marfish

Status Report of Fish Spawning Aggregations in the Mesoamerican Reef 2024

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Executive summary

The scientific reports and concerns of overfishing in Fish Spawning Aggregations (FSAs) in the Mesoamerican Reef System (MAR) span more than 70 years. Conservation efforts in the region, which began in Belize, are entering their fourth decade. The scientific evidence is clear: to conserve fish populations, they must be protected during spawning periods. Although progress has been made in this regard, much remains to be done to restore fish populations to the abundance levels of previous decades. Managers and decision makers must acknowledge the possibility of a shifting baseline, given that knowledge is not always transmitted fully between the institutions responsible for FSAs. The low abundance of spawning fish at present reflects unknown trends, although previous studies, particularly those up until the early 2000s, reported higher numbers of fish. The traditional ecological knowledge of fishers and landing data suggest that breeding fish are present in MAR sites; however, visual verifications must be conducted to identify FSAs before implementing spatial management strategies. It is also essential to strengthen regional coordination between the four MAR countries to manage transboundary species. Finally, implementing adaptive management in the face of climate change and improving management and data sharing in the region are crucial to ensuring the continuity of conservation actions.

Introduction

Fish Spawning Aggregations (FSAs) are temporary, yet massive concentrations of fish that gather specifically to reproduce (Sadovy de Mitcheson and Colin 2012). These aggregations have been documented in 53 countries, all marine ecosystems, and all five oceans. In coral reefs, FSAs occur in specific sites and at specific times (Heyman and Kjerfve 2008, Colin 2012, Erisman et al. 2018), with some sites hosting FSAs for diverse species throughout the year (Heyman and Kjerfve 2008). Fish often travel long distances to reach these specific sites and concentrate most of their reproductive activity during FSAs. Thus, FSAs represent essential events in the life cycles of numerous commercially important species, such as groupers *(Epinephelidae)* and snappers *(Lutjanidae)* (Erisman et al. 2018).

Large numbers of fish can be caught quickly with minimal effort in FSAs, especially considering that fishers can accurately predict the arrival of fish in sites because the sites remain same over time. However, fishing in FSAs is neither sustainable (Sadovy and Domeier 2005) nor economically optimal considering that the oversupply of a single species at a specific time in the market drives down prices (Sadovy and Domeier 2005). Given that fish arrive at FSA sites to spawn, fishers in these sites will always encounter fish species at maximum abundance and, thus, catch them in abundance. Notably, fish will continually return to spawn in FSA sites, even when the surrounding reefs are slowly depopulated. Thus, fishing in FSAs can appear to be stable due to a concept known as hyperstability (Erisman et al. 2011). Hyperstability occurs when the catch per unit effort (CPUE) remains high even while the fish population declines. This scenario is particularly common in data-poor fisheries, which are found in many FSA sites. A particularly famous example of an FSA species that suffered due to hyperstability is the Atlantic cod *(Gadus morhua);* catches of this species remained high right up until a massive population collapse (Rose and Kulka 1999).

The Mesoamerican Reef System (MAR) is located in the Caribbean Sea and extends for more than 1,000 km from Cabo Catoche, Quintana Roo, Mexico to Islas de la Bahía, Honduras. The MAR ecoregion covers 457,536 km2 and includes parts of Mexico, Belize, Guatemala, and Honduras. The MAR is considered to be an area of high biodiversity: the coastal zone hosts 65 species of stony corals *(scleractineans),* more than 500 fish species, and many emblematic marine species, including whale sharks *(Rhincodon typus),* five species of marine turtles, manatees *(Trichechus manatus),* and the Atlantic goliath grouper *(Epinephelus itajara).*

MAR fisheries are an important economic driver in the region and provide employment, income, and food security for thousands of people. In Belize, fisheries contribute 5% to the national GDP and employ 3,507 fishers and over 15,000 people involved in processing and export. Guatemala only has 70 km of Caribbean coastline, yet its fisheries in this region employ 1,067 fishers. In Mexico, approximately 1,087 fishers operate in the Caribbean. However, Mexican fisheries in this region contribute less than 0.1% to the GDP of Quintana Roo, despite annual catches including high-value species (e.g., lobster), which is indicative of the importance of tourism in the Caribbean. In Honduras, fisheries contribute 6.2% to national GDP, and around 4,300 small-scale fishers operate along the Caribbean coast (Green et al. 2017, McField et al. 2024).

Table 1 includes a summary of the most relevant publications on the distribution or status of FSAs.

Table 1. Summary of the key publications on the distribution and status of fish spawning aggregations (FSAs) in the Mesoamerican Reef System (MAR).

TITLE	AUTHOR	YEAR	DESCRIPTION
Fish spawning aggregations in the Mesoamerican Reef System: national consultancy–Mexico	Sosa-Cordero et al.	2002	Interviews and traditional ecological knowledge used to identify potential FSA sites in Quintana Roo, Mexico
Fish Spawning Aggregation Sites in the MBRS Region: Recommendations for monitoring and management	Heyman & Requena	2002	Evaluation of FSA sites in Belize
The Nassau Grouper Spawning Aggregation at Caye Glory, Belize: a Brief History	Paz & Truly	2007	Detailed history of the best documented FSA in the MAR–Glory Caye (Emily), Belize
Fishing, management, and conservation of the Nassau Grouper, Epinephelus striatus, in the Mexican Caribbean	Aguilar-Perera et al.	2009	Summary report on Nassau grouper stocks, fisheries, and FSA in the MAR
Report of reproductive aggregation of fish in Roatan Bank, Mariposales, La Grupera, and Punta Pelicano, Cayos Cochinos, Honduras	Aronne	2009	Descriptive report of FSA sites in Islas de la Bahía, Honduras
Brief History of Management and Conservation of Nassau grouper and their Spawning Aggregations in Belize: A Collaborative Approach	Burns-Perez, & Tewfik	2016	Summary of the work of the Belize Breeding Aggregation Working Group (since 2001)
Technical report and results of validation and monitoring of the FSAs of snappers and groupers in central and southern Quintana Roo	Fulton et al.	2016	Report on the visual validation of the sites reported in Sosa-Cordero et al. (2002)
Plan for a network of replenishment zones (RZs) in northern Honduras	Chollett	2017	Plan for a network of fish replenishment zones, including an extensive bibliographic review of the known and presumed FSA sites, in the Caribbean of Honduras
Policy Brief on Fish Spawning Aggregations	Gonzalez-Bernat et al.	2020	Policy brief documenting the importance of FSAs in the MAR
2024 Mesoamerican Reef Report Card	McField et al.	2024	The MAR report includes a summary of FSA information for each country

Historical information plays a key role in understanding changes in FSA sites. However, our scientific knowledge of FSAs is based on information that has been gathered over a relatively small amount of time. Until the arrival of SCUBA equipment in the 1940s, FSA sites were only identified because of the abundant catches reported by fishers during certain months. With the advent of SCUBA gear, researchers began to conduct visual censuses of FSA sites. By the time researchers were diving FSAs in the MAR in the 1990s, fish populations were already severely depleted. Today, FSAs with only 1,000 fish are considered "large" or "unique" by both scientists and younger fishers. However, we must recognize that the current "normal" may potentially reflect a notable population decline over the last 50 to 100 years. This "shifting baseline" (Pauly 1995) has also been reported for the same species in other regions (Saenz-Arroyo et al. 2005, Bravo-Calderon et al. 2020). Currently, shifting baselines make it difficult to identify prior abundance levels, as we only have current reference points for comparison. However, historical literature sources contain quotes, like the following, which seem unimaginable today:

> "According to fishers, a grouper fishery...operated during December and January at Mahahual. In 1965, fishers told [the interviewer] that they captured 20 to 30 tons of grouper during this [time] " *(in: Miller 1982)*
>
> "Groupers congregate here in almost innumerable numbers in late December or early January; they are reported to be so close together as to obscure the white sandy bottom." (Thompson 1944 - *Caye Glory, Belize)*

MAR Fish Project

The Fish Spawning Aggregation Project of the Mesoamerican Reef System (MAR) is a conservation initiative that aims to protect marine biodiversity and fisheries resources. The main objective is to support the recovery of the Mesoamerican reef fish stock by strengthening the monitoring of a network of fish spawning aggregations sites, which reflect critical biological events in which diverse fish species congregate in specific sites to reproduce. These FSAs are essential for maintaining healthy populations and the functional balance of marine ecosystems.

The MAR region, which includes the coastal areas of Mexico, Belize, Guatemala, and Honduras, is home to a great diversity of marine species. However, overfishing and the degradation of essential habitats have compromised the sustainability of these ecosystems. The MAR Fish Project addresses these threats through an integrative approach that combines scientific research, community engagement, and strategic management.

The key activities of the project include:

- Scientific research: identification, characterization, and monitoring of FSA sites using advanced observation and analysis techniques.

- Community participation: training and raising the awareness of local communities, with an emphasis on promoting sustainable fishing practices and strengthening community governance.
- Establishment of protected areas: implementation of spatial conservation measures to minimize extraction during critical breeding periods.

The MAR Fish Project operates within a framework of collaboration among diverse actors and stakeholders, including local communities, fishers, researchers, NGOs, and government authorities. This intersectoral approach ensures inclusive and evidence-based decision-making, which strengthens ecosystem resilience and the livelihoods associated with these systems.

Through comprehensive actions, the MAR Fish Project contributes to preserving key species and maintaining ecosystem services while advancing broader objectives, such as ensuring sustainable fisheries management, developing alternative economic activities (e.g., ecotourism), and adapting to climate change. The implementation of the MAR Fish Project stands as an example of a replicable model of integrated management for marine conservation.

The 2023 MAR Fish Workshop

The 2023 MAR Fish regional partner workshop was held in Cancun on 8–9 August 2023. The main objective of the 2023 workshop was to follow up on the efforts and achievements of the project partners since 2020, when the last workshop was held. The MAR Fish partners presented their results and achievements, the challenges they faced, and the future opportunities they identified. In total, 19 people (10 women and 9 men) from 10 organizations within the MAR Fish network participated, representing civil society organizations, fishing communities, resource managers, and research organizations (see Annex 1 for the full list). During the 2023 workshop, data standardization was addressed, with the partners evaluating its advantages and disadvantages in various contexts. Likewise, the advantages and drawbacks of using new technologies for monitoring, such as passive acoustic monitoring, tagging, fisheries monitoring, and environmental DNA (eDNA), were discussed. A key product of the 2023 workshop was a description and analysis of the results obtained in MAR sentinel sites, which allowed for a more profound evaluation of these strategic locations.

Photo: COBI

Cayman Crown: importance and management

Cayman Crown is a site of high ecological importance. Located in the Gulf of Honduras, this reef sits on the maritime border between Belize and Guatemala. Historically, Cayman Crown was poorly documented. In 2013, Cayman Crown was identified as having higher than expected coral cover, as well as characteristics that made it a potential FSA. Subsequent research characterized the users of the site and offered a better understanding of their socioeconomic activities, particularly fishing.

Both Belize and Guatemala have implemented legislation to protect Cayman Crown. In May 2020, Belize expanded the boundaries of the Sapodilla Cayes Marine Reserve, while Guatemala established a temporary 10-year fisheries closure via Ministerial Agreement (July 2020).

Cayman Crown is a central component of the MAR Fish Project. The project has dedicated specific efforts to characterizing, monitoring, and conserving the area and to promoting collaborative management among Belize, Guatemala and Honduras, which share the Gulf of Honduras.

The technical approach of these actions encompasses:

- Biological monitoring: continuous assessments of coral cover, the presence of key species, and the dynamics of reproductive aggregations using standardized methodologies.
- Cross-border management: promotion of bilateral and multilateral agreements to ensure the site is protected effectively, considering its strategic geopolitical location.
- Socioeconomic integration: analysis of the impacts of fishing activities and their integration into sustainable management schemes that benefit the ecosystem and the communities that depend on it.

The protection of Cayman Crown is crucial for conserving marine biodiversity and maintaining the essential ecosystem services that the reef provides to the Gulf of Honduras region. Its effective management constitutes a model of multinational conservation and serves as a benchmark for the protection of critical marine ecosystems.

Sentinel site descriptions

Prior to the 2023 workshop, MarFish Project partners and representatives from each organization were provided with a template for data collection in each site. The following pages contain overviews of each sentinel site.

SITE	ORGANIZATION	COMMENTS
Punta Allen (San Juan)	COBI[1]	
Punta Allen (Niche Habin)	COBI	
Xcalak (Blanquizal)	COBI	Xcalak replaced Punta Herrero (El Faro) as a sentinel site
TAMR (Maugre Caye)	TASA[2]	
TAMR (Dog flea)	TASA	
TAMR (Caye Bokel)	TASA	
Caye Glory (Emily)	BFD[3]	
Nicholas Caye	BFD	
Gladden Spit	SEA[4]	
Cayman Crown	TIDE[5]/HRHP[6]/ FUNDAECO[7]/ CORAL[8]	
Sandy Bay	CORAL	
Man of War	CORAL	Man of War replaced Texas as a sentinel site
Cordelia Banks	CORAL	

[1] Comunidad y Biodiversidad A.C. (COBI)
[2] Turneffe Atoll Sustainability Association (TASA)
[3] Belize Fisheries Department (BFD)
[4] Southern Environmental Association (SEA)
[5] The Toledo Institute for Development and Environment (TIDE)
[6] Healthy Reefs for Healthy People (HRHP)
[7] Fundación para el Ecodesarrollo y la Conservación (FUNDAECO)
[8] Coral Reef Alliance (CORAL)

PUNTA ALLEN (SAN JUAN), MEXICO

Site description

This rocky reef is located 21 km from the coast near an underwater ravine. The site has been protected as a fishing refuge since 2016 and has a maximum depth of 36 m.

Species and abundance

The main species in the site are the Nassau grouper *(Epinephelus striatus)* (estimated population size: 50–70 fish; size: 50–90 cm) and the black grouper *(Mycteroperca bonaci)* (estimated population size: 50–70 fish; size: 40–90 cm). Courtship behaviour and color changes have been observed in both species. Other species associated with the site include permit *(Trachinotus falcatus),* horse-eye jack *(Caranx latus),* dog snapper *(Lutjanus jocu),* and great barracuda (Sphyraena barracuda).

Monitoring and management

Monitoring has included size and abundance estimates, as well as acoustic monitoring and DNA and eDNA sampling (eDNA samples have yet to be analyzed). Passive acoustic monitoring and data analysis have been conducted on a continuing basis, whereas opportunities for visual surveys have been limited due to poor weather.

Photo: COBI

SITE NAME	SAN JUAN		
Protected area	Sian Ka'an Biosphere Reserve and *Arrecifes de Sian Ka'an* Biosphere Reserve		
Protected from fishing	Yes		
Type of spatial protection	Fish Refuge Zone		
Protected Area Manager	CONANP[9] / CONAPESCA[10]		
Organization responsible for management	CONAPESCA		
Organization responsible for monitoring	SCPP *Pescadores de Vigía Chico* / CECIMS[11] / COBI		
Fishing pressure on site	Unknown		
Ease of surveillance	Relatively difficult		
Species	**Max. abundance**	**Visually verified**	**Abundance tendency**
Epinephelus striatus	200	Yes	Decreasing
Epinephelus guttatus			
Mycteroperca bonaci	100	Yes	Decreasing
Mycteroperca venenosa	1–50	Yes	Decreasing
Mycteroperca tigris			
Lutjanus jocu			
Lutjanus analis			
Lutjanus cyanopterus			
Lutjanus griseus			
Lutjanus synagris			
Ocyurus chrysurus			
Notes	First documented in 2005; protected for five years in 2016. No spawning observed. Spawning indicators included color changes, fish aggregations, and fish behavior. Peak abundances were observed in 2010; current abundances are much lower <50 fish.		
Key literature	Franquesa-Rinos and Loreto- Viruel (2006), ASK and COBI (2010), Fulton et al. (2016), Fulton et al. (2018).		

[9] Comisión Nacional de Áreas Naturales Protegidas (CONANP)
[10] Comisión Nacional de Acuacultura y Pesca (CONAPESCA)
[11] Centro Comunitario de Investigación y Monitoreo Submarino (CECIMS)

PUNTA ALLEN (NICHE HABIN), MEXICO

Site description

Niche Habin is located near the fishing community of Punta Allen (Quintana Roo, Mexico). The site is located on a reef composed of ridges and channels. The coral ridges rise up 5–10 m, and the seabed is located at ~40 m depth. At the request of SCPP *Pescadores de Vigía Chico,* a fishing cooperative, Niche Habin was protected by declaring it a Fish Refuge in 2016. Monitoring in the site is conducted by divers from the fishing cooperative in collaboration with COBI.

Species and abundance

The main spawning species in Niche Habin, the Nassau grouper *(Epinephelus striatus),* is critically endangered. Approximately 1,000–2,000 Nassau groupers gather in the site to spawn between January and March. The black grouper *(Mycteroperca bonaci)* has also been documented in Niche Habin, although in low numbers. The black grouper may spawn in deeper waters than the Caribbean grouper, which are located towards the edge of the reef.

Monitoring and management

The Fishing Refuge of Niche Habin (15 km^2) is managed by the National Commission of Aquaculture and Fisheries of Mexico (CONAPESCA, for its Spanish acronym). The site is also located within the Sian Ka'an Biosphere Reserve, which is managed by the National Commission of Protected Natural Areas (CONANP, for its Spanish acronym). Lastly, the site is located within the fishing concession of the fishing cooperative SCPP *Pescadores de Vigía Chico,* and trained divers from the fishing cooperative have monitored the site since 2005. In 2020, the Community Center for Underwater Research and Monitoring (CECIMS, for its Spanish acryonym) was created. Since then, this community monitoring group that has led the visual surveys, eDNA sampling, and hydrophone acoustic monitoring efforts in this FSA site.


Photo: COBI

SITE NAME	NICHE HABIN		
Protected area	Sian Ka'an Biosphere Reserve and *Arrecifes de Sian Ka'an* Biosphere Reserve		
Protected from fishing	Yes		
Type of spatial protection	Fish Refuge Zone		
Protected Area Manager	CONANP / CONAPESCA		
Organization responsible for management	CONAPESCA		
Organization responsible for monitoring	SCPP *Pescadores de Vigía Chico* / CECIMS / COBI		
Fishing pressure on site	None		
Ease of surveillance	Moderate		
Species	**Max. abundance**	**Visually verified**	**Abundance tendency**
Epinephelus striatus	1000–2000	Yes	Increasing
Epinephelus guttatus			
Mycteroperca bonaci	1–50	Yes	Stable
Mycteroperca venenosa			
Mycteroperca tigris			
Lutjanus jocu			
Lutjanus analis			
Lutjanus cyanopterus			
Lutjanus griseus			
Lutjanus synagris			
Ocyurus chrysurus			
Notes	*Epinephelus striatus* spawning has been observed on several occasions and was first documented in 2005. The site has been protected since 2016.		
Key literature	Franquesa-Rinos and Loreto-Viruel (2006), ASK and COBI (2010), Fulton et al. (2016), Fulton et al. (2018).		

XCALAK (EL BLANQUIZAL), MEXICO

Site description

El Banquizal is located 8.5 km from the coast and has a maximum depth of 32 m. The seabed is covered by alternating reef crests that reach 10 m in height and sandy channels. This site is part of the Arrecifes de Xcalak National Park. Despite not being completely protected, the fishing resources in the site are not currently exploited.

Species and abundance

The key species in El Blanquizal is the Nassau grouper *(Epinephelus striatus)* (estimated population: 1,000 fish; size: 40–90 cm). Seven black groupers *(Mycteroperca bonaci)* have also been recorded in the site. Courtship behaviors, color changes, and spawning have been observed in both species. In addition, tiger grouper *(Mycteroperca tigris)* have been observed to the south of the *E. striatus* aggregation.

Monitoring and management

Monitoring has included estimating sizes and abundances, recording courtship and behavior, conducting acoustic monitoring, and collecting DNA and eDNA samples (eDNA samples have yet to be analyzed). In 2023, monitoring also included collaborations with local researchers, although opportunities to perform visual surveys were limited due to bad weather.

Photo: COBI

SITE NAME	EL BLANQUIZAL		
Protected area	Arrecifes de Xcalak National Park		
Protected from fishing	Yes		
Type of spatial protection	NA		
Protected Area Manager	CONANP		
Organization responsible for management	CONANP		
Organization responsible for monitoring	COBI		
Fishing pressure on site	None		
Ease of surveillance	Moderate		
Species	**Max. abundance**	**Visually verified**	**Abundance tendency**
Epinephelus striatus	2000–5000	Yes	Increasing
Epinephelus guttatus			
Mycteroperca bonaci	1–10	Yes	Stable
Mycteroperca venenosa			
Mycteroperca tigris	1–10	Yes	Stable
Lutjanus jocu			
Lutjanus analis			
Lutjanus cyanopterus			
Lutjanus griseus			
Lutjanus synagris			
Ocyurus chrysurus			
Notes	Large grouper aggregations were first documented in 2001. In the 2024 monitoring, the aggregation of *Epinephelus striatus* was recorded.		
Key literature	Medina-Quej et al. (2004).		

TURNEFFE ATOLL MARINE RESERVE: MAUGER CAYE, BELIZE

Site description

Mauger Caye is located north of the Turneffe Atoll Marine Reserve (TAMR) within a fully protected area. The site is located approximately 300 m from the reef crest, in a system of spurs and channels located at depths of 25–35 m. The spawning site has five main crests and four channels.

Species and abundance

A notable fluctuation in the abundance of Nassau grouper *(Epinephelus striatus)* has been observed over the years. From 2016 to 2021, the abundance of the *E. striatus* population was relatively low; a moderate increase was observed in 2022, with a dramatic jump in 2023 (~2,500 individuals). These changes suggests that the presence of this species in the area increased during the last monitoring period.

Monitoring and management

In 2022, monitoring was taken over by TASA, after having been previously carried out by the University of Belize Environmental Research Institute (UBERI, for its Spanish acronym). During the 2022–2023 spawning aggregation monitoring season (December to February), underwater visual surveys, laser sizing, and passive acoustic monitoring were conducted.

Foto: https://visitturneffe.org

SITE NAME	MAUGER CAYE		
Protected area	Turneffe Atoll		
Protected from fishing	Yes		
Type of spatial protection	Marine Reserve[12]		
Protected Area Manager	TASA		
Organization responsible for management	TASA		
Organization responsible for monitoring	University of Belize ERI		
Fishing pressure on site	Low		
Ease of surveillance	Moderate		
Species	**Max. abundance**	**Visually verified**	**Abundance tendency**
Epinephelus striatus	2500	Yes	Increasing
Epinephelus guttatus			
Mycteroperca bonaci	10-15	Yes	Unknown
Mycteroperca venenosa	1-50	Yes	Unknown
Mycteroperca tigris	<10	Yes	Unknown
Lutjanus jocu	1-50	Yes	Unknown
Lutjanus analis			
Lutjanus cyanopterus			
Lutjanus griseus			
Lutjanus synagris			
Ocyurus chrysurus			
Notes			
Key literature	Paz and Grimshaw (2001), Heyman and Requena (2002), Burns-Perez and Tewfik (2015).		

[12] Marine Reserve refers to sites protected by the 2003 (SI-162) and 2009 (SI-49) statutory instruments. For more information, please visit: http://www.spagbelize.org/Legislation.aspx

TURNEFFE ATOLL MARINE RESERVE: DOG FLEA, BELIZE

Site description

Dog flea is located to the northeast of the Turneffe Atoll Marine Reserve (TAMR) and to the south of Mauger Caye. The site is fully protected and found within a highly sheltered zone. Dog flea is located ~1 km from the edge of the reef on a steep slope that leads to a canyon that begins at ~30 m depth. The spawning area comprises three main ridges.

Species and abundance

During the 2023 monitoring season, several species were recorded in varying abundance. Among the most notable species were yellowtail snapper *(Ocyurus chrysurus)* (280 individuals) and bar jack *(Caranx ruber)* (170 individuals), as well as horse-eye jack *(Caranx latus)* (70 individuals), mahogany snapper *(Lutjanus mahogoni)* (25 individuals), and tiger grouper *(Mycteroperca tigris)* (25 individuals). In addition, black grouper *(Mycteroperca bonaci)* (3 individuals), dog snapper *(Lutjanus jocu)* (2 individuals), yellowfin grouper *(Mycteroperca venenosa)* (4 individuals), and Nassau grouper *(Epinephelus striatus)* (5 individuals) were recorded in the site, although in much lower abundance.

Monitoring and management

During the 2023 monitoring season, visual underwater surveys, laser measurements, and passive acoustic monitoring were conducted, which provided key data to understand population dynamics at this critical spawning site.

Foto: www.travelbelize.org

SITE NAME	DOG FLEA CAYE		
Protected area	Turneffe Atoll		
Protected from fishing	The site is protected, but the aggregation must be relocated or recharacterized		
Type of spatial protection	Marine Reserve		
Protected Area Manager	TASA		
Organization responsible for management	TASA		
Organization responsible for monitoring	University of Belize ERI		
Fishing pressure on site	NA		
Ease of surveillance	NA		
Species	**Max. abundance**	**Visually verified**	**Abundance tendency**
Epinephelus striatus	1-10	Yes	Unknown
Epinephelus guttatus			
Mycteroperca bonaci	1-10	Yes	Unknown
Mycteroperca venenosa	1-10	Yes	Unknown
Mycteroperca tigris	1-25	Yes	Unknown
Lutjanus jocu	1-50	Yes	Unknown
Lutjanus analis			
Lutjanus cyanopterus			
Lutjanus griseus			
Lutjanus synagris			
Ocyurus chrysurus	280		
Notes			
Key literature	Burns-Perez and Tewfik (2015), Cho-Ricketts (2019)		

TURNEFFE ATOLL MARINE RESERVE: BOKEL CAYE, BELIZE

Site description

Bokel Caye is located at the southernmost point of the Turneffe Atoll Marine Reserve (TAMR), approximately 1 km from the reef crest on a steep slope that begins at ~30 m depth. It is a fully protected area within a highly protected area. Bokel Caye is known for its strong underwater currents.

Species and abundance

During the 2023 monitoring season, several species of interest were recorded in this site. Among the most notable species were horse-eye jack *(Caranx latus),* yellowtail snapper *(Ocyurus chrysurus),* cubera *(Lutjanus cyanopterus),* bar jack *(Caranx ruber)* and dog snapper (*Lutjanus jocu).*

Monitoring and management

During the 2023 monitoring season, visual underwater surveys, laser sizing, and passive acoustic monitoring were conducted, which provided detailed information on the species present and their abundance in this important FSA.

Foto: TASA

SITE NAME	BOKEL CAYE		
Protected area	Turneffe Atoll		
Protected from fishing	Yes		
Type of spatial protection	Marine Reserve		
Protected Area Manager	TASA		
Organization responsible for management	TASA		
Organization responsible for monitoring	University of Belize ERI		
Fishing pressure on site	High for snappers		
Ease of surveillance	Relatively difficult		
Species	**Max. abundance**	**Visually verified**	**Abundance tendency**
Epinephelus striatus			
Epinephelus guttatus			
Mycteroperca bonaci	200		
Mycteroperca venenosa	60		
Mycteroperca tigris	400		
Lutjanus jocu	1600	Yes	
Lutjanus analis	300	Yes	
Lutjanus cyanopterus	2500	Yes	
Lutjanus griseus			
Lutjanus synagris			
Ocyurus chrysurus	2800	Yes	
Notes	Other species observed in smaller numbers, including the red grouper *(Epinephelus morio),* rock hind *(Epinephelus adscensionis),* and hogfish *(Lachnolaimus maximus).*		
Key literature	Paz and Grimshaw (2001), Heyman and Requena (2002).		

CAYE GLORY (EMILY), BELIZE

Site description

Glory Caye (Emily) is located near a steep cliff in the reef curve. This site, which covers 1,351 acres, has historically been an important FSA for Nassau grouper *(Epinephelus striatus)* during December and January. In the 1960s, it was a productive fishing ground for E. striatus (daily catch of nearly 2 metric tons). According to the Department of Fisheries, 1,000 individuals were recorded in 2003 and 2004.

Species and abundance

The main species observed in 2021 were Nassau grouper *(Epinephelus striatus)* (375 individuals), dog snapper (*Lutjanus jocu*) (2,400 individuals), yellow jack *(Caranx bartholomaei)* (100 individuals), horse-eye jack *(Caranx latus)* (250 individuals), and black grouper *(Mycteroperca bonaci)* (2 individuals).

Monitoring and management

Monitoring was conducted via visual underwater surveys to collect data on species abundance and spawning-related behaviors. Glory Caye (Emily) faces several challenges, including a lack of financial resources, adverse weather conditions that limit opportunities for visual surveys, and illegal fishing that hinders species conservation efforts. Despite these obstacles, the site is monitored regularly, and fisheries management and sute protection have remained priorities.

Photo: Craig 1969

SITE NAME	CAYE GLORY (EMILY)		
Protected area	No		
Protected from fishing	Yes		
Type of spatial protection	Marine Reserve		
Protected Area Manager	BFD		
Organization responsible for management	BFD		
Organization responsible for monitoring	BFD		
Fishing pressure on site	Low		
Ease of surveillance	Moderate		
Species	**Max. abundance**	**Visually verified**	**Abundance tendency**
Epinephelus striatus	200-1000	Yes	Unknown
Epinephelus guttatus			
Mycteroperca bonaci	1-50	Yes	Unknown
Mycteroperca venenosa	1-50	Yes	Unknown
Mycteroperca tigris	1-50	Yes	Unknown
Lutjanus jocu	1000-2000	Yes	Unknown
Lutjanus analis	1-50	Yes	Unknown
Lutjanus cyanopterus			
Lutjanus griseus			
Lutjanus synagris			
Ocyurus chrysurus			
Notes	Data from 1999 reported 3,000 *E. striatus*, which declined to zero in 2001-2002 before increasing to ~250 in 2005. Divers reported 2,000 fish in 2014 and only 238 in 2019.		
Key literature	Paz and Grimshaw (2001), Heyman and Wade (2007), Burns-Perez and Tewfik (2015), Cho-Ricketts (2019).		

NICOLAS CAYE, BELIZE

Site description

Nicolas Caye is located at the southern end of the Belize Reef System, which covers 1,664 acres. The site is under high fishing pressure and is intensively exploited by fishers from Honduras and Guatemala.

Species and abundance

One of the most important species in the site is Nassau grouper *(Epinephelus striatus),* with reports of 90 individuals in 2019, 300 individuals in 2020, 36 individuals in 2021, 155 individuals in 2022, and 273 individuals in 2023.

Monitoring and management

Monitoring was conducted via visual underwater surveys to collect data on species abundance and behavior. Due to the high fishing pressure in the area, management and protection measures must be strengthened to properly conserve species in this critical FSA.

Foto: TIDE

SITE NAME	NICHOLAS CAYE		
Protected area	Sapodilla Cayes Marine Reserve		
Protected from fishing	Yes		
Type of spatial protection	Marine Reserve		
Protected Area Manager	BFD		
Organization responsible for management	BFD		
Organization responsible for monitoring	TIDE		
Fishing pressure on site	High		
Ease of surveillance	Moderate		
Species	**Max. abundance**	**Visually verified**	**Abundance tendency**
Epinephelus striatus	100–300	Yes	Stable
Epinephelus guttatus			
Mycteroperca bonaci	40	Yes	Unknown
Mycteroperca venenosa			
Mycteroperca tigris			
Lutjanus jocu			
Lutjanus analis			
Lutjanus cyanopterus			
Lutjanus griseus			
Lutjanus synagris			
Ocyurus chrysurus			
Notes	TIDE has continued to monitor the site according to FSA data provided.		
Key literature	100-200 *E. striatus* were reported in 2014-2015, but only 107 were reported in 2018.		

GLADDEN SPIT AND SILK CAYES, BELIZE

Site description

Gladden Spit and Silk Cayes is a marine reserve located in the central portion of the Belize Reef System. This site hosts more than 25 species of reef fish, as well as manta rays and whale sharks that frequent the area to feed on fish eggs.

Species and abundance

A drastic decline in the number of individuals of most species has been observed in this site. Peak species counts were considerably higher in the first years of the underwater censuses of this FSA.

Monitoring and management

Monitoring has been conducted through visual underwater surveys, with data collected from 2003 to 2023 (except in 2021 and part of 2022). Monitoring has been negatively impacted by staff changes and the limited involvement of community researchers. A preliminary analysis of the data collected over 20 years of monitoring has been completed.

Photo: SEA

SITE NAME	GLADDEN SPIT		
Protected area	Gladden Spit and Silk Cayes Marine Reserve		
Protected from fishing	Yes (temporary)		
Type of spatial protection	Marine Reserve		
Protected Area Manager	SEA		
Organization responsible for management	SEA		
Organization responsible for monitoring	SEA		
Fishing pressure on site	Moderate		
Ease of surveillance	Easy		
Species	**Max. abundance**	**Visually verified**	**Abundance tendency**
Epinephelus striatus	1-50	Yes	Decreasing
Epinephelus guttatus	1-50	Yes	Unknown
Mycteroperca bonaci	1-50	Yes	Unknown
Mycteroperca venenosa	1-50	Yes	Unknown
Mycteroperca tigris	1-50	Yes	Unknown
Lutjanus jocu	5000	Yes	Stable
Lutjanus analis	1000-2000	Yes	Increasing
Lutjanus cyanopterus	250-1000	Yes	Stable
Lutjanus griseus			
Lutjanus synagris			
Ocyurus chrysurus	1-50	Yes	Unknown
Notes	Surveyed in 2000 (100 *E. striatus*). Friends of Nature monitored the site in 2002; the site had 350 *E. striatus*. Data from 2012-2015 indicated fewer than 200 fish. In 2017, 6,000 *L. analis* were reported. Special permits available for fishing for *L. analis* between March and June.		
Key literature	Paz and Grimshaw (2001), Heyman and Requena (2002), Burns-Perez and Tewfik (2015), Cho-Ricketts (2019).		

CAYMAN CROWN

Site description

This high-coverage reef zone, which includes valleys and buttress reefs, has drops of up to 500 m. The Cayman Crown reef in Guatemala has been declared a completely restricted area by Ministerial Agreement (85-2020). In Belize, the Sapodilla Cayes Marine Reserve was expanded in July 2020 to protect the Belizean portion of this key ecosystem.

Species and abundance

Twenty-four species of megafauna have been reported in Cayman Crown, including 19 species of cetaceans, 5 elasmobranchs, and fish such as schoolmaster snapper *(Lutjanus apodus),* dog snapper *(Lutjanus jocu),* crevalle jack *(Caranx hippos),* bar jack *(Caranx ruber),* and Atlantic spadefish *(Chaetodipterus faber).*

Monitoring and management

In 2021, in collaboration with TIDE, FSA monitoring (via visual underwater censuses and onboard observations) and megafauna monitoring were conducted, with 30-min exploratory dives to obtain additional information. The following achievements in site management stand out: a hydrographic survey of the Cayman Crown, issuance of navigation warnings, a diagnosis of the coastal marine zone of the Wildlife Refuge of Punta de Manabique (RVSPN, by its Spanish acronym) and Cayman Crown, the creation of a governance table, strengthening dialogue with the fishing sector, promoting economic alternatives, and training.

Foto: HRI

SITE NAME	CAYMAN CROWN		
Protected area	No		
Protected from fishing	Yes		
Type of spatial protection	Temporary Space Prohibition Zone for 10 years. Ministerial Agreement 85-2020		
Year first documented as ARP	Spawning is not yet visually verified		
Protected Area Manager	DIPESCA[13]		
Organization responsible for management	DIPESCA		
Organization responsible for monitoring	HRHP[14] and TIDE		
Fishing pressure on site	Moderate		
Ease of surveillance	Moderate		
Species	**Max. abundance**	**Visually verified**	**Abundance tendency**
Epinephelus striatus			
Epinephelus guttatus	1-50	Yes	Unknown
Mycteroperca bonaci	1-50	Yes	Unknown
Mycteroperca venenosa			
Mycteroperca tigris			
Lutjanus jocu	50-100	Yes	Unknown
Lutjanus analis	50-100	Yes	Unknown
Lutjanus cyanopterus			
Lutjanus griseus			
Lutjanus synagris			
Ocyurus chrysurus	50-100	Yes	Unknown
Notes	Reproductive behavior of fish has been observed in the site. However, fish spawning has not been documented. In addition to the species mentioned above, reproductive behavior has also been observed in other species like Hypoplectrus gemma, *Canthidermis sufflamen*, and *Caranx hippos*. A temporary fishing ban in Guatemala was declared for the site for 10 years via Ministerial Agreement (85-2020), which was published in the Official Diary on 22 May 2020. In Belize, the site was included in the Sapodilla Cayes Marine Reserve in 2020.		
Key literature	Perez-Murcia (2020).		

[13] Dirección de Normatividad de la Pesca y Acuicultura (DIPESCA)
[14] Healthy Reefs For Healthy People (HRHP)

SANDY BAY, HONDURAS

Site description

Sandy Bay is located in the outer reef area at the northwestern end of Roatan Island. The site contains a sand basin at its center, and its maximum depth is 40 m.

Species and abundance

Approximately 75 – 250 tiger grouper *(Mycteroperca tigris)* and 15 black grouper *(Mycteroperca bonaci)* were observed in the area.

Monitoring and management

Monitoring has been conducted via visual underwater surveys, laser sizing, and acoustic monitoring. An achievement that should be recognized is that monitoring, which has indicated an increase in fish biomass, has been conducted successfully for three consecutive years in Sandy Bay.

Foto: Daniel Giraldo/RMP/CORAL

SITE NAME	SANDY BAY		
Protected area	Bay Islands National Marine Park		
Protected from fishing	During spawning season		
Type of spatial protection	Temporary Fishing Zone		
Protected Area Manager	Technical Committee / ICF[15]		
Organization responsible for management	Technical Committee / ICF		
Organization responsible for monitoring	Roatan Marine Park		
Fishing pressure on site	Low		
Ease of surveillance	Easy		
Species	**Max. abundance**	**Visually verified**	**Abundance tendency**
Epinephelus striatus			
Epinephelus guttatus			
Mycteroperca bonaci	1–50	Yes	Unknown
Mycteroperca venenosa			
Mycteroperca tigris	250–1000	Yes	Unknown
Lutjanus jocu			
Lutjanus analis			
Lutjanus cyanopterus			
Lutjanus griseus			
Lutjanus synagris			
Ocyurus chrysurus			
Notes	Aggregation behavior, color changes, courtship, and spawning have been recorded in *Mycteroperca tigris*.		
Key literature	Chollett (2017).		

[15] Instituto Nacional de Conservación y Desarrollo Forestal, Áreas Protegidas y Vida Silvestre (ICF)

MAN OF WAR, HONDURAS

Site description

This site is located on the northwestern side of the island and exhibits a maximum depth of ~40 m. Man of War is an outer reef with reef mounds and a sandy, central patch.

Species and abundance

Tiger grouper *(Myceteroperca tigris)* have been observed in the area.

Monitoring and management

Monitoring has been carried out through underwater visual censuses. Although spawning was confirmed, the number of fish is small enough to be considered a possible aggregation. In 2022, underwater cameras were used without success.

SITE NAME	MAN OF WAR		
Protected area	Bay Islands National Marine Park		
Protected from fishing	During spawning season		
Type of spatial protection	Temporary Fishing Zone		
Protected Area Manager	Technical Committee / ICF		
Organization responsible for management	Technical Committee / ICF		
Organization responsible for monitoring	Roatan Marine Park		
Fishing pressure on site	Low		
Ease of surveillance	Easy		
Species	**Max. abundance**	**Visually verified**	**Abundance tendency**
Epinephelus striatus			
Epinephelus guttatus			
Mycteroperca bonaci			
Mycteroperca venenosa			
Mycteroperca tigris	24	Yes	Unknown
Lutjanus jocu			
Lutjanus analis			
Lutjanus cyanopterus			
Lutjanus griseus			
Lutjanus synagris			
Ocyurus chrysurus			
Notes			
Key literature	Chollett (2017).		

CORDELIA BANKS, HONDURAS

Site description

This site is located on an outer reef on the southern side of the island and exhibits a maximum depth of ~40 m. Spawning occurs in the water column in front of the reef wall.

Species and abundance

The following species have been observed in the site: Nassau grouper *(Epinephelus striatus)* (250 individuals), yellowfin grouper *(Mycteroperca venenosa)* (300 individuals), black grouper *(Mycteroperca bonaci)* (50 individuals), and tiger grouper *(Mycteroperca tigris)* (100 individuals), with spawning in March and April in 2023

Monitoring and management

Monitoring has been conducted via visual underwater surveys, acoustic monitoring, and laser sizing. A notable achievement was the successful rediscovery of an FSA that was previously considered extinct. In addition, spawning of Nassau grouper *(Epinephelus striatus)* and yellowfin grouper *(Mycteroperca venenosa)* was confirmed in April 2023, with aggregations observed in March.

Foto: Claudio Contreras/
International League of Conservation Photographers

SITE NAME	CORDELIA BANKS		
Protected area	Bay Islands National Marine Park		
Protected from fishing	During the spawning season		
Type of spatial protection	Temporary Fishing Zone		
Protected Area Manager	Technical Committee / ICF		
Organization responsible for management	Technical Committee / ICF		
Organization responsible for monitoring	HRHP, CORAL, RMP[16], BICA[17], ZOLITUR[18]		
Fishing pressure on site	High		
Ease of surveillance	Difficult		
Species	**Max. abundance**	**Visually verified**	**Abundance tendency**
Epinephelus striatus	100-250	Yes	Decreasing
Epinephelus guttatus	1-50	No (TEK)[19]	Decreasing
Mycteroperca bonaci	100-250	Yes	Decreasing
Mycteroperca venenosa	100-250	Yes	Decreasing
Mycteroperca tigris	100-250	Yes	Decreasing
Lutjanus jocu	100-250	Yes	Decreasing
Lutjanus analis	50-100	No (TEK)	Decreasing
Lutjanus cyanopterus	100-250	Yes	Decreasing
Lutjanus griseus	50-100	No (TEK)	Decreasing
Lutjanus synagris			
Ocyurus chrysurus	100-250	Yes	Decreasing
Notes	Despite the high number of species and their abundance in this site, no complementary information, articles, or grey literature could be found to further support the interview information.		
Key literature	Chollett (2017)		

[16] Roatán Marine Park (RMP)
[17] Bay Islands Conservation Association (BICA)
[18] Zona Libre Turística Islas de la Bahía (ZOLITUR)
[19] Traditional Ecological Knowledge (TEK)

Visual censuses and data collection and analysis

Foto: COBI

Visual underwater surveys are the most widely used technique to monitor FSAs. In November 2019, a monitoring workshop was held in Cancun to discuss monitoring protocols and techniques, which have been widely implemented throughout the development of the MAR Fish project. Notably, the COVID-19 pandemic hindered monitoring activities during the snapper (May–July) and grouper (December–March) spawning seasons of 2020–2021 and 2021–2022. Due to the limited field activities and the necessity to work in smaller teams during these seasons, fewer data were collected.

During the 2023 workshop, participants highlighted the challenges they faced that were associated with training and retaining specialized survey divers. In particular, the cancellation of the regional training workshop that had been planned for 2020 in Belize due to the COVID-19 pandemic left some organizations with personnel who lacked experience in FSA monitoring and with uncertainties regarding how to properly implement protocols. Although virtual support was offered by MAR Fish Project partners, these challenges persisted, especially those related to the limited number of trained survey divers to simultaneously collect data in different FSAs. Nonetheless, the high number of Dive Masters in Honduras due to the tourism sector, represents an opportunity to meet this challenge, although frequent staff turnover and variable availability have still resulted in uncertainty prior to each monitoring season. Similarly, in Belize, staff turnover and the time needed to train new divers were also identified as challenges. In Mexico, COBI has worked closely with local fishing cooperatives to secure a pool of trained divers to conduct surveys.

To address these challenges, workshop participants recommended implementing regular training and refresher courses, similar to the HRI and AGRRA training programs for coral reef surveys, at the regional level. This could include a “train the trainer” program, where long-term staff in each country act as focal points for local training. In Belize, nation-wide training was conducted in October 2023. The importance of each diver having a thorough knowledge of each FSA site was also stressed by workshop participants. Even if a diver is well trained, if they are unfamiliar with local conditions, underwater landmarks, currents, or fish behavior, then the effectiveness of their surveys may be hindered.

Acoustic data collection and analysis

Acoustic sensors offer a relatively inexpensive and autonomous means to collect long-term data in FSAs. As part of the MAR Fish Project, SNAP hydrophones from Loggerhead Instruments have been deployed at sites in Mexico, Guatemala, and Honduras. In FSAs in Belize, hydrophones are scheduled to be installed for the 2023–2024 grouper spawning season. During the workshop, Jacobo Caamal of COBI led a hands-on training session to explain hydrophone components and common operational mistakes, as well as recommendations to effectively deploy these instruments. Questions arose regarding how best to install the hydrophones (e.g., required strutures), optimize battery life, and analyze data. Jacobo indicated that COBI has found that Energizer batteries provide the best battery life, while the manufacturer recommends batteries from Amazon's own brand.

The analysis of acoustic data remains ongoing and requires substantial computational power. COBI will provide support to HRHP and CORAL to analyze acoustic data using the FADAR algorithm, which detects sounds of Nassau grouper *(Epinephelus striatus),* black grouper *(Mycteroperca bonaci),* yellowfin grouper *(Mycteroperca venenosa),* and groupers (Epinephelidae). The FADAR algorithm was developed by researchers at Florida Atlantic University using grouper sounds from other Caribbean regions. However, due to erroneous detections in 2020 data from Mexico, the algorithm was retrained with data from the MAR region to adapt to local sound differences. To date, hydrophones have been deployed at Punta Allen, Xcalak, and San Juan in Mexico; Cayman Crown in Belize and Guatemala; and Cordelia, Sandy Bay, and Texas in Honduras. At Gladden, data analysis is being conducted using a new algorithm. In Gladden Spit and Glory Caye, the project partners plan to install hydrophones before the end of the year.

Photo: COBI

Photo: COBI

Databases and data analysis

The MAR Fish FSA database and monitoring survey sheets can be found on the AGRRA website. The survey sheets provide a standardized template for data entry during visual underwater surveys. Once new information is added, the online database and visualizations update automatically. Data from test surveys conducted in Mexico, Belize, and Honduras have already been entered into the database. Some MAR Fish Project partners have requested data entry support due to the large number of surveys that they have historically conducted.

In parallel, HRHP is conducting regional monitoring of coral reef health in all four MAR countries. The surveys include reef sites close to FSA sites. The data collected in these sites and historical reef data will be analyzed to assess whether these nearby reefs have additional fish biomass due to their proximity to FSAs.

During 2024, the data generated by MAR Fish Project partners was entered into a digital database developed by AGRRA. This digitalization of data was crucial to centralizing information from the different organizations that monitor FSAs in the region and ensuring the data are accessible. To accomplish this task, COBI hired Juan Pech, a member of a fishing community in the Yucatán Peninsula who is currently interning at UNAM Puerto Morelos. The MAR Fish team has supported Juan as he coordinates the digitalization of data from the participating organizations.

During the digitization process, data were collected from five key organizations: COBI, TIDE, SEA, EDF, and CORAL, covering the period from 2020 to 2024.. These data (482 new records) were uploaded to the AGRRA platform and added to the 86 records already present in the database, resulting in a total of 569 records for FSAs. Each record in the database represents a monitoring survey dive conducted at a different FSA.

To date, COBI, TIDE , SEA, EDF, and CORAL have contributed 22, 283, 100, 1, and 163 records, respectively. In some cases, certain data could not be uploaded due to the lack of mandatory information, such as the geographic coordinates of the FSA. However, by communicating with the participating organizations, most of these missing data were recovered.

One of the main challenges during this process was related to data management by the participating organizations. Not all organizations delivered the data in the correct format, which made it difficult to directly upload the information to the database. For instance, EDF delivered photographs of the monitoring sheets without the corresponding coordinates, which necessitated additional work to manually transcribe the information from each sheet into a digital format. In addition, another challenge was associated with the ArcGIS Online platform, which did not allow users to edit data that had already been uploaded without authorization from AGRRA. Therefore, any error in data

Key recommendations

1. Regional coordination: FSAs are transboundary resources. Managing FSAs effectively requires international collaboration, productive dialogue, and the participation in decision-making of actors and stakeholders from the government, academia, fishing sector, and civil society.
2. Effective data management: the loss of data and, consequently, knowledge has occurred in previous decades for multiple reasons. Digital ecosystems and repositories can help to reduce the probability of losing information. The MAR Fish database should be used in a standardized manner across the project, and its use should be promoted throughout the Caribbean region.
3. Standardized monitoring: the promotion and implementation of monitoring protocols should continue, in addition to training, to standardize monitoring efforts. Regional databases and information repositories should be accessible and provide simple, robust, and systematized indicators of each FSA. However, sensitive data must be protected to prevent overfishing.
4. Scientific principles and local knowledge: management tools should be based on the best available scientific information, effective design principles, and local ecological knowledge.
5. Encourage participation: participatory processes should be encouraged that promote best practices and that help fill the gap left by underfunded and oversized management agencies in the long-term.
6. Adaptive management: climate change brings uncertainty, and management strategies must be thoroughly reviewed over the coming decades.

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Annexes

Annex 1. 2023 MAR Fish Workshop participants.

PARTICIPANT	ORGANIZATION	SENTINEL SITES
Stuart Fulton	COBI	Punta Allen (Niche Habin), Xcalak (Blanquizal)
Jacobo Caamal	COBI	Punta Allen (Niche Habin), Xcalak (Blanquizal)
Omar Rivera	COBI	Punta Allen (Niche Habin), Xcalak (Blanquizal)
Melanie McField	HRHP	Cayman Crown
Melina Soto	HRHP	
Ana Giro	HRHP	Cayman Crown
Antonella Rivera	CORAL (virtual)	Man of War, Sandy Bay, Cordelia
Grace Horberry	CORAL/RMP	Man of War, Sandy Bay, Cordelia
Guillermo Galvez	FUNDAECO	Cayman Crown
Michelle Fernandez	MAR Fund (virtual)	
Cecilia Guerrero	TIDE	Cayman Crown
Elizabeth Avila	SEA	Gladden Spit
Tyrell Reyes	Belize Fisheries Department	Caye Glory (Emily)
Nic Requena	EDF	
Virginia Burns	TASA	
Asad Magaña	TIDE	Cayman Crown
Israel Muñoz	HRHP	
Judith Morales	MAR Fund (virtual)	

Annex 2. 2023 MAR Fish Workshop participant schedule.

TIME	TUESDAY 8TH AUGUST 2023	WEDNESDAY 9TH AUGUST 2023
09:00	Welcome	Review of day 1
09:30	Workshop objectives	Visual census data discussion – achievements and challenges
10:00	15 min updates from MARFish partners	
10:30		
11:00	Coffee break	Coffee break
11:30	15 min updates from MARFish partners	Acoustic sensor data discussion – achievements and challenges
12:00	Database discussion – where are we are and where do we go from here?	
12:30		
13:00	Lunch	Lunch
13:30		
14:00	Focus on Cayman Crown – achievements, challenges and results	What's next? Update on future plans at sentinel sites
14:30		
15:00		How to continue this regional effort
15:30	Coffee break	Coffee break
16:00	MARFish monitoring and evaluation – FFEM indicators	Review of agreements and commitments
16:30		
17:00		Close