism, research, education)

BFD: National guidelines currently do not exist; however, they are considered an important product which the BFD would gladly endorse in the short term. There are certainly no formal guidelines for tourism, and guidelines for research are encompassed in the permitting system. Finally, the national Spawning Aggregation Working Group has the mandate to conduct outreach and does so via multiple pathways. The department is aware of a study conducted at Gladden Spit, where tourism activities have historically taken place W. D. Heyman et al. (2010).

14. Improve understanding of regional larval connectivity patterns

BFD: The department is in support of work which attempts to determine such connectivity. Presently, work is being done on queen conch by the University of Rhode Island.

Long-term actions (Within ten years)

1. Generate and compile scientific and traditional information on FSAs

BFD: This work has already been done/is being done at present by the national Spawning Aggregation Working Group and should be updated with new information following cues from the RFSAMP. Extensive baselines on scientific and traditional information do exist in Belize and can serve to inform outreach and educational products on the importance of healthy FSAs.

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

BFD: The department strongly supports this aspect of the RFSAMP and will encourage fisher participation throughout the pilot process and on an ongoing basis.

4. Map locations and timing of known Nassau grouper and mutton snapper FSAs, pre-spawning migrations routes and determine their population status, using scientific methods and fisher knowledge.

BFD: This was already done at the turn of the century but could potentially be revisited.

5. Adopt and progressively implement regional monitoring frameworks to collect fishery dependent and independent data.

BFD: The department is happy to support the development and implementation of such frameworks in accord with its institutional commitments.

6.Develop effective national/subregional/regional alliances and protocols, to collect socioeconomic and trade data associated with Nassau grouper and mutton snapper fishing at/during FSA areas/seasons.

BFD: Nassau grouper export ended many years ago, and most of the legal FSA fishing occurs at Gladden Spit. The department supports the collection of data around fishing at this site during the snapper season.

9. Promote the development and implementation of national plans to protect FSAs and aggregating species starting with Nassau grouper and mutton snapper.

BFD: A draft management plan for Nassau grouper was written in 1994 but was never implemented. A proposed multispecies fishery management plan (which subsumes management of Nassau grouper and mutton snapper) was published by UNCTAD in 2022 but has also not entered into legal force.

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

BFD: Significant livelihood benefit from Nassau grouper FSAs ended long ago. Consultation with fishers will be a prerequisite to assessing their reliance on unprotected mutton snapper FSAs, their proposed solutions to specific challenges in the fishery for that species, and their alternative livelihood interests.

13. Develop regional/subregional marketing and awareness strategies/campaigns for the general public on the importance of healthy aggregations to maintain ecosystem services and socioeconomic benefits, initially focused on Nassau grouper and mutton snapper, in support to the FSA Working Group regional communication strategy.

BFD: Can support the development of such campaigns via in-house communications & outreach focal point. The department would also recommend the engagement of the national spawning aggregation working group.

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

BFD: Such a study has not yet been done in Belize but would need to be pursued in collaboration with an academic partner. This study may require capacity that does not exist locally.

16. Increase Nassau grouper and mutton snapper FSA protection by improving management of current MPAs or establishment of new MPAs where the conservation of FSAs is included in the objectives.

BFD: Belize is presently expanding its MPA system in pursuit of 30 percent MPA coverage by 2030. This expanded system should benefit many marine species, including Nassau grouper and mutton snapper.

Conclusions and recommendations

Belize is an example of a country with a strong network of social actors who have actively collaborated to manifest many of the recommended best practices for management of fish spawning aggregations, with emphasis on Nassau grouper. Their regulations are so comprehensive with respect to this focal species that the only real advancement which could be made would be a total moratorium on harvest or possession of *E. striatus* and its products. Belize has also utilised harmonised monitoring and archival methodologies across monitoring agencies and has robust streams of data with respect to the abundance of breeding fish at the FSAs. Organizations have begun to independently expand their repertoire of technologies and methods employed for monitoring. Supplementary datasets on reef fish surveys exist, and limited fishery dependent datasets provide windows into the status of national fisheries catch. The national Spawning Aggregation Working Group is still active and vibrant after two decades, and engages a cross section of participants from government, NGO and fisher organizations in decision-making. Further, the Government of Belize is keen to participate in WECAFC's regional management efforts and is supportive of the actions proposed by the RFSAMP.

However, when critically examined through the lens of Project Objective 1[2] and the three short-term/priority actions proposed by the RFSAMP, areas for improvement of management paradigms in Belize become apparent. Belize has already protected thirteen multispecies FSA sites and prioritised eight for regular monitoring effort, and streams of data exist to further prioritise and adapt governance within this selection of areas. The country has also already enacted closed season for Nassau grouper in alignment with the period proposed in the RFSAMP. However, the RFSAMP also proposes a closed period for mutton snapper, which Belize does not have. There are also no specific regulations for management of mutton snapper at the national level.

Status: FSA management effectiveness

There is no formal monitoring and evaluation framework or national process for reviewing the effectiveness of FSA-specific management. Management of FSAs is subsumed and evaluated, at best, under management of finfish, for which there is no operational management plan. The guidelines for development of a multispecies finfish management plan (UNCTAD, 2022) includes special considerations for Nassau grouper and mutton

[2] Project Objective 1: "Compile/update/ collect scientific and traditional information on Nassau grouper and mutton snapper spawning aggregations, and other complementary fishery-dependent and -independent information to improve our understanding of the species' current status and to provide recommendations to improve their fishery management and conservation strategies in key selected countries within the WECAFC region."

snapper which may be limited in their sensitivity to the social-ecological system impacting these and other FSA associated species due to reliance on just three indicators. Further, the indicators rely on landings data and reef survey data as their data streams, when landings data are limited at present and collection of finfish data is challenging in the local context without large resource inputs. Reef survey data, while helpful as a supplementary data stream, has inherent limitations with respect to assessment of grouper and snapper species, as the life histories and ontogenetic habitat usage of these fish species mean that the individuals encountered at >15 m/50 ft (the general depth limitation of reef surveys conducted by SCUBA) may not be representative of the entire population.

It is recommended that Belize adopt a formal monitoring and evaluation framework specific to FSA management, considering a broad spectrum of fishery dependent, life history- and habitat-related, enforcement, participation and outreach indicators to make holistic assessments of the governance system, FSAs and the ecosystems upon which they rely for their life history processes.

This monitoring and evaluation framework should include periodic reviews, benchmarks and trigger points for management actions, with aspiration to implement regulations and management plans for adaptively management of Nassau grouper, mutton snapper and other FSA species (i.e. other large groupers and snappers, jacks, permits, bonefish, *inter alia*).

Future adaptations which might promote the health of FSAs and related species include:

- Listing national priorities for research on Nassau grouper, mutton snapper and other FSA related finfish including strategies to address existing data gaps on:
    - fishery dependent data; and
    - socioeconomic impact data.

- Legally enforced regulation of other FSA related finfish species (including, but not limited to, the operationalization of the proposed multispecies management plan)
- Prioritization of ontogenetic structure and habitat usage as considerations for management of threats to finfish species e.g. degradation/destruction of habitat, fishing effort
- A mandate for outreach to increase community knowledge and capacity for engagement in:
    - governance of finfish and FSA management; and
    - best practices for extractive and non-extractive resource consumption.
- Regionally harmonised approaches to management of Nassau grouper and mutton snapper, with emphasis on:

- collaborative enforcement actions to deter transboundary incursions; and
- synchronised regulations which mandate closed seasons to eliminate markets which act as transboundary sinks for fishery products originating in Belize.

It must be noted, however, that recent publications by the MARFISH project (Fulton, Acevedo, et al., 2020; Fulton, José González-Bernat, et al., 2020) provide management recommendations and context for the prioritisation of FSA sites in Belize and other Mesoamerican reef countries and serve as excellent reference documents.

Status: FSA Populations

Nassau groupers are considered to be a relatively rare species across Belize, while mutton snapper is considered to have declined in abundance but are still a prized fishery target. Eight of the thirteen protected multispecies FSAs are regularly monitored by the BFD or partner NGOs belonging to the national Spawning Aggregations Working Group (Burns Perez & Tewfik, 2016). Nassau grouper has received the lion's share of monitoring effort, and this bias is evident in the relative lack of data on mutton snapper and other FSA species. The exception to this rule is Gladden Spit, where a wealth of information has been documented on several FSA-related species.

While some *E. striatus* FSAs appear to have been extirpated (e.g. Rocky Point, Gladden Spit), to exhibit apparent signs of decline (e.g. Northeast Point) or consistently small breeding groups (e.g. Nicholas Caye), the data from a few FSAs suggest the presence of persistent breeding groups of 1 000-4 000 fish (e.g. Sandbore, Caye Glory, Mauger Caye). The variability of the datasets from the latter group, and intra-organizational reports which indicate increased rates of success with respect to locating the main body of the FSA through the use of search patterns or fish finders, suggest that many of the GPS points presently being used to locate FSAs may be obsolete. Monitoring agencies might benefit from adopting the use of fish finders to increase the efficacy of underwater visual surveys, and thus the accuracy of reported fish abundances at FSAs on an annual basis.

Status: Availability and Accessibility of Data

There is an abundance of consistent and robust data streams for assessment of FSAs and their populations. However, this data is not used within a national monitoring and evaluation framework to trigger adaptive management. The datasets and the reports which are generated are not easily accessible even within country, nor are they analysed with academic rigour on a regular basis. Intra-organizational reports and interorganizational reports have been found to be valuable sources of contextual information key to the interpretation of time series of data. However, they are massively underutilized, largely due

to inaccessibility. As a result, the entire time national series of data are not readily synthesized with recommendations outside of key publications (Burns Perez & Tewfik, 2016).

This is not necessarily a barrier to the implementation of adaptive FSA management; however, as adequate information and reference documents exist to facilitate this process.

Opportunities for Regional Support from WECAFC

The following areas were cited by the Belize Fisheries Department as management areas where Belize might benefit from regional support:

- Training/Capacity Building Tools for Assessment and Monitoring
- Communication & Education Tools
- Community/Stakeholder Engagement strategies
- Best practice resources & nature-based solutions for FSA management
- Funding to carry out:
    - enforcement during closed seasons;
    - fishery dependent data collection; and
    - national assessment of FSA status.

References

Babcock, E. A., Tewfik, A., & Burns-Perez, V. (2018). Fish community and single-species indicators provide evidence of unsustainable practices in a multi-gear reef fishery. *Fisheries Research*, *208*, 70–85. https://doi.org/10.1016/j.fishres.2018.07.003

Blue Bond & Finance Permanence Unit. (2024). *Belize Blue Bonds - Blue Finance for Nature and People 2021-2023*.

Bowman, C. A., Mangi, S. C., & Oxenford, H. A. (2021). Using stakeholder's perspectives of "Managed Access" to guide management efforts in small-scale fisheries. *Environmental Conservation*, *48*(2), 100–109. https://doi.org/10.1017/S0376892921000047

Burns Perez, V., & Tewfik, A. (2016, November 9). Brief History of Management and Conservation of Nassau grouper and their Spawning Aggregations in Belize: A Collaborative Approach. *68th Gulf and Caribbean Fisheries Institute*.

Carter, J., & Marrow, G. (1991). *Preliminary Fishery Management Plan for the Nassau Grouper (Epinephelus striatus) Fishery*.

Carter, J., Marrow, G. J., & Pryor, V. (1994). Aspects of the ecology and reproduction of Nassau Grouper, Epinephelus striatus, off the coast of Belize, Central America. *Proceedings of the 43rd Gulf and Caribbean Fisheries Institute*.

Carter, J., & Perrine, D. (1994). A Spawning Aggregation of Dog snapper, Lutjanus jocu (PISCES: LUTJANIDAE) In Belize, Central America. *BULLETIN OF MARINE SCIENCE*, *55*(1), 228–234.

Craig, A. K. (1966). *Geography of Fishing in British Honduras and Adjacent Coastal Waters*. http://ambergriscaye.com/pages/mayan/geographyoffishing.html

Craig, A. K. (1969). The grouper fishery of cay glory, british honduras. *Annals of the Association of American Geographers*, *59*(2), 252–263. https://doi.org/10.1111/j.1467-8306.1969.tb00669.x

Froese, R. (2004). Keep it simple: three indicators to deal with overfishing. *Fish and Fisheries*, *5*, 86–91.

Fulton, S., Acevedo, A., Estrada, J., & Caamal, J. (2020). *Status Report on Fish Spawning Aggregations in the Mesoamerican Reef 2020*.

Fulton, S., José González-Bernat, M., Silvia Martínez, A., González, M. J., Nuñez, F., Gonzalez-Bernat, M. J., Fulton, S., Martinez, A. S., & Gonzalez, M. J. (2020). Policy Brief on Fish Spawning Aggregations. In *MAR Fish Project*.

Gibson, J., Pott, R. F., Paz, G., Majil, I., & Requena, N. (2007). Experiences of the Belize Spawning Aggregation Working Group. *Proceedings of the 59th Gulf and Caribbean Fisheries Institute*, 455–462.

Graham, R. T., Carcamo, R., Rhodes, K. L., Roberts, C. M., & Requena, N. (2008). Historical and contemporary evidence of a mutton snapper (Lutjanus analis Cuvier, 1828) spawning aggregation fishery in decline. *Coral Reefs*, *27*(2), 311–319. https://doi.org/10.1007/s00338-007-0329-4

Graham, R. T., & Castellanos, D. (2012). Apex predators target mutton snapper spawning aggregation. *Coral Reefs*, *31*(4), 1017. https://doi.org/10.1007/s00338-012-0921-0

Granados-Dieseldorff, P. (2013). *The mutton snapper (Lutjanus analis) spawning aggregation fishery at Gladden Spit, Belize: inter-annual and within-season dynamics* [Doctoral Dissertation]. Texas A&M University.

Harms-Tuohy, C. A., Scharer, M. T., Ruiz, H., Tuohy, E., & Figuerola, M. (2022). *Identifying critical habitats of juvenile Nassau grouper (Epinephelus striatus) in Puerto Rico*. https://doi.org/10.13140/RG.2.2.11120.74244

Heyman, W. D., Carr, L. M., & Lobel, P. S. (2010). Diver ecotourism and disturbance to reef fish spawning aggregations: It is better to be disturbed than to be dead. *Marine Ecology Progress Series*, *419*, 201–210. https://doi.org/10.3354/meps08831

Heyman, W., & Requena, N. (2002). *Status of Multispecies Spawning Aggregations in Belize*.

Heyman, W., & Wade, B. (2007). Status of reef fish spawning aggregations in Belize. *Proceedings of the 58th Gulf and Caribbean Fisheries Institute*. http://hdl.handle.net/1834/28983

Hixon, M. A., Johnson, D. W., & Sogard, S. M. (2014). BOFFFFs: On the importance of conserving old-growth age structure in fishery populations. *ICES Journal of Marine Science*, *71*(8), 2171–2185. https://doi.org/10.1093/icesjms/fst200

Kobara, S., & Heyman, W. D. (2010). Sea bottom geomorphology of multispecies spawning aggregation sites in Belize. *Marine Ecology Progress Series*, *405*, 243–254. https://doi.org/10.3354/meps08512

Paz. (2002). *CRITICAL ANALYSIS OF INFORMATION ON SPAWNING AGGREGATION SITES IN MBRS PROJECT COUNTRIES AND RECOMMENDATIONS FOR THEIR MONITORING & MANAGEMENT (DRAFT REPORT)*.

Paz, E., & Grimshaw, T. (2001). *Life History Characteristics & Management Recommendations for Nassau Grouper in Belize*.

Paz, G. E., & Grimshaw, T. (2001). *STATUS REPORT ON NASSAU GROUPERS FOR BELIZE, CENTRAL AMERICA: A Scientific Report of the Green Reef Environmental Institute*.

Phillips, M. (2024). *Minutes of Belize Workshop #2 - Pilot Implementation of WECAFC Regional Fish Spawning Aggregation Management Plan*.

Phillips, M., Tewfik, A., & Burns Perez, V. (2024). Approaching extirpation of an isolated Nassau grouper (Epinephelus striatus) population at Glover's Reef, Belize . *Manuscript in Preparation*.

Sadovy, Y., Prada Triana, M., Azueta, J. O., & Lindemann, K. C. (2022, July 26). Regional Fish Spawning Aggregation Fishery Management Plan: Focus on Nassau Grouper and Mutton Snapper (FSAMP). *Western Central Atlantic Fishery Commission (WECAFC) 18th Session*.

Sala, E., Ballesteros, E., & Starr, R. M. (2001). Rapid Decline of Nassau Grouper Spawning Aggregations in Belize: Fishery Management and Conservation Needs. *Fisheries*, *26*(10), 23–30. https://doi.org/10.1577/1548-8446(2001)026<0023:rdongs>2.0.co;2

Starr, R. M., Ballesteros, E., Sala, E., & Llenas, J. M. (2018). Spawning behaviour of the tiger grouper (Mycteroperca tigris) in a Caribbean atoll. *Environmental Biology of Fishes*, *101*(12), 1641–1655. https://doi.org/10.1007/s10641-018-0813-4

Starr, R. M., Sala, E., Ballesteros, E., & Zabala, M. (2007). Spatial dynamics of the Nassau grouper Epinephelus striatus in a Caribbean atoll. *Marine Ecology Progress Series*, *343*, 239–249. https://doi.org/10.3354/meps06897

Tewfik, A., Babcock, E. A., Gibson, J., Perez, V. R. B., & Strindberg, S. (2017). Benefits of a replenishment zone revealed through trends in focal species at Glover's Atoll, Belize. In *Marine Ecology Progress Series* (Vol. 580, pp. 37–56). Inter-Research. https://doi.org/10.3354/meps12290

Tewfik, A., Babcock, E. A., Phillips, M., Moreira-Ramírez, J. F., Polanco, F., Marroquin, J., Castillo, M., Auil Gomez, N., & McNab, R. (2022). Simple length-based approaches offer guidance for conservation and sustainability actions in two Central American small-

scale fisheries. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *32*(8), 1372–1392. https://doi.org/10.1002/aqc.3827

Tewfik, A., Phillips, M., Maaz, J., & Ramnarace, J. (2020). *A SMARTer approach to collection of catch data for conservation and sustainability*.

Thompson, E. (1945). The Fisheries of British Honduras. In *Bulletin of Development & Welfare Organisation in the West Indies* (Issue 21). Advocate Company.

UNCTAD. (2022). *Towards a Climate Resilient Multispecies Finfish Management Plan for Belize*. United Nations. https://doi.org/10.18356/9789210013666

Walker, Z. (2020). *National Protected Areas System - Management Effectiveness Assessment Tool*.

Wildtracks Belize. (2019). *Management Plan - Glover's Reef Marine Reserve (2019-2023)*. https://rris.biopama.org/sites/default/files/2021-02/Glovers%20Reef_MR_MP%202019%20-%202023.pdf

Zeller, D., Graham, R. T., & Harper, S. (2011). Reconstruction of total marine fisheries catches for Belize. In M. L. D. Palomares & D. Pauly (Eds.), *Fisheries Center Research* (Vol. 19, Issue 6, pp. 142–151). Fisheries Center, University of British Columbia. www.seaaroundus.org;

Appendix 1. Minutes of Workshop #1: 17 January 2024

"Improving ecosystem approach to fisheries by advancing fish spawning aggregation information gathering and increase of public engagement in the WECAFC region"

Initial Meeting with Belize National Spawning Aggregation Working Group

17 January 2024

1.30 pm – 3.00 pm

ATTENDEES

Belize Fisheries Department	Mauro Gongora Shakera Arnold Tyrell Reyes (Secretary) Alicia Eck-Nunez Kenneth Esquivel
Belize Audubon Society	Dominique Lizama
MARAlliance	Rachel Graham Kirah Forman
Turneffe Atoll Sustainability Association	Kevin Novelo

ABSENT (WITH APOLOGIES)

Coastal Zone Management Authority and Institute	Alyssa Coleman
Turneffe Atoll Sustainability Association	Virginia Burns-Perez (Chairperson)
Wildlife Conservation Society	Julio Maaz
University of Belize – Environmental Research Institute	Jake Snaddon

OTHER INVITEES

- Toledo Institute for Development & Environment
- Southern Environmental Association

MINUTES

13:30 Welcome

The meeting began at 1.30 pm. Mr Myles Phillips welcomed all attendees, giving a brief overview of the project, and the intended aims for this 90-minute session. He emphasized that this was the second of three planned engagements – the first of which was a meeting with staff of the Belize Fisheries Department, and the third of which would be a hybrid virtual/in-person workshop with a broader stakeholder base, including fishers, external scientists and key community members.

13:35 Opening Remarks – Belize Fisheries Department

Mr Mauro Gongora welcomed all participants, voicing his support for the implementation of the Regional Fish Spawning Aggregations Management Plan.

13:40 Presentation – Project Overview

Mr Phillips delivered a brief presentation (attached) which summarised the context under which the project was taking place. This context included the history of the RFSAMP, its aims, objectives and the related Big Fish Communications Plan (https://linktr.ee/bigfishinitiative).

13:50 Question & Answer

Dr Rachel Graham asked regarding the FSA Working Group's interest in Goliath grouper? She indicated that this species is in worse shape than Nassau grouper or mutton snapper, with her data from Belize showing steep downward trends in the population size.

Upon request, Mr Phillips indicated that she could write a letter to the FAO-WECAFC to propose that the Goliath grouper be upgraded to WECAFC Group 1 species for greater regional conservation focus. Her data has been published and the articles are hosted on the MARAlliance website. Other data was published in a special issue with Endangered Species Research in 2009.

Mr Mauro Gongora indicated that, to his knowledge, Goliath grouper has not received a sufficiently severe population status in assessments by IUCN, Convention on Migratory Species, etc. to merit increased priority locally. The species is listed only as Vulnerable in the IUCN Red List, and there is not enough information locally to speak to the species' status. As a result, the BFD would be willing to look at the issue and review any existing information but doesn't feel justified in making it a priority at the time or stating that the species is overfished.

Ms Alicia Eck-Nunez asked regarding whether management effectiveness would be measured at the organizational or country level. Mr Phillips told her that it would be measured at country level, with BFD considered to be the management authority. She further queried whether there was a specific tool which would be used for measuring management effectiveness. Mr Phillips responded saying that there was no consensus yet on a specific tool, but that in the meantime, effectiveness would be reviewed based on stated intentions in seminal documents and legislation.

14:00 Identification of Contact Persons & Stakeholders

- Communications
- Monitoring
- Fisher, Co-op and Community
- Regional/International

Participants were asked to submit the names and contact information of their organization's monitoring and communications focal points via email.

Mr Phillips requested the names of local and international stakeholders to populate the attendee list for the planned hybrid workshop. Mr Mauro Gongora suggested Mr Elmer Rodriguez (National Fisherman Co-operative) and Mr Esteban Solis (Northern Fishermen Co-operative). He further indicated that Mr Tyrell Reyes and Ms Alicia Eck-Nunez would be able to create a list of historical site users who should attend. Dr Rachel Graham also proposed a short list of regional/international colleagues who might be interested in attending, and said she would send their contact information via email:

- Stuart Fulton
- Mauricio Hostim
- Johan Mourier
- Alfonso Aguilar-Perera

14:20 Identification of Information Sources

- fishery-dependent data (landings, catch, fishing effort, stock assessment);
- fishery-independent data (monitoring data);
- methodologies for relevant data collection;
- historical data sources; and
- relevant reports/published literature (national, regional, species specific).

Mr Phillips gave the attendees a demonstration of the mutton snapper Excel sheet into which they would put the metadata for their monitoring information. Follow up will occur on 24 January. Mr Phillips will be requesting the metadata as well as copies of the data. The data sharing agreement of the working group, the

endorsement of the project by the BFD, and the agreement of cooperation between the Belize Government and the FAO all work to facilitate this process. MARAlliance confirmed that they have access to the historic data collected by the Southern Environmental Association on Gladden Spit FSA.

While the SPAG Working Group's member organizations generally use the 2004 monitoring manual produced by TNC and updated in 2011 with citation:

Heyman, W., Azueta, J., Lara, O., Majil, I., Neal, D., Luckhurst, B., Paz, M., Morrison, I., Rhodes, K. L., Kjerve, B., Wade, B., & Requena, N. (2004). Spawning Aggregation Monitoring Protocol for the Meso-American Reef and the Wider Caribbean. Version 2.0.

... as their source of methodologies for FSA related monitoring, MARAlliance also captures grouper and snapper related data during other survey types, including:

- megafauna surveys;
- baited remote underwater video; and
- deepwater surveys.

Dr Rachel Graham noted further that they hope to discover spawning aggregations for deep-dwelling grouper and snapper species.

With respect to literature, Mr Phillips informed the group that he had populated a library of publications in the SPAG Working Group Google Drive (https://drive.google.com/drive/folders/1jcsZoCTZHBBazS3qNeayuBoJo8QM5uQL?usp=drive_link).

He requested that working group members add any works from their files which are not already in the folder, which would serve as a resource in posterity.

Appendix 2. Minutes of Workshop #2: 17 May 2024

Pilot Implementation of WECAFC Regional Fish Spawning Aggregation Management Plan

"Improving ecosystem approach to fisheries by advancing fish spawning aggregation information gathering and increase of public engagement in the WECAFC region"

Belize: Summary of Workshop #2 (Hybrid)

The Tapir Room, Belize Biltmore Hotel

17 May 2024, 8.30am – 2.30pm

Background

This technical workshop is being held as part of the project GCP/SLC/223/EC "*Improving ecosystem approach to fisheries by advancing fish spawning aggregation information gathering and increase of public engagement in the Western Central Atlantic Fisheries Commission (WECAFC) region*". The project serves as a pilot implementation of the WECAFC Regional Fish Spawning Aggregation Management Plan (endorsed in 2022) and is described in Appendix 3. The Wildlife Conservation Society is the service provider to WECAFC for this project and is leading implementation in the three pilot countries: Belize, the Bahamas, and Cuba.

Workshop objectives

The aim of this second workshop is to engage a diverse group of Belizean stakeholders for validation of information collected on the status and management of fish spawning aggregations (with particular interest in Nassau grouper and mutton snapper). The first workshop was held in January 2024, and included representatives of the Belize Fisheries Department and the Belize National Fish Spawning Aggregation Working Group. The SWOT Analysis which resulted from the first meeting has been updated and is included as Appendix 1. Outcomes of the second workshop will contribute to preparation of a country report which WECAFC will use to inform future institutional support to Belize as a member state. Specific objectives include:

1. Present information collected by WCS on:
    a. monitoring data;
    b. fisheries data;
    c. livelihoods impacts;

    d. enforcement and compliance; and
    e. traditional knowledge.
2. Through plenary discussions and group exercises, fill gaps in information with institutional and traditional knowledge.
3. Review and assess management and conservation approaches to FSAs in Belize
4. Propose adaptive recommendations for management of these species at the following scales:
    a. national;
    b. subregional (i.e. Mesoamerican reef); and
    c. regional (i.e. Western Central Atlantic/Gulf and Caribbean region)

Reference Documents

- Regional Fish Spawning Aggregation Fishery Management Plan: Focus on Nassau Grouper and Mutton Snapper (FSAMP)
- Recommendation WECAFC/XVIII/2022/4 - WECAFC Working Group on Spawning Aggregations

Participant List

Name	Organization	Position
Gabriela Ugarte	Belize Audubon Society	Marine Research and Monitoring Officer
Kenneth Esquivel	Belize Fisheries Department	CFU Coordinator
Mauro Gongora	Belize Fisheries Department	Fisheries Officer
Tyrell Reyes	Belize Fisheries Department	Fisheries Officer
Abigail Quiroz	Belize Fisheries Department	
Leandra Cho-Ricketts	Belize Fund for a Sustainable Future	Executive Director
Norman Castillo	Hopkins Fishermen Association	Chairman
Kirah Forman	MarAlliance	National Coordinator
Juan Munoz	Sarteneja Fisherman Association	Executive Member
Kevin Novelo	Turneffe Atoll Sustainability Association	Conservation Science Manager
Virginia Burns Perez	Turneffe Atoll Sustainability Association	AMP Director
Jake Snaddon	University of Belize Environmental Research Institute	Director
John Thomas	Wabafu Fishermen Association	Chairman
Julio Maaz	Wildlife Conservation Society	SSF Technical Coordinator
Eden Cruz	Wildlife Conservation Society	Communication Asst.
Henry Brown	Wildlife Conservation Society	Marine Technical Asst.
Nicole Auil Gomez	Wildlife Conservation Society	Director
Addiel Perez	Bonefish & Tarpon Trust	Program Manager
Martha Prada	Caribbean Fisheries Management Council	
Peter Murray	Caribbean Regional Fisheries Mechanism	Advisor
Victor Sho	Coastal Zone Management Authority & Institute	Sports Fishing Coordinator
Stuart Fulton	Comunidad y Biodiversidad (COBI)	Director of Change
Raphael Martinez	Healthy Reefs Initiative	Belize Coordinator

Nancie Cummings	WECAFC Fisheries Data & Statistics Working Group	Chairperson
Yvette Diei Ouadi	Western Central Atlantic Fisheries Mechanism	Secretary
Janet Gibson	None	Local Expert

MINUTES

Session 1: Project Overview

The participants received a presentation which introduced the history and content of the WECAFC Regional Fish Spawning Aggregation Management Plan (RFSAMP) and its accompanying communications campaign, the Big Fish Initiative. The project "Improving ecosystem approach to fisheries by advancing fish spawning aggregation information gathering and increase of public engagement in the WECAFC region" was also explained in terms of its objectives, components, and its role as the pilot for implementation of the RFSAMP.

After the presentation, it was suggested by the Belize Fisheries Department (BFD) that the film (Treasures of the Caribbean) should be shown at coastal communities as an outreach tool.

BFD further recommended that fish spawning aggregation (FSA) sites which show indications of high relative abundance of fish should receive priority for continuous monitoring.

The Belize Fund for Sustainable Future (BFSF) asked whether the regional plan was endorsed by BFD, and whether the pilot project would incorporate relevant existing datasets and recommendations (e.g. MARFish Policy Brief and Status Report on FSAs). BFD confirmed its endorsement of the RFSAMP and emphasized the need for FSA work in Belize to align with regional commitments e.g. WECAFC. It was also confirmed that the pilot project would not reinvent the wheel and would incorporate as much of the existing data and recommendations as was practical.

Session 2: FSA Management in Belize

The second presentation briefly revisited the history of FSA management in Belize, highlighting relevant regional and national initiatives over the past several decades. Regulations, research and known aggregations were presented, and the group reviewed the adaptive management cycle as part of an attempt to categorize existing work on Nassau grouper and other aggregating species. Targets and indicators were also suggested as a helpful monitoring and evaluation tool. Belize was considered to have a strong baseline of information, and long-time series of information on several FSAs. However, the data was not easily accessible. Peer-reviewed articles were found to be the most accessible sources of information on FSAs in posterity. It was highlighted that there had been no changes to FSA-specific regulations since 2009, and that Nassau grouper remained the only **fished** species with specific regulations despite the drafting of a proposed multispecies finfish

management plan within the last five years (complete fishing bans exist for certain species, and sportfish are mandated for catch and release). Sportfish (e.g. permit, bonefish) not usually included in FSA management discussions despite FSA behaviours.

While many things are still not well understood about the fin fisheries and FSAs of Belize, how much information is enough information? The precautionary principle was promoted as a guiding principle, given the significant known impacts to FSA species e.g. Nassau grouper. Management should happen before species approach extinction.

It was proposed that a national review of focal species (Nassau grouper, mutton snapper) should be achievable with existing information. Recent literature exists which proposes recommendations to guide future management of FSAs/finfish in Belize, and to support harmonized regulation of these species in the Mesoamerican Reef region. Institutional engagement of OSPESCA might be the most effective path forward to achieve these ends.

In response to a query about the existence of further mutton snapper spawning aggregations in Belize, BFD indicated the presence of potential mutton snapper FSA sites at the 'elbow', and south of Lime Caye in the Sapodilla Cayes Marine Reserve. The chairmen of the Wabafu and Hopkins Fisher Associations also suggested that there are other Mutton FSA areas south of Gladden Spit. However, they did not want to state specific locations, as these were considered to be prized fishing spots.

WCS suggested that factors such as the timing of spawning activities and the location/depth at which FSAs occur is changing over time.

A discussion about the proposed theory of change and its accompanying targets and indicators ensued. The BFD emphasized that education of the fishers from coastal communities will help to maximize their ability to comply with fisheries regulations. They should be encouraged and supported in their efforts to self-organize and represent their interests. If we are successful in getting their buy-in on management and protection measures, we can avoid conflict and foster mutually agreeable management. Community outreach effort is important and should be measured. BFD further commented that fishers are known to elude enforcement patrols because they study the BFD patrol schedules.

Hopkins Fisherman Association asked what have BFD done to deal with the increase in illegal fishing. They suggested that there was a need to consider the perspectives of fishermen who are willing to comply and assist in enforcement using their knowledge and experience.

BFD conceded that there would be a benefit to finding ways to incorporate fishers who want to assist in stopping illegal fishing.

The Wabafu Chairman said that he believed there is a trust issue between fishers and BFD enforcement. He suggested that members of the BFD enforcement team were condoning illegal fishing, through taking bribes or turning a blind eye to harvesting the marine products from MPA zones which prohibit commercial fishing.

UBERI urged that all stakeholders need to support the resource managers (BFD). We must be careful with how we talk about compliance, as the specific wording and narrative are extremely important to how messages come across to and from other groups. They and other groups highlighted the need to revisit the proposed indicators to ensure that they were SMART and appropriately phrased. WCS reminded the group that what was shown was not meant to be a proposal for final indicators. They were meant to jog the minds of the group for an activity where the group would propose appropriate indicators for enforcement and monitoring. Unfortunately, this activity was necessarily shelved due to the rich discussion consuming the allocated time.

BFD, CRFM and COBI highlighted the need especially for proper indicators of effectiveness with respect to enforcement. TASA noted that effective and strategic patrols must have captains with the knowledge and skills to navigate the remote and sometimes hazardous seas associated with FSAs, and that these captains should be piloting appropriate vessels. A commitment was made to flesh out these indicators using appropriate references and conversations with experts.

Session 3: Belize FSA Data

The third presentation laid out the fishery dependent and independent methodologies and datasets which were used in Belize. The Northeast Point FSA at Glovers Reef Atoll was used as a case study to show how these datasets could be used to assess the ecology and management of Nassau grouper, as well as the characteristics of its related fishery. The presentation went on to show abundance and size composition data collected at the protected spawning sites. Based on the theory that Nassau grouper typically does not cross deep water, and require contiguous reef for long distance migration, the protected FSAs were divided into “Main Barrier Reef FSAs” and FSAs at each of Belize’s three atolls; Turneffe Atoll, Lighthouse Reef Atoll, and Glovers Reef Atoll. Twenty-year datasets showed where some aggregations, including Caye Glory (once the most commercially important FSA in Belize and believed to have been extirpated by the year 2000), were believed to migrate vertically and horizontally in the general area of the spawning site. This presented a challenge for scientists monitoring the FSAs in terms of correctly assessing the number of fish, as finding the main body of the FSA is not guaranteed by GPS location. As many as 2 000–3 000 fish have been found at the Caye Glory FSA by fortunate monitoring teams.

After the presentation, the group was asked about any further historic or present FSAs which had not been mentioned. The Wabafu Fisher Association indicated that around South Water Caye and Carrie Bowe Caye channel, there is an area where large numbers of black groupers are seen. Other finfish species utilize this area in large numbers as well, including porgy and black snapper. It was unclear whether this was a migration route or an FSA. He and the chairman of the Hopkins FA affirmed knowledge of a mutton snapper aggregation near to Middle Caye at Glovers Reef Atoll and indicated that mutton snappers were known to "run" (migrate en masse) when heavy Northerly winds descend on Belize. They were emphatic that weather determines a seasonal abundance of many species, including mutton snapper.

WCS suggested the use of fish finders to locate fish aggregation at the different established FSA sites during the monitoring seasons. This might improve the efficiency and accuracy of monitoring and assessment at these sites, as the tendency of aggregations to vary in location, depth and spatial extent was now well documented. Aggregating species were also known to form multiple groups within the same general large area.

It was also noted that both WCS and TASA had deployed hydrophones at their FSAs and were in possession of one year of data each.

The fisher associations and BFD commented on the usefulness of this kind of information for outreach to educate and inform fishers. BFD suggested that WCS should break it down using pamphlets, presentations and other educational material for communities, fishers, and primary and secondary schools.

Participants were also asked to provide clarifying comments on certain FSAs, as noted below:

Rocky Point FSA, Bacalar Chico Marine Reserve – The BFD only did surveys from Jan-Feb for Nassau grouper. However, sea conditions during this time of year can be prohibitive to monitoring activities at this site. While Nassau groupers are generally not encountered at this site, black groupers are common. However, they are in deep water way beyond the scuba diving limits. In terms of mutton snapper, from 2009 to 2021, the Rocky Point FSA was not monitored during the mutton snapper spawning season. As such, the status of this species, and others with similar timing for their spawning activities, is unknown.

Caye Glory FSA, Main Barrier Reef (Central) – Caye Glory was known to be a multispecies spawning site which is used by many fish species, including porgies, jacks, yellow tail snapper and jimmy (rock or red) hind. Caye Glory is believed to host a roving aggregation which often evades the efforts of monitoring teams to locate and assess it. Successful survey teams improve their chances of encountering the spawning group by conducting transect style surveys across a broad area.

Gladden Spit FSA, Gladden Spit and Silk Cayes Marine Reserve – Fishers commented that many species of finfish, including mutton, dog and cubera snapper, are present in high abundance. However, protection of sharks and subsequent increases in population have made them a pest in the area. Sharks often damage or consume fish caught on fishing lines, making the area unprofitable as a fishing ground. Fishers also concurred with the speculation that the Nassau grouper FSA has been extirpated from this area, as they have not been seen in large numbers in many years.

Session 4: Supplementary Datasets

The final presentation summarized the findings from other datasets which indicate population status of FSA species, including reef survey data and catch data. Reef survey data from Glovers Reef clearly showed three separate size classes of fish inhabiting the shallow lagoon (less than 30 ft), the fore reef (less than 50 ft) and the fish spawning aggregation site. It was proposed that the spawning aggregations might be even more important than previously thought for monitoring the breeding populations of Nassau grouper, as reef surveys are limited in depth to less than ~50 ft, and sexually mature individuals seemed to live below this depth. Reef surveys might mostly capture juvenile and sub-adult fish.

Catch data collected from fishing grounds at Glovers Reef and Turneffe Atoll were presented, as well as extracts of data from a national survey of fish landing sites by WCS and TIDE from 2017 to 2020. Nassau groupers were extremely rare in the catch, while mutton snappers were considerably less so. Fishing depth from fishing ground catch data was used to characterize the fisheries for these species in the two areas, and it was shown that for both species, where they were caught at less than 40 ft, they tended to be sexually immature (based on their mean length in comparison to the known length where these species have 50 percent probability of maturity). Larger, sexually mature Nassau grouper were reliably caught at depths greater than 50 ft (15 m) at Turneffe Atoll.

For mutton snapper, this did not result in an infraction, but for Nassau grouper, with a legal minimum size of 508 mm, this life history related trend had relevance to the design of outreach for prevention of illegal fishing. It also highlighted that there was very little data on finfish populations in Belize. The group seemed to agree that the country does not possess adequate data to speculate as to the effect that the shallow reef fisheries for mutton snapper were having/might have on the population.

Fishers were enthusiastic and interested in the life history aspects of the discussion and repeated the call for further outreach to share this kind of information with fishers. The chairman of the Hopkins FA suggested that fishers might be able to adapt their methods and

practices if reports created from the catch data was shared with the same fishers that the raw data was collected from.

The fishers also indicated that landings of Nassau grouper might be low on the fishing grounds and at the landing sites because most fishers simply avoid bringing them in. Fishers do not routinely carry the necessary measuring equipment on their boats and are generally unable to ensure that the fish are within the size range stipulated by the regulations. For this reason, most try to avoid the penalties by simply releasing or discarding any Nassau grouper they catch. There has also been no market for Nassau grouper at the fisher co-ops for more than two decades.

Enforcement data corroborated the fishers' perspectives. Infractions by locals with respect to Nassau grouper were considered rare, and primary challenges cited were nighttime incursions by vessels from neighbouring Honduras, and lack of fuel for consistent patrols of sensitive areas including FSAs. It was suggested that in the case of Caye Glory, which is not encompassed by a marine reserve, there is a coast guard base is in proximity. BFD might be able to improve presence at this FSA through interagency collaboration. With respect to transboundary IUU, it was proposed that harmonized regulations via OSPESCA might make international enforcement collaborations easier to navigate.

Finally, the group agreed that the ways in which climate change was affecting marine species was not well understood in Belize. Fishers were asked about the ways that they believed climate change was impacting them with respect to finfish fisheries, and the ways in which they were adapting to these impacts. Their responses included:

- Climate change is definitely a factor affecting the weather and thus the movement patterns of several fish species. Weaker cold fronts have occurred over time, and it was observed that fish do not migrate en masse to the shallow fishing grounds in the way they once had.
- With higher ocean temperatures overall, the fishers had noticed that marine creatures were moving from shallow habitat and go deeper for cooler temperatures. Fishers must exploit deeper, more distant waters to catch the same marine products they had in the past.
- Fishers have changed their fishing gears and methods, as well as their fishing areas.

Session 5: SWOT Analysis

The group revisited the SWOT analysis drafted by the National Spawning Aggregation Working Group. The updated version can be found in Appendix 1.

Strengths

- Fishers affirmed that they and their associations are strongly in support of protection of FSAs.

Weaknesses

- The BFD did not agree with the statement that Nassau grouper and mutton snapper are not adequately protected outside of FSA sites and conservation (no commercial fishing) zones. The regulations had resulted in a clear change in behaviour, with fishers often opting not to target or land Nassau grouper. Counterarguments were made that:
    - there is still no specific regulation for mutton snapper
    - the proposed multispecies finfish management plan is still only a proposal, and has no legal status

Opportunities

- The Belize Fund for a Sustainable Future (BFSF) will be providing funding for MPA improvements and FSA protections.

Threats

- The BFD proposed that there is insufficient data to support the notion that recruitment or growth overfishing are occurring presently. This was countered by WCS and BFSF who insisted that recruitment overfishing and growth overfishing are indeed threats to fin fisheries. Even if the argument could be made in the appropriate forums that they are not happening at present, they could still occur in the future. As such, the risk must be assessed, and strategies must be put in place to prevent/deal with them.

Appendix 3. Official statement from Bonefish and Tarpon Trust re: Sportfish FSAs

By: Dr Aaron Adams and Dr Addiel U. Perez, Bonefish and Tarpon Trust

Directed to:

Myles Phillips

Technical Coordinator – Marine Research

Wildlife Conservation Society – Belize Program

13 May 2024

Incorporating Bonefish (*Albula vulpes*) and Permit (*Trachinotus falcatus*) spawning locations in the Western Central Atlantic Fisheries Commission's (FAO-WECAFC) Regional Fish Spawning Aggregation Management Plan for Belize

The FAO-WEFAC RFSAMP is focused on groupers and snappers and is to some extent envisioned as a template for protection of other spawning aggregation fishes in the future. Species that largely depend on coral reefs, seagrass and mangrove habitats found in areas distributed and connected by areas known as flats habitats nation-wide.

Here, we propose that Bonefish and Permit are incorporated directly into the WEFAFC RFSAMP currently being developed. We understand the reasons that the RFSAMP is focused on reef fish, but with changing economic and social structures, and knowledge of species biology, species like Bonefish, Permit, and others now have similar justification (economic, social, cultural) for conservation consideration. Importantly, there is spatial overlap in fish spawning aggregation locations among groupers, snappers, bonefish, and permit, thus including bonefish and permit will provide more leverage for management attention and action.

The Belize flats fishery for bonefish, permit, and tarpon has an annual economic impact exceeding BZD 240 million, supporting more than 4 500 jobs. The fishery's economic and cultural importance is reflected in protective regulations in Belize that include bonefish, permit, and tarpon as being catch and release only. However, important habitats associated with spawning remain in need of protection. Specifically, more protections are needed for: bonefish – spawning migration pathways, pre-spawning aggregation (PSA) sites, and

offshore spawning areas; permit – spawning migration pathways, feeding and resting areas, and spawning sites which are also those of snappers and groupers.

Bonefish Biology

Adult bonefish use small home ranges on the flats, typically covering just a square mile. However, bonefish migrate long distances, as much as 100 miles each way, to reach a pre-spawning aggregation (PSA) site. PSA sites are typically semi-protected bays, with depths ranging from 6 to 20 ft, near the continental shelf drop-off. Individual bonefish show high PSA site fidelity. Bonefish spawning season is typically from October through April, with spawning most frequently occurring near full and new moon phases.

Spawning occurs offshore at night, where bonefish dive to depths of up to 450 ft before ascending rapidly towards the surface as they spawn via a process known as broadcast spawning. Bonefish offshore spawning areas are frequently offshore of known multispecies fish spawning aggregation sites.

After spawning, adult bonefish return to their home ranges. Bonefish eggs hatch into larvae called leptocephalus, which spend 41 to 71 days in the open ocean before making their way inshore, where they transition into juveniles in open bottom or sparse seagrass bottom protected from wave energy.

Permit Biology

Adult permit show broader movement patterns than bonefish but are still creatures of habit. They tend to repeat movement patterns within a home range region and tend to show high spawning site fidelity. Permit spawning sites tend to be reef promontories and are often at multispecies spawning aggregation sites.

Permit spawning typically occurs from February or March to October near the third quarter moon phase via broadcast spawning. After the eggs hatch, larvae are planktonic for 15 to 25 days before settling on medium-energy sandy beaches.

After spawning, some permits remain along the reef tract or at the spawning site until the next moon phase, other permits return to their home ranges.