

## Grouper Spawning Aggregations Off the Yucatan Peninsula, Mexico: Fishing, Management, and Conservation

### Agrupaciones de Desove de Meros Frente a la Península de Yucatán, México: Pesca, Manejo, y Conservación

### Agregation de Frai de Merou dans la Peninsule du Yucatan, Mexique: Peche, Gestion, et Conservation

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#### ABSTRACT

Very little is known on the fish spawning aggregations in Mexico, and the information available stems on groupers (Epinephelidae) mainly from the Pacific and Caribbean. More scientific information is needed to provide better management options and reach proper conservation alternatives. The present work aims to elucidate the current situation on the grouper spawning aggregations off the Yucatan Peninsula in terms of fishing, management, and conservation. In the Campeche Bank and the Mexican Caribbean, at least 17 grouper species are commercially exploited but only five species (*Epinephelus striatus*, *E. guttatus*, *Mycteroperca bonaci*, *M. venenosa*, *M. tigris*) are known to form spawning aggregations. With the exception of aggregations of *M. bonaci*, all aggregation's species have been scientifically validated for few locations. Unfortunately, management approaches in Mexico have not incorporated aspects of aggregating behavior of groupers yet. Thus, there is a need to use scientific approaches to identify and describe grouper aggregations and monitor those aggregations known already. In Mexico, fishing on grouper aggregations is a common practice since 1960s. The only management measure currently available is one-month ban year-round. The fishery status of various aggregations is unknown and some aggregations (e.g., *E. striatus*) have showed evidences of serious problems to the level of disappearance. Conservation initiatives on studying grouper aggregations from the Yucatan Peninsula have been promoted by The Nature Conservancy and helped to identify linkages between government and academia to begin addressing the importance of protecting them.

KEY WORDS: Spawning aggregations, groupers, coral reefs, conservation, Mexico.

#### INTRODUCTION

Fish spawning aggregations (FSAs) are predictable events in coral reefs that are ancestrally known by local fishers. Such predictability in space and time and a lack of adequate fishery management, with the intrinsic life history of aggregating species, make FSAs vulnerable to fishing. In fact, many FSAs exploited for more than 50 years have been severely disrupted to the level of disappearing from traditional sites (Sadovy et al. 2008). While fishing is a way for obtaining economic revenues, it is a non-responsible practice when inappropriate fishing gears (e.g., dynamite) are used and no care is taken for reproductive seasons. Fishing FSAs represents a major threat to many populations worldwide. If heavy fishing on FSAs persists unregulated, there is a high potential that fishing can remove a substantial amount of reproductive active fishes that in turns compromises seriously the population persistence (Sadovy and Domeier 2005).

Worldwide, relatively few FSAs are properly managed and specifically incorporated into marine protected areas (MPAs), or any other kind of protection, such as seasonal closures (Sadovy et al. 2008). In fact, very few exploited aggregating species are regularly monitored. There is a need of the conservation society for greater awareness among managers, fishery biologists, and the general public, that FSAs are extremely vulnerable and that must be a priority on conservation, research, and management agendas. In November 2002, the IUCN recommended on how to better protect FSAs; thus, the awareness is being spread.

A FSA is defined as a group of conspecific fishes that have migrated and gathered at a specific site and time in the reef for the purpose of spawning, with fish densities, or numbers, significantly higher than those found during the non-reproductive period (Domeier and Colin 1997, Claydon 2004). Two types of FSAs are recognized:

- i) Resident FSA form at specific times of the day, often synchronized to a particular lunar phase, over a lengthy spawning season (year round), and
- ii) Transient FSA is brief and form at specific times of the year, often during a specific lunar phase. Transient FSAs are those recognized for many commercially important species, such groupers (Serranidae), snappers (Lutjanidae) and jacks (Carangidae) among others.

In Mexico, a couple of transient FSAs have been studied, with special emphasis on groupers, given their commercial importance (Aguilar-Perera and Aguilar-Dávila 1996, Aguilar-Perera et al. 2008, Tuz-Sulub 2008). However, the management of grouper spawning aggregations still remains elusive and fishery authorities need to address them more directly. Consequently, it is necessary to offer better alternatives based on good science for the conservation of grouper aggregations. The objective of this study was to examine the current situation of grouper spawning aggregations off the Yucatan Peninsu-

la, Mexico, through a review of the available studies, analysis of case examples, and a revision of the official regulations in place for the fishery resources in Mexico.

### The Mexican Caribbean Experience

The main and most notorious FSA in the region is that of the Nassau grouper, *Epinephelus striatus*, off the southern coast of Quintana Roo in the Mexican Caribbean. This grouper is recognized by the IUCN under the category of endangered (Cornish and Eklund 2003). Historically, first accounts on *E. striatus* aggregations derived from Craig (1966) who established the existence of “astonishing numbers of groupers congregated” or “corridas” (runs) displacing over given distances along the Mexican Caribbean coast. Using this account, the first research initiative in documenting and compiling information on the Nassau grouper aggregation off the Mahahual addressed both a preliminary description of the folk fishery and testimonials based on interviews from fishermen who began fishing the aggregation early in the 1950s (Aguilar-Perera 1994). The Nassau grouper formed aggregations reaching 1,000 individuals three to four days before and after the full moon phase for December and January mainly, and used to remain at the traditional aggregations site of Mahahual for at least a week (Aguilar-Perera and Aguilar-Dávila 1996). However, the grouper began showing signs of disappearance by 1996 to the level of stop arriving to the site (Aguilar-Perera 2006) (Table 1).

Early in the 1990s, at least 7 Nassau grouper spawning

aggregation sites were known to exist for the southern Mexican Caribbean; and only one (Mahahual) was verified and documented (Aguilar-Perera 1994). Early in 2000, more aggregation sites were reported through interviews applied to local veteran fishermen recording at least 29 sites (Sosa-Cordero et al. 2002). Of these latter, less than 10 have been verified, including that off Mahahual. A relatively recent verified and documented aggregation site is located off Xcalak, Quintana Roo (less than 20 km from northern Belize) that fishermen know as El Blanquikal. During 2002, a Nassau grouper aggregation composed by 3,000 individuals was detected at 40 m deep (Medina-Quej et al. 2004). Since 1996, the local (state) fishery authority (Secretaría de Pesca) enacted a ban prohibiting the use of speargun during December, January and February for capturing any grouper in the Mexican Caribbean. However, fishermen use gill nets in areas far from the traditional site off Mahahual in areas where the Nassau grouper migrate for displacing to the aggregating sites. Consequently, capturing some part of the migrating groupers (Aguilar-Perera and Aguilar-Dávila 1996). Nowadays, fishers avoid fishing groupers during the season but only from those aggregations occurring within marine protected areas (Banco Chinchorro and Xcalak). The aggregation site off Mahahual still remains unregulated (Aguilar-Perera et al. 2009).

Late in the 1990s, for other areas of the Quintana Roo The Nature Conservancy (TNC) and Amigos de Sian Ka'an (ASK) embraced a collaboration to determine the

**Table 1.** Grouper spawning aggregations validated and unvalidated for the Mexican Caribbean and Gulf of Mexico.

Species	Northern Yucatan Peninsula (Yucatan)	Number of Fishes	Active (A) or Inactive (IN)	S	Eastern Yucatan Peninsula (Quintana Roo)	Number of Fish	Active (A) or Inactive (IN)	S
<b>Nassau grouper</b> <i>Epinephelus striatus</i>	Alacranes Reef	3,000	¿?	1	Mahahual	1,000	¿?	2
	Bajos del Norte	+ 5000	¿?	**	Niche-jabin	800	A	3
					Xcalak	4,000	A	4
					Banco Chinchorro	800	A	5
<b>Black grouper</b> <i>Mycteroperca bonaci</i>	Alacranes Reef	+500	A (until 2009)	**				
<b>Tiger grouper</b> <i>Mycteroperca tigris</i>	Bajos del Norte	+2000	A	**				
	Cayo Arenas	+ 2000	A	6				
<b>Yellowfin grouper</b> <i>Mycteroperca venenosa</i>	Alacranes Reef	+2000	A	6				
	Bajos del Norte							
<b>Red hind,</b> <i>Epinephelus guttatus</i>		+5000	A	**				
	Alacranes Reef	+3000	A	**				
	Bajos del Norte			7				
		+ 4000	A	**				

S = Source, 1 = Aguilar-Perera unpublished, 2 = Aguilar-Perera (1994), 3 = Loreto-Viruel et al. (2006), 4 = Bolio-Moguel (2007), 5 = Maricarmen García comm. Pers., 6 = Tuz- Sulub (2008), 7 = Tuz-Sulub and Aguilar-Perera (2012).

\*\* Fishermen communications, ¿? = unknown.

species and locations for FSAs in the Sian Ka'an Biosphere Reserve (SKBR) in Quintana Roo (mid coast of the Mexican Caribbean). At least three sites in the SKBR have been verified by ASK and managers of the SKBR (from CONANP), these sites are: Chenchomac, Nichehabin, and Punta Pajaros, all within the Ascension Bay (Albert Franquesa, Personal communication). In Chenchomac, there are aggregations of Nassau (*E. striatus*) and black grouper (*Mycteroperca bonaci*), in Nichehabin there are Nassau grouper aggregations only (Loreto-Viruel et al. 2006). Early in 2000, Sosa-Cordero et al. (2002), under funding by authorities of the Mesoamerican Barrier Reef System, documented the existence of 39 FSAs sites off Quintana Roo (Mexican Caribbean) using traditional ecological knowledge (TEK). Of these sites at least 24 (for 16 species, mostly snappers and groupers) are located within marine protected areas (MPAs) as follows: 14 in the SKBR, five in the Arrecife Xcalak National Park, and five in the Banco Chinchorro Marine Biosphere Reserve. In 2008, TNC funded a project to the Comision Nacional de Areas Naturales Protegidas (CONANP), a government agency from the Secretaria de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP), for studying FSAs in the Banco Chinchorro Marine Biosphere Reserve (Maricarmen García, Personal communication).

### The Gulf of Mexico Experience

The most notorious efforts to document FSAs in the Gulf of Mexico, specifically in the Campeche Bank off the northern Yucatan Peninsula allowed documenting aggregations of the Red hind (*Epinephelus guttatus*) in the Alacranes Reef (Tuz-Sulub et al. 2006, Aguilar-Perera et al. 2008). Other grouper aggregations have been documented, including those of Yellowmouth, *Mycteroperca interstitialis*, Tiger, *M. tigris*, and Yellowfin, *M. venenosa* during March, April and May for "Bajos del Norte", a submerged rocky shelf c. 254 km north of the coast, covered by massive corals, and those of *M. tigris* and *M. venenosa* in Cayo Arenas during April to June (Tuz-Sulub 2008). At least 17 grouper species (from the genera *Cephalopholis*, *Mycteroperca* and *Epinephelus*) are commonly exploited in the Campeche Bank (Colas-Marrufo 1998). Aside of the works by Tuz-Sulub (2008), Tuz-Sulub et al. (2006), Aguilar-Perera et al. (2008), Tuz-Sulub and Aguilar-Perera this issue) no other publications report formations of grouper aggregations off the northern coast of the Yucatan Peninsula (Table 1).

During 2008, research efforts from the Universidad Autónoma de Yucatan (UADY) were devoted to determine the current situation of the spawning aggregations of the Nassau grouper, *Epinephelus striatus* that used to form in the Alacranes Reef (Aguilar-Perera, Unpublished data). Veteran lobster fishermen were interviewed in order to confirm the presence of this grouper and the location of its spawning aggregation. At least two veteran fishermen explained that they used to exploit a "gigantic Nassau

grouper aggregation in the northern area of the Alacranes Reef". They say "we decimated such aggregation" "we were responsible that this grouper practically disappeared from the reef". According to veteran fishermen interviews, the Nassau grouper aggregation used to form in a very shallow shoal (less than 10 m deep) in the northern area and close to a shipwreck called "Vapor" in Alacranes Reef. Arriving to the aggregation site early in the morning (3 AM) and waiting to the dawn, fishermen were able to count about 4,000 groupers in a given fishing day. During interviews, fishermen mentioned "we were diving in very turbid water" "turbid because of the sperm released by the groupers". We conducted underwater surveys in the suspect Nassau grouper aggregation site mentioned by fishermen but our efforts were unsuccessful in finding the aggregation. A combination of bad weather (strong currents and wind) and logistic approach limitations to the site (15 km from Isla Perez where it is possible to stay safe) prevented us to dive the site during dawn and sunrise hours. These hours are more adequate for potentially find grouper aggregations and spawning in other geographic areas (Sadovy and Eklund 1999).

Other grouper aggregations known to form in very remote locations off the northern Yucatan Peninsula are those from the Bajos del Norte, which is a reef shoal 66 miles (160 km) northeast Alacranes Reef and very close to the geological border of the platform. In this area, there have been located large spawning aggregations of *Mycteroperca venenosa* (Tuz-Sulub, Personal communication) at more than 30 m deep. Some fishermen know of the existence of these aggregations and fish them every year during full moon days of January. It is not easy to get there due to the distance from shore (300 km) and the weather conditions during winter in the Gulf of Mexico. Despite these limitations, some fishermen venture to go there and exploit the aggregation. Tuz-Sulub (2008) was able to document aggregations of *M. venenosa*, *M. bonaci* and *E. guttatus* not only in Bajos del Norte but also in the Alacranes Reef and Cayo Arenas.

### Fishing

In the Gulf of Mexico and Mexican Caribbean, the grouper spawning aggregations were historically fished by the 1950s using hook and line. Eventually, aggregations were mostly exploited with speargun. In the Mexican Caribbean, the speargun is used to catch Nassau grouper; however, in some areas some fishermen claim to use hook and line for very deep sites. In the Gulf of Mexico, in the Alacranes Reef and Bajos del Norte the fishermen use speargun only. The fishery authorities do not distinguish or record any indication that the landings come from spawning aggregations. This is because when the fishermen vessels arrive to port after 15-day trip, fishermen sell the fish gutted. Thus, there is not any morphological evidence the fish came from spawning aggregations. This applies for the black, Red hind, Tiger, Yellowfin, and even the Gag.

Fisher managers are not aware of the reproductive seasons of these latter groupers but only pay attention to the “Veda de Mero” (grouper Ban) that applies for one month only (15 February to 15 March) (DOF 2009).

### Management

In Mexico, there is not any official regulation considering the grouper spawning aggregations. Some of the conservation programs for the marine protected areas (Xcalak, Chinchorro, Alacranes) only briefly mention the presence of aggregations without providing any specific guideline or monitoring protocol to be followed. The only fishery management regulation currently in place for the Gulf of Mexico and Mexican Caribbean waters is the “Grouper Ban” that considers only one month (15 February to 15 March) to restrict the extraction (DOF 2009). This ban is more directed to the Red Grouper (*Epinephelus morio*) but also includes the other 16 commercially exploitable groupers. This fishery management regulation clearly does not include the reproductive season for all groupers, such as the Nassau, Red hind, Black, Tiger, Gag and others whose reproductive peaks occur beyond the one-month fishing restriction period.

Other fishery regulatory documents not considering grouper spawning aggregations include: the National Fishery Chart (Carta Nacional Pesquera) and the Mexican Official Standards (Normas Oficiales Mexicanas). The former includes a database of key information on the main fishery resources (vertebrates and invertebrates) in Mexican waters. There is only a mention of the “grouper resource” where the leading grouper resource is the Red grouper, *E. morio* and the “by-catch” groupers. A list of “by-catch” groupers is attached to the section of “meros” (Groupers), but there is not any mention about the formation and location of their spawning aggregations. The only suggestion is to do research on other aspects of groupers (CONAPESCA 2010). In Mexico, current management for FSAs includes only brief considerations of their presence (specially groupers) in management plans for two MPAs: Reserva Marina de la Biosfera Banco Chinchorro (SEMARNAT 2000) and the Parque Nacional Arrecifes Xcalak (SEMARNAT 2004); however, no further details are provided on how management is applied. In fact, out of 33 MPAs for all Mexico (accounting for 38,733 km<sup>2</sup>, Bezaury-Creel 2005) only these two MPAs consider FSAs briefly within their management plans.

### Conservation

Initiatives to address the importance of protecting grouper spawning aggregations in Quintana Roo come mainly from coalitions between national and international NGOs. The Nature Conservancy in the Mexican Caribbean, helped by Amigos de Sian Kaan began efforts from 2006 to monitor grouper aggregations in the Sian Kaan Biosphere Reserve (Loreto-Viruel et al. 2006). However, eventually, the Comisión Nacional de Áreas Naturales

Protegidas (CONANP) joined to the efforts to study grouper aggregations in the Banco Chinchorro Marine Biosphere Reserve (M. García, Personal communication). The Nature Conservancy (TNC) moved forward in 2008 funding an initiative on the northern Yucatan Peninsula, in the southern Gulf of Mexico; specifically in the Arrecife Alacranes National Park. At the same time, TNC created a Working Group, including fishermen, managers (CONANP), other NGOs, (such as COBI-Arrecife Mesoamericano) and scientists (Universidad Autónoma de Yucatan), to address issues related to conservation and management of FSAs in the Yucatan Peninsula. However, currently this Working Group is not having meetings due to a lack of funding. At least for the northern Yucatan Peninsula, TNC is not currently funding any study related with fish spawning aggregations.

### Recommendations

In general, there is a substantial amount of scientific research to be done to know details not only on grouper but also other fish spawning aggregations off the Yucatan Peninsula and in other regions of Mexico. Some gaps in management and conservation include:

### Management

- i) Begin formally a scientific database on fish spawning aggregations, and assess their status based on fishing information and protection initiatives.
- ii) Promote fund rising to maintain any initiative to study these aggregations through focal groups with veteran fishermen, brief workshops to promote fish ecology learning to fishermen, outreach to disseminate the information derived from studies to local community
- iii) Advise fishery managers to identify and include information on fish spawning aggregations into official fishery documents, such as the National Fishery Chart. Elaborate a proposal of a technical key to be considered within the NFC explaining the relevance and importance of spawning aggregations.
- iv) Elaborate booklets (in Spanish and English) for the local people about the importance of fish spawning aggregations and local examples from the region (northern and eastern Yucatan Peninsula's coast).
- v) Promote in restaurants and fish markets the difference between the “mero” (Red grouper) and the other groupers (Black, Red Hind, Tiger, Yellowfin) in terms of reproductive seasons.
- vi) Establish species-specific bans for aggregating groupers.

## Conservation

- i) Conduct population dynamic studies (density and abundance) through monitoring overtime of aggregations of given species for comparison among years.
- ii) Conduct mark and recapture studies to determine displacement patterns (connectivity) among individuals to know common used sites
- iii) Elaborate studies involving several disciplines, such as sociology, anthropology and ecology in order to address the many aspects of fish spawning aggregations in the Southern Gulf of Mexico and Mexican Caribbean.
- iv) Forge the possibility to establish no-take marine reserves to protect grouper spawning aggregation sites.

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