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Policy Brief on Fish Spawning Aggregations

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POLICY BRIEF ON FISH SPAWNING AGGREGATIONS

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Executive Summary

Fish spawning aggregations (FSA) are of vital importance to the Mesoamerican Reef (MAR). FSA are key sites in the life cycle of many fish species and are indicators of healthy marine ecosystems. This document describes the science behind the conservation of FSA, the steps that need to be taken to effectively monitor the sites, and how their effective management can help us recover commercial fish populations in the MAR. We establish recommendations for managers, conservation organizations, and fishers in the MAR with the goal of a coordinated eco-regional vision for FSA management and conservation.

FSA sites are hotspots of biodiversity, productivity, and reproductive potential. They sustain complex food webs, as these small areas attract large numbers of fish to reproduce, apex predators to feed on spawning fish, and planktonic feeders to feast on masses of protein-rich eggs. In the Caribbean, the most important commercial fish species found that form FSA are groupers (Epinephelidae), and snappers (Lutjanidae).

Groupers and snappers are a transboundary resource because they can travel more than 100 km to spawn. While population movements between spawning sites are poorly understood, fish abundances at FSAs continue to decline due to fishing pressure outside of spawning season, during migrations to spawning sites and due to legal or illegal fishing directly at the sites. Therefore, the population range of these species needs to be considered for a multilateral recovery plan. Researchers in the MAR believe that there are currently 24 active sites, seven of which currently have fish populations in decline, three are stable, four are increasing, and the tendency in 10 sites is unknown due to lack of consistent monitoring.

The creation of fish replenishment zones (also known as no-take zones or marine reserves) on FSA is a highly recommended management tool. Other management and conservation measures to be implemented in the MAR also include prioritizing and aligning surveillance and enforcement, synchronizing size limits regulations, and homogenizing closed seasons for key species based on the best available science.

1 Introduction

Fish Spawning Aggregations (FSA) are defined as gatherings of conspecific fish that meet predictably and repeatedly for the purpose of reproduction [1]. Individuals can travel vast distances to breed in immense aggregations that occur at specific times and locations [2]. These sites are crucial to guarantee the persistence of fish populations and are common across a large diverse group of marine fishes [3]. FSA are found in tropical and temperate coastal waters and are important for maintaining ecological processes and food security [1, 3].

The predictability of FSAs in space and time, and the large numbers of fish they include, make them important sites for fisheries, as fishers capitalize on the predictable nature of aggregations to harvest large numbers of fish with minimal effort [2, 4]. Unfortunately, these same characteristics often make them vulnerable to overfishing and many aggregations have declined or collapsed due to overfishing, and today, several species are at risk of extinction [2, 4]. Increased fishing pressure at FSAs has been documented to lead to rapid stock depletion, localized extirpations, fishery collapses, ecosystem imbalances, and the loss of structural and functional integrity of marine ecosystems [4, 5].

Effective management of fish spawning aggregations is now recognized as vital for maintaining livelihoods and protecting biodiversity. Understanding the dynamics of these sites should be prioritized by all countries and complemented with effective management actions and conservation policies. This document details information on FSAs in the Mesoamerican Reef Region, highlighting important legal and scientific justifications for their protection and expands on the need for a regional vision to protect these transboundary resources.

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2 What species aggregate and what do FSA sites look like?

FSAs are formed from fish that are transient migrants or local residents [1, 4]. Transient spawners can travel long distances (>100 km^2) to spawn in aggregations that last only a few days to weeks. These aggregations happen at specific times, often during lunar or tidal phases. Species that form transient aggregations have 'slow' life-history traits, such as slow growth, large size, long lifespan, and late maturity. The Nassau grouper (*Epinephelus striatus*) is an emblematic example from the Caribbean and is currently classified as Critically Endangered by the IUCN, primarily due to FSA fishing [6].

Resident spawners reproduce frequently within their home range and consist of fish that travel only short distances (meters to km). These FSAs are often synchronized for specific times and can occur daily. Common examples include small-bodied herbivores and grazers, such as wrasse and parrotfish (Labridae), surgeonfish (Acanthuridae), and some jacks (Carangidae). One example is the Bluehead wrasse (*Thalassoma bifasciatum*) that spawns daily, year-round at the same locations with site fidelity that can last four generations [1].

FSA sites can be multispecific, with several species spawning at the same place, during different times of the year. The sites can also serve as productivity hotspots, as these small areas attract large numbers of fish to reproduce, apex predators to feed on spawning fish, and planktonic feeders to feast on masses of protein-rich eggs [7]. FSA have high biodiversity, productivity, and reproductive potential, sustaining complex food webs [8].

In the wider Caribbean, the geomorphology of multispecific FSA is strikingly similar [9]. According to a study conducted by Kobara & Heyman, [10], for example, in Belize, all FSA sites occur along shelf edges, with convex-shaped reef structures jutting out over steep drop-offs into deep water. Understanding the geomorphology of FSAs might provide a fishery-independent mechanism to locate potential FSA sites in other locations [4]. Predicting the location of these FSA sites (independently of whether they are presently fished), can help to prioritize protection and contribute to the effective design of MPAs for the management and conservation of FSAs.

© Alexander Tewfik, Nassau Grouper. Lighthouse Reef, Belize.

3 What can be done to protect them?

Historically, FSA were minimally affected by fishing because of the limited technical capabilities and low numbers of fishers exploiting them. Today, aggregations are viewed as fortuitous fishing opportunities in certain seasons or for special cultural events [3].

According to the most recent and comprehensive report on the global status of marine FSA, 52% of the documented aggregations have not been assessed, less than 35% of known FSA are protected by any form of management, and only about 25% have some form of monitoring in place. Among those FSA that have been evaluated, 53% are in decline and 15% have disappeared altogether [4]. These results highlight the need for management intervention and effective management initiatives to maintain ecologically important populations of (typically) large predatory fishes such as groupers and snappers, and other important reef fish species [4].

In general, FSA should be protected from exploitation through national and regional fisheries management and conservation planning; monitoring frameworks should be implemented, and key biological, socio-economic, fishery and trade information should be collected to develop management and conservation protocols. Community-based strategies should be applied to include the fisher community in management and science.

3.1 Available protection measures

Management and conservation options for FSA sites vary from country to country, due to differences in fisheries legislation and the options available to managers. Some of the most frequently used management tools can include [4]:

- Species-specific protections, including sale, export, or possession restrictions, (seasonally or year-round).
- Minimum size limits to ensure fish growth, and maximum size limits to protect large, highly fecund females and large males.
- Temporal and spatial protection, including spawning reserves and fisheries closures.
- Fishery input and output restrictions such as limited entry to a fishery, catch quotas, fish size limits, or fishing gear limitations.
- Complete species bans and protection for species that have been highly impacted by constant overfishing.
- Community-based fisheries management approaches, which include Locally Managed Marine Areas (LMMAs).

The most appropriate management for any particular FSA or species is best made on a case-by-case basis and will depend on local social and economic factors, as well as the spawning behavior, biology, prevailing fishing pressure, and conservation status of the target species. In the MAR region, the creation of fish replenishment zones (also known as no-take zones or marine reserves) at FSA and seasonal closures have been the preferred management tools, particularly as both allow limited enforcement resources to be concentrated at specific times or sites.

3.2. International legislation and recommendations on the protection of FSA

The need for improved management and conservation of FSAs is part of an international agenda that recognizes their importance. For example, FSA are prime candidates for designation as ecologically and biologically significant areas (EBSAs) under the Convention of Biological Diversity (CBD). Others include the Food and Agriculture Organization of the United Nations (FAO), where the FAO Code of Conduct for Responsible Fisheries clearly articulates in article 7.5.1 that “the absence of adequate scientific information should not be used as a reason for postponing or failing to take conservation and management measures”. Also, article 7.6.1 mentions that “States should ensure that the level of fishing permitted is commensurate with the state of the fishery resource under exploitation” using the ‘best available scientific data’ [11, pg. 12 and 13].

In 2004, during the International Union for the Conservation of Nature (IUCN) World Conservation Congress (Rec 3.100, p. 115), governments were urged to “establish sustainable management programs for sustaining and protecting reef fish and their spawning aggregations (...)", and international and fisheries management organizations, including non-governmental organizations, were requested to "take action to promote and facilitate the conservation and management of fish spawning aggregations (...)". Other important conservation commissions and working groups include the CFMC/WECAFC/OSPESCA/CRFM Working Group on Spawning Aggregations [12] and the IUCN Grouper and Wrasse Specialist Group [13]. These groups strongly encourage improved management actions to protect FSA sites, highlighting the need for Fisheries Management Plans that consider the protection of species forming FSA; for the standardization of existing FSA monitoring programs for improved local, national and regional management efforts; and request that fishers and other stakeholders be involved in cooperative research and FSA management (See [14]).

The International Coral Reef Initiative (ICRI) also made a statement on "Coral reef fish spawning aggregations" in 2006. This statement urges governments to establish sustainable management programs for sustaining and protecting reef fish and their spawning aggregations, including a range of spatial and seasonal measures that can be adapted to local needs and circumstances. These series of statements and recommendations provide greater leverage for both government and NGOs to progress conservation initiatives for FSA, as all recognize the importance of evaluating spawning aggregations as an essential part of fisheries and MPA management [15, 16].

In the MAR, the biophysical principles for the effective design of fish replenishment zones [17] consider FSA sites to be critical areas for the life history of focal species. The principles recommend protecting areas of importance for the life cycles of these species, such as nursery areas or spawning grounds. Protecting these areas can provide significant benefits to fisheries in the future.

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4 Fish Spawning Aggregations in the Mesoamerican Reef

In the Caribbean, 37 fish species from 10 families are known to form FSA [9]. A recent literature review by Kobara et. al [9] reports 29 sites, but research in each of the four MAR countries, including expert contributions suggests there are currently 2currently 24 active sites that researchers are aware of (see Fig 1,) [18,19]. Of these, managers, NGOs, and researchers identified that seven currently have fish populations that are in decline, three are stable, four are increasing, and the tendency in 10 sites is unknown due to lack of consistent monitoring [19].

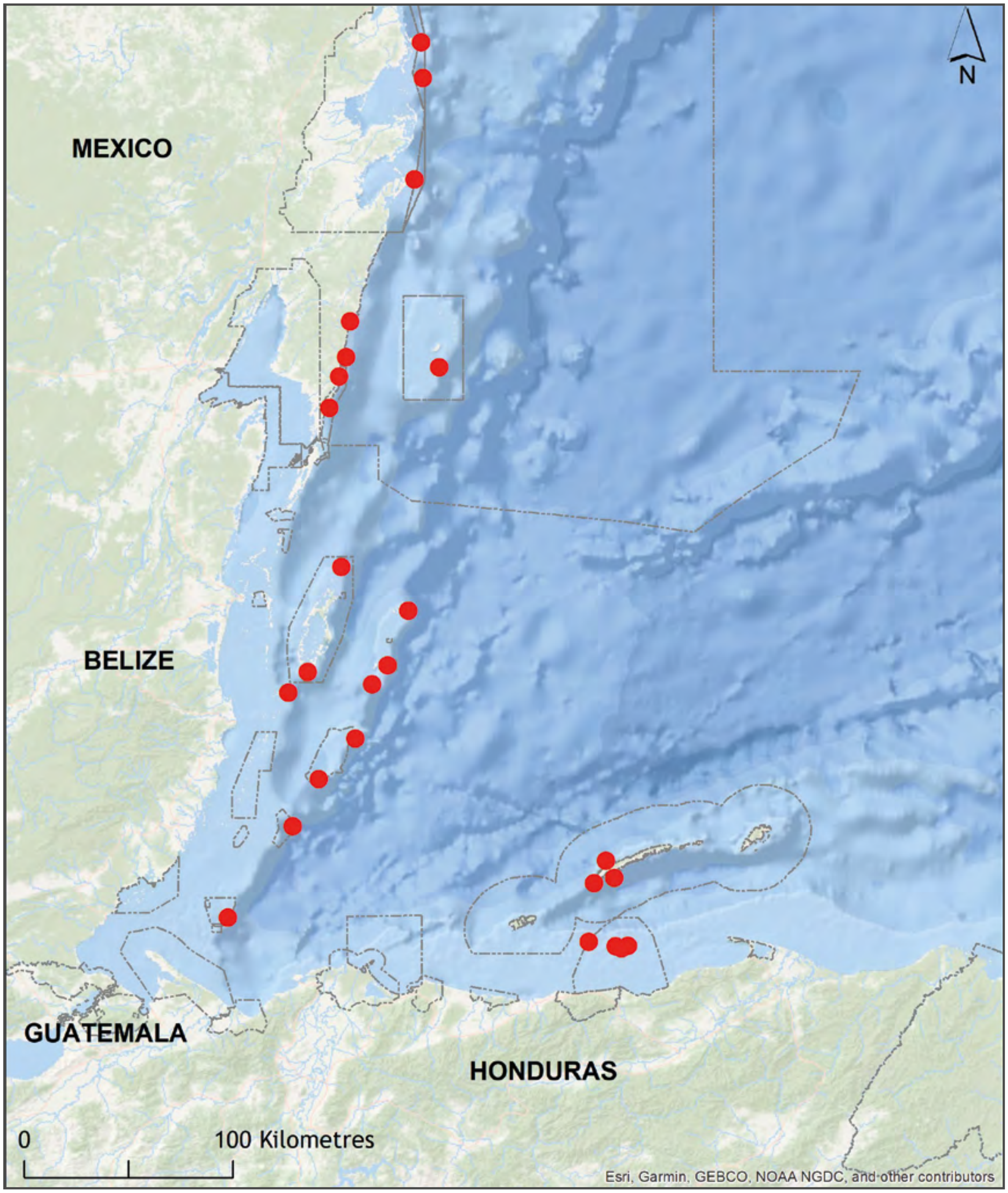
The total number of known FSA sites can be difficult to document, due to the difficulty of regular monitoring at all sites, and even differing opinions on what constitutes an active FSA [20]. Among the most common fish found at FSA, sites are Epinephelidae (groupers) and Lutjanidae (snappers) [21]. Species include the Nassau grouper (*E. striatus*, Critically Endangered), Black grouper (*Mycteroperca bonaci*, Near Threatened), Yellowfin grouper (*M. venenosa*, Near Threatened), Mutton snapper (*Lutjanus analis*, Near Threatened), Dog snapper (*L. jocu*, Data Deficient) and Cubera Snapper (*L. cyanopterus*, Vulnerable). Many of these species have suffered drastic population declines throughout the Caribbean, and some FSA sites known to have been extirpated [22]. To a lesser extent, other fish families that also aggregate to spawn include many Acanthuridae (surgeonfishes), Siganidae (rabbitfishes), Scaridae (parrotfishes), Labridae (wrasses) [21].

4.1 Conservation Measures for FSA in the MAR region

4.1.1. Belize

- Belize protected a network of 13 known multiple species FSAs in 2001, seven of which are specific for Nassau grouper (*Epinephelus striatus*).
- The management of each FSA is independent of the marine reserves. Most are located close, next to or within a marine reserve, and have different regulations regarding fishing effort and gear types[1].
- There are no formal management plans for FSAs at present. The new Fisheries Resources Act (signed February 2020) will guide their development.

[1] The different regulations for each marine reserve can be found at http://fisheries.gov.bz/.



Source: COBI, 2020

Fig. 1. Approximate location of known and verified FSA in the Mesoamerican Reef.

- Eight of the FSA have had some level of direct population monitoring for Nassau groupers conducted over the last 15 years; the remainder have also been monitored at different times, [23]

- The current state of FSA is generally decreasing but mostly unknown. There is a need for additional research to re-characterize the sites.

- In Gladden Spit Silk Cayes Marine Reserve there is a multi-specific FSA where traditional fishing is allowed on a seasonal basis for snappers only.

4.1.2. Mexico

- The Gulf of Mexico and Mexican Caribbean region has a grouper management plan and fisheries regulations, however, the focus is the Red grouper (Ephinephelus morio), a species that does not feature heavily in the Caribbean fishery.

- Fish replenishment zones (either fish refuges or subzones of Protected Areas) have been implemented to specifically protect FSA (five of eight visually verified FSAs are protected).

- There are currently eight visually verified FSA sites in the Mexican Caribbean. Four are stable, two are decreasing, one is extinct and one is unknown.

- Protected Areas also limit spatial fishing effort and some gear types through their management plans.

4.1.3. Honduras

- Two protected areas management plans have established regulations for FSA: Bay Islands National Marine Park and Cayos Cochinos National Marine Monument. Most management plans are updated every five years and now include sections for managing FSA, if they have been reported in the area.

- There are six validated FSA in two protected areas:

  - Bay Islands: two FSAs are located within a Special Marine Protection Zones (a sub-zoning within the National Park) where harvesting of groupers and snappers is not permitted.

  - Cayos Cochinos: no fishing is permitted within the marine monument from December to March, where four FSAs are located.

- There is no up to date information about the status and population trends of Honduran FSAs.

- Minimum landing size:
    - There is no national minimum landing size regulation, although the Bay Islands Marine Reserve has a standard minimum catch size of 20 cm for all finfish.
- Gear types are limited in the protected area management plan or decree.

4.1.4. Guatemala

- There are no verified FSA in Guatemala at this time, but researchers believe there may be one and are working to characterize the site.

Table 1. Snapper and grouper regulations in the MAR.

Regulations	Mexico	Belize	Guatemala	Honduras
Closed season for Nassau groupers	February 1 - March 31	December 1 - March 31	December 1 - March 31	December 1 - March 31
Closed season for other groupers	February 1 - March 31	No	No	Goliath grouper (*Epinephelus itajara*) capture prohibited
Size Limit for groupers	Only one species *Epinephelus morio* has a minimum size of 36.3cm TL	Nassau groupers must be 20-30inches (50-76cm), must be landed whole	No	No
Closed season for snappers	No	No	May 1 – June 15*	No
Size Limit for snappers	No	No	No	No
FSA protected	5	10	0	0 (6 sites have temporal protection)

Source: HRI, 2020

*Ministerial Agreement 40-2020

5 Shifting baselines: What were things like in the past and how did they support fisheries?

> *The groupers congregate here in almost countless numbers in late December or early January; it is reported that they are so closely packed as to hide the white sand bottom*
> *([24] - Caye Glory, Belize, 1944)*

Historical scientific evidence combined with fisher's traditional ecological knowledge can be a powerful tool for understanding population changes in key species. It can also be used to document how perceptions of a resource change over time [25]. In 1971, a FSA of over 100,000 Nassau grouper was reported in the Bahamas [26], a site that by 2013 had only five fish [27]. Reports in the MAR are similar and document significant fishing activity related to FSA sites during the same period. In Belize for example, 300 boats, each with three fishers onboard, were heading to Caye Glory (Emily) during the spawning season, catching an estimated 100 tons of grouper. An experienced crew could catch 1,200 – 1,800 fish during the season [28]. However, by the 1960s catches were already much lower than in previous years.

Fishing FSA sites is generally not economically optimal, as the market receives an oversupply of a single species at a specific time, and prices are driven down [29]. Despite this, FSA fisheries have supported important local economies, but declining catches in recent decades has reduced the profitability of FSA fishing further. As fishing became more efficient, catches continued to decline at FSA sites, with more powerful boats catching more fish, and operating in rougher seas, with many FSA sites both in the Caribbean and worldwide currently hosting a fraction of the number of fish from previous years.

The scientific knowledge we have about FSA has been collected over a limited timescale. Until the advent of SCUBA in the 1940s, FSA sites were only really known because of the abundant catches they allowed fishers in certain months of the year. SCUBA allowed researchers to begin documenting the underwater spectacles. At present, a FSA with just 1,000 fish is considered a “large” or “unique” site, by both scientists and younger fishers, but we should recognize that today's “normal” is potentially a significant decrease from the population of 50 to 100 years ago. This “shifting baseline” has been reported for the same species in other regions [30, 31] and describes a situation in which it is currently hard to recognize past abundances as we only have current reference points with which to compare.

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6 The need for a regional vision

6.1. This is a transboundary resource that must be managed both at the regional and country level

Grouper and snapper in the MAR are transboundary resources. In the Caribbean, Nassau grouper have been known to migrate more than 300 km to a FSA site [32], equivalent to a fish swimming from Guatemala to Mexico to spawn. A concerted population recovery plan for the emblematic and commercially important species needs to consider the population range of the species. While groupers and snappers are present throughout the Caribbean, it is likely the MAR has significant self-recruitment that maintains local populations as Nassau groupers in the MAR are genetically distinct to those in the Eastern Caribbean and Bahamas [34]. This means that the actions we take in the MAR have direct impacts on the health of our fish stocks.

Population movements between spawning sites are also poorly understood and more research is needed. It has been theorized that a declining aggregation at a specific site could be the result of the disappearance of a geographically close and potentially connected FSA. Additionally, when FSAs have been exploited consistently over long periods of time, as was the case for the Mahahual site in Mexico documented by Aguilar-Perera [34], the older fish are removed, leaving few experienced individuals to lead new recruits to the traditional sites. This potentially results in inefective migrations to the traditional sites, further reducing spawning potential and reproductive capacity for the species [34].

6.2. Although there are several FSA currently legally protected, numbers are declining. Why?

Achieving healthy grouper and snapper stocks goes beyond protecting FSA sites, particularly in resource-stretched countries where enforcement can be limited. It is likely that fish abundances at spawning sites continue to decline due to considerable fishing pressure on the stock outside of spawning season, during migrations to spawning sites and during legal or illegal fishing directly at FSA sites. Additionally, most of the currently protected FSA were protected recently, when their fish abundances were a fraction of previous levels. Recovery will take time. Due to their long adult migrations, plus the larval dispersion period which can move larvae between countries, a regional, multi-lateral vision is the only way to assure stock health. The actions of one MAR country alone will not be enough.

6.3. What can be done to protect the FSAs?

Knowing where FSAs are is the first step to effective conservation. Once sites are located and characterized, effective conservation measures can be proposed based on the fish species that use the site, country regulations, and site-specific needs. Once discovered, FSA sites should also be effectively monitored to measure changes to fish populations and the impacts of the conservation actions. One way to ensure effective processes is through the use of standardized protocols for site evaluation and monitoring.

© Alexander Tewfik, Nassau grouper. Glover's Atoll, Belize.

6.3.1. Involve stakeholders

While “discovering” FSA sites is often the goal of researchers and conservationists, it is unlikely that many virgin FSA sites exist in the MAR, and wider Caribbean. Most, if not all, sites are already known to fishers. Similarly, conservation and sustainable fishery measures will not be effectively implemented without the support of the fishing community, particularly in regions where resources for enforcement may be limited. To ensure long-term conservation benefits, create capacity and co-responsibility, fishers and fishing communities should be involved in FSA exploration and monitoring, ideally as citizen scientists [14].

6.3.2. An example of regional collaboration, the MAR Fish Project

The MAR Fish project is the latest and largest coordinated FSA work in the MAR. The project seeks to establish a regional monitoring network of FSA sites, through the collective effort of partner organizations in the four MAR countries. The overall objective is to promote the recovery of fisheries by strengthening the protection of the FSAs as critical areas in the life cycle of the species, through better knowledge and understanding of the aggregations in the region. The project incorporates the participation of several actors, including fishery managers, NGOs, researchers, fishers, and other members of coastal communities.

6.4 Recommendations by country

6.4.1. Belize

- Closure of all spawning aggregation sites to fishing.
- Integrate and align network of spawning aggregation sites into a multi-species finfish management plan for Belize.
- Increase strategic patrolling and surveillance in FSAs within and outside MPAs.
- Conduct a national status assessment of all grouper and snapper FSAs.
- Empower local fishers and fishing cooperatives to protect, monitor, and manage FSAs in their fishing grounds.
- Improve monitoring of FSA with the use of technology.
- Recommendations for monitoring:
    - Use of submersible drones to monitor FSA.

- Use of acoustic monitoring devices to detect the movement/sound of fishes and boats in the FSA sites.
- Support the replacement of patrol equipment (engines, SMART2 devices, computers, etc.)
- Support for research.

6.4.2. Mexico

» Officially recognize FSA as critically important sites in fisheries legislation and increase enforcement during spawning seasons.

» Separate the Caribbean region and species from the Gulf of Mexico closed season and increase the closed season from Cabo Catoche to the Belize border from two to four months to align with Belize.

» Increase minimum landing sizes for grouper species to include length at maturity to ensure spawning potential.

» Evaluate the snapper fishery to create science-based recommendations and a regional management plan.

» Review and update MPA management plans considering FSA information (MPAs should review management plans every five years as part of an adaptive management regime, most have never been changed).

6.4.3. Honduras

» Create replenishment zones on FSA with adequate surveillance and enforcement.

» Considering the lack of validated FSA, management measures at different temporal scales should be established:

- In the short-term: general output control measures, such as species-specific closures, seasonal sales restrictions, and minimum catch sizes.
- In the mid-term: once FSA locations, species, and seasonality has been determined, input control measures, such as gear restrictions, temporal closures, and fish replenishment zones can be implemented.

[2] SMART - Spatial Monitoring and Reporting Tool - https://smartconservationtools.org/ is a data collection tool for enforcement and monitoring in protected areas.

  - In the long-term: once data on the exploitation of fish stocks has been generated, catch limits per species should be implemented.

- Include local fishers in actions to protect, monitor, and manage FSA in their fishing grounds to build capacity and empower local communities for long-term management actions.

6.4.4. Guatemala

- Closed seasons for all species of groupers and snappers should be extended to:
  - Groupers: December to March
  - Snappers: April to June
- Increase surveillance and enforcement during spawning seasons.
- Update MPA management plans to include fish replenishment zones as a management tool for FSA.
- Declare all known FSA sites as fish replenishment zones.
- Characterize and monitor FSA and fish stocks to obtain information for adaptive fisheries management.

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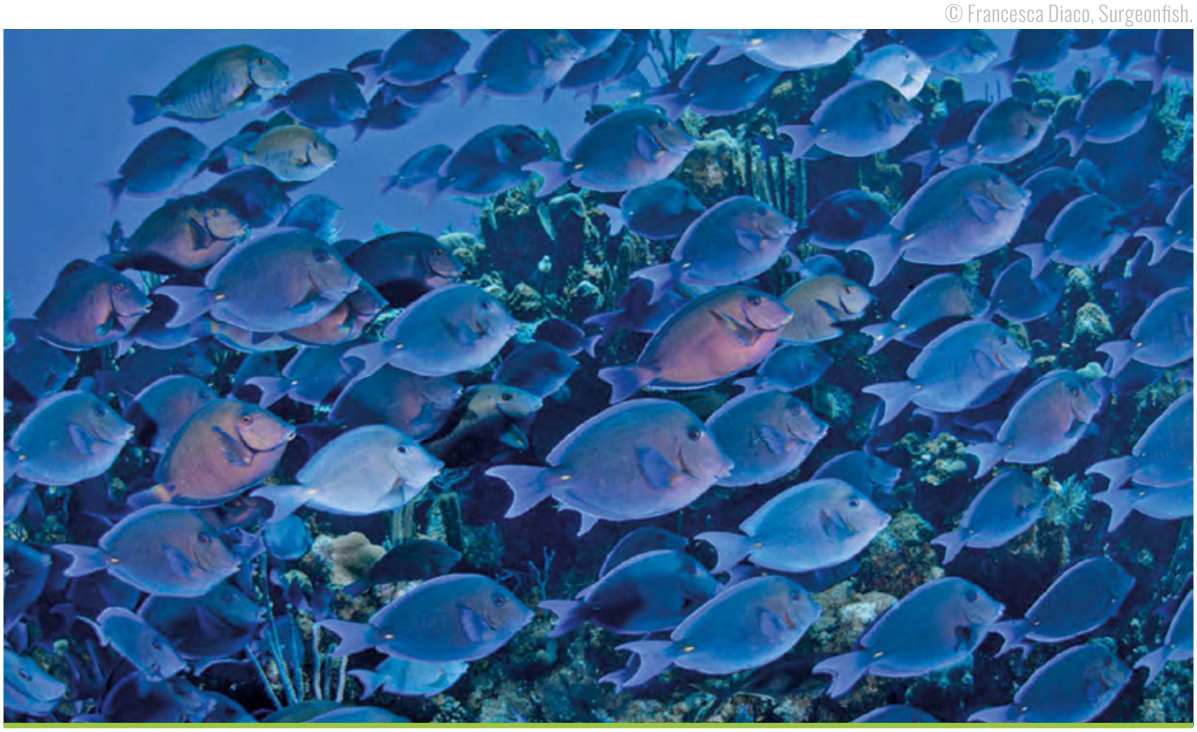

7 A bleak future without FSA

A future without fish spawning aggregations is a future without a healthy Mesoamerican Reef. The fish that spawn at FSA sites form an important part of the coral reef food chain, maintain livelihoods by supporting fisheries, and are a draw for tourists who see them on the reefs. Despite the management actions taken in the MAR countries to date, our efforts have not been sufficient. It is time to focus our efforts in protecting and conserving this resource with concrete and aligned multilateral efforts in the four MAR countries.

7.1 Actions needed to sustain the FSA in the MAR region

- Develop a common vision for regional management and conservation planning for FSA sites.
- Create fish replenishment zones at FSA sites that are currently not protected, considering the biophysical, socioeconomic, and governance design principles established for the MAR.
- Prioritize and align surveillance and enforcement with spawning seasons.
- Homogenize size limit regulations and closed seasons for key species, particularly groupers and snappers.
- Validate, characterized, and periodically monitor all FSA sites to obtain scientific information to guide adaptive management. Apply standardized monitoring frameworks that collect key biological, socio-economic, and governance information through standardized protocols.
- Develop a regional database and data sharing protocols to ensure continuity, more effective data management, and maintain institutional FSA knowledge over time.
- Promote the conservation and restoration of key habitats (e.g. mangroves and coral reefs) which are important for the life cycle of fish species.
- Increase community-based strategies for monitoring, data collection, and management to promote co-responsibility and project acceptance and sustainability.
- Ensure effective enforcement at all FSA and during closed seasons.
- Consider and investigate the impacts of climate change on FSA.
- Raise awareness through communication campaigns, with key stakeholders and the general public, about the importance of FSA for maintaining food security and biodiversity conservation.

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For more information

Belize National Spawning Aggregation Working Group
http://www.spagbelize.org/
Caribbean Fisheries Management Council
https://www.caribbeanfmc.com/
Grouper and Wrasse Specialist Group
https://www.iucn.org/ssc-groups/fishes/grouper-and-wrasse
Science and Conservation of Fish Aggregations (SCRFA)
https://www.scrfa.org/
Western Central Atlantic Fishery Commission (WECAFC)
/ Comisión de Pesca para el Atlántico Centro Occidental (COPACO)
http://www.fao.org/fishery/rfb/wecafc/en

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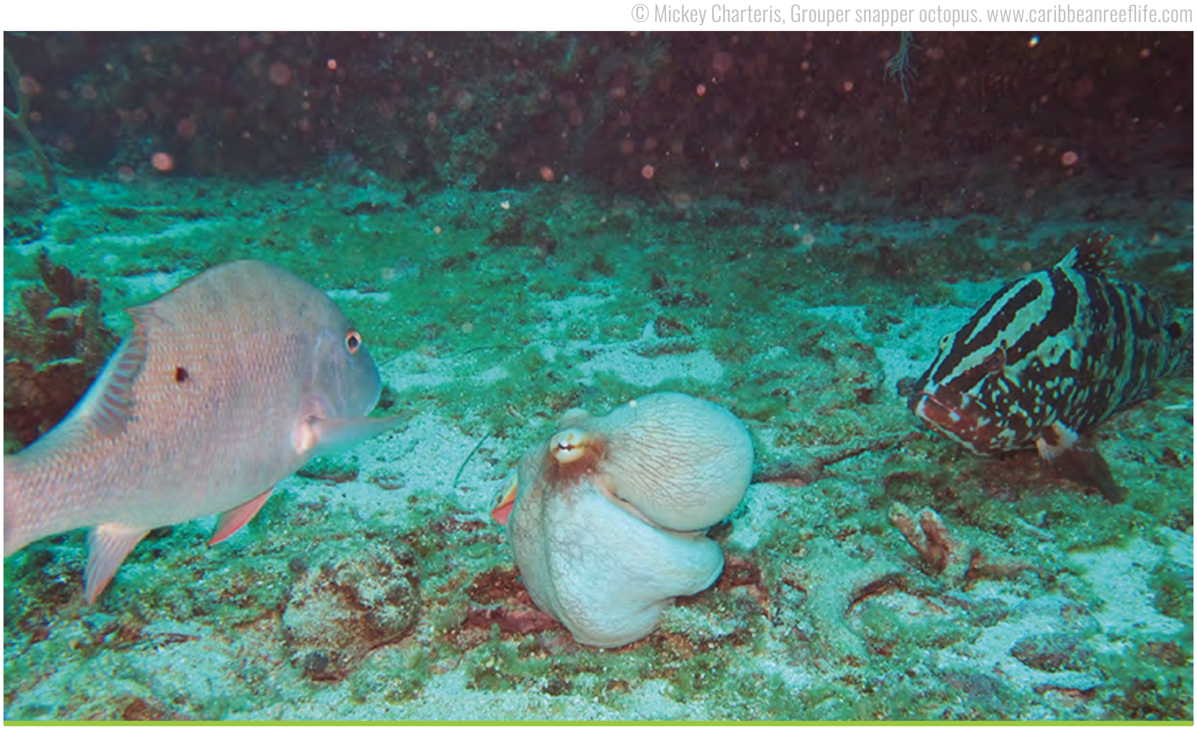

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