Identifying Reef Fish Spawning Aggregations in Alacranes Reef, off Northern Yucatan Peninsula, Using the Fishermen Traditional Ecological Knowledge

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ABSTRACT

Fish spawning aggregations (FSAs) are among the most relevant ecological events in tropical, shallow waters. Many fish species migrate to build spawning aggregations at specific traditional sites in coral reefs every year, and many of these aggregations are severely exploited to the level of disappearance. In Mexico, the knowledge of such events is scarce, but efforts exist to document their characteristics. In Yucatan, there is scarce information available and they have not been considered further within both management and conservation plans. This work aims to identify and document the presence of key FSAs in Alacranes reef, based on the perspective of veteran and experienced local fishermen (traditional ecological knowledge), as to incorporate the importance of FSAs in management and conservation approaches.

KEY WORDS: Reef fish, spawning, fishermen, TEK, Yucatan

Identificación de Agregaciones Reproductivas de Peces en Arrecife Alacranes, Norte de la Península de Yucatán, Usando el Conocimiento Ecológico Tradicional de Pescadores

Las agregaciones reproductivas de peces arrecifales (ARPs) figuran entre los eventos ecológicos más relevantes de mares somero tropicales. Muchas especies de peces migran para formar agregaciones reproductivas cada año en sitios tradicionales específicos en arrecifes coralinos y muchas de estas agregaciones están severamente explotadas al nivel de desaparición. En México, el conocimiento de tales eventos es escaso, pero hay esfuerzos para documentar sus características. En Yucatán, hay información escasa disponible y no están consideradas ampliamente dentro de los planes de conservación y manejo. Este trabajo intenta identificar y documentar la presencia de ARPs clave, basándose en la experiencia de pescadores locales veteranos experimentado (conocimiento ecológico tradicional), para incorporar la importancia de los enfoques de manejo y conservación.

PALABRAS CLAVES: Pez arrecifal, desove, pescadores, CET, Yucatán

INTRODUCTION

Worldwide, at least 164 reef fish species (Claydon 2004) form either resident or transient spawning aggregations at times and sites that are predictable (Domeier and Colin 1997). Many of these fish aggregations are susceptible to exploitation and have been severely reduced; some have ceased to form and many are not regulated and monitored (Sadovy and Domeier 2005). The vulnerability of fish spawning aggregations (FSAs) stems on their predictable nature and the particular life history traits (slow growth, strong site fidelity, late sexual maturity) of the species involved; particularly snappers and groupers (Coleman *et al.* 1996), and the fact that most FSAs represent a substantial proportion of the total spawning stock biomass representing almost the entire reproductive output. At least 60% of known FSAs show signs of decline, 20% have ceased to form and 20% show signs of certain stability (SCRFA 2006).

Most of the knowledge about the existence of many FSAs comes mainly from fishermen (Johannes 1978) who have regularly exploited them for decades. This knowledge, important within the perspective of fishermen, has served them for managing their own fishery resources under traditional governance (Johannes 1978, 1997). In general, the traditional ecological knowledge (TEK) is defined as ‘‘a cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including human beings) with one another and with their environment’’ (Berkes 1993). Hamilton *et al.* (2005), using TEK, have approached the management of grouper aggregations in Melanesia, and Johannes *et al*. (1999) provided effective elements of judgment as to properly incorporate fishermen information into management.

In the western Atlantic, Smith (1972) documented the first formal spawning aggregation of the Nassau grouper, *Epinephelus striatus*, based on fishermen information and in situ observations. Subsequently, at least 35 fish species have been confirmed as forming FSAs in the wider Caribbean (Luckhurst 2004); from these, a large proportion of commercially important species are comprised by groupers (Serranidae) and snappers (Luitjanidae), but also jacks (Carangidae) and grunts (Haemulidae) (Domeier y Colin 1997). Many FSAs have experienced substantial declines due to fishing impact (Luckhurst 2004). Progressively, various researchers have incorporated TEK as to know times and locations of FSAs; such is the case of Cuba (mainly, snappers and groupers, Claro and Lindeman 2003), Brazil (Cavaleri Gerhardinger *et al.* 2006), and Mexico and Belize (Mesoamerican reef system) (Heyman *et al*. 2005).

In Mexico, the knowledge on the existence of FSAs remains relatively elusive for many managers and government entities, with only some documented cases on the Mexican Caribbean, particularly for the Nassau grouper, *E. striatus* (Aguilar-Perera 1994, 2007) and groupers from the Pacific Ocean (Sala *et al.* 2003). While various studies on fish (mainly grouper) reproduction exist for the Yucatan Peninsula region (Brulé *et al.* 2003), with the exception for one species (*Epinephelus guttatus*, Tuz-Sulub *et al.* 2006), undocumented FSAs remain to be described. Aside of Tuz-Sulub (unpublished), no other effort has been concentrated on describing FSAs off northern Yucatan Peninsula. Additionally, no previous work has attempted to describe the TEK of Yucatec fishermen regarding FSAs. Consequently, this work aims to address (in a first phase), based on the TEK from local fishermen, to identify how many fish species, where and when, form aggregations in Alacranes reef. This knowledge, in turn, could be incorporated within both management and conservation strategies.

MATERIALS AND METHODS

Study Area

Alacranes reef, located 135 km (Korniker and Boyd 1962) off northern Yucatan Peninsula (22°21'N; 89°36', Liceaga and Hernández, 2000), is a semi-elliptic, atoll-like structure emerging on a platform rising from 50 m depth. Alacranes reef presents various morphological structures distinguished by characteristics according to wave exposure and depth, such as reef shelf, windward barrier, north reef ridge, leeward reef ridge, reef plateau. It also has five sandy islands named as follow: Desterrada, Pérez, Pájaros, Chica y Muertos (Bonet 1967, Bello *et al.* 2005). Alacranes is 27 km long and 14.6 km wide, with a reef platform covering a surface of 299.75 km^2 (Bello 1998). In 1994, Alacranes reef was recognized as a National Marine Park, in which certain fishing activities established by law are allowed in accordance to the management plan (SEMARNAT 2006). Basically, this marine protected area (MPA) is divided in major components: two core (no-take) zones (at north and south) and one buffer zone (along the periphery of the reef) (Figure 1). The first two are related with conserving the ecosystem and the latter with allowing certain level of sustainable use. A management plan is available for the MPA recognizing grouper spawning aggregation sites (without specifying species) within the subzone of sustainable use of natural resources II in the buffer zone (SEMARNAT 2006).

Fishermen Interviews

This approach represents the phase one of a larger project involving further in situ verification of FSAs in Alacranes (phase two) using procedures in compliance

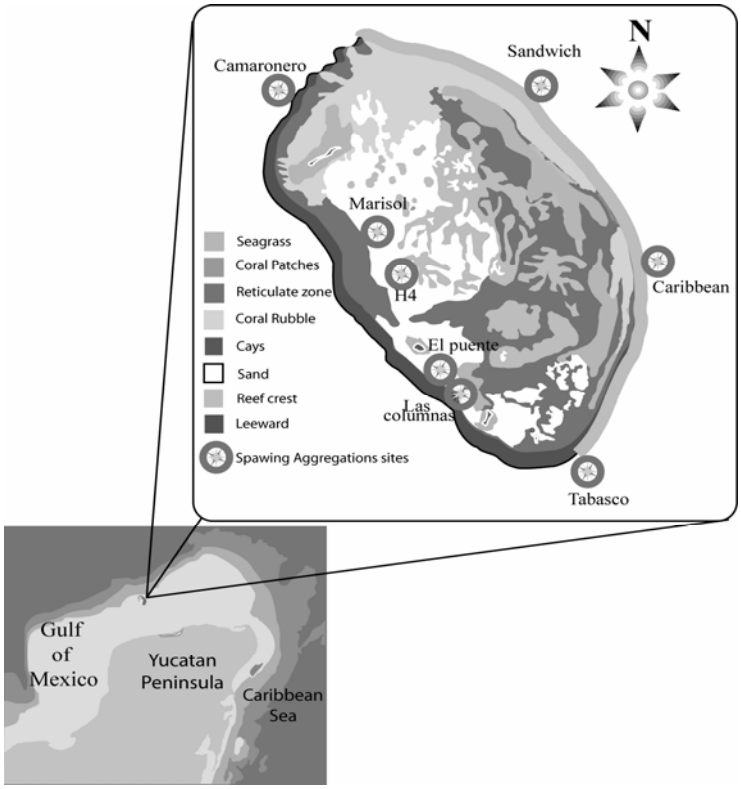

Figure 1. Alacranes Reef, off northern Yucatan Peninsula, showing the fish spawning aggregation sites reported by local fishermen.

with standard protocols of monitoring suggested when dealing with FSAs (Johannes *et al.* 1999, Colin *et al.* 2003, Heyman *et al.* 2005). In this phase one, semi-structured interviews were prepared for recording fishermen TEK on FSAs. Interviews were prepared in compliance with standard protocols already used in other regions (Johannes *et al.* 1999, Colin *et al.* 2003) and the wider Caribbean (Heyman *et al.* 2005), but adapting them to local idiosyncrasy of fishermen and fish species subjected to fishing in Alacranes. The final products of phase one attempt to determine:

i) Which species are commonly aggregating in Alacranes reef,
ii) The fisheries relative importance,
iii) Fishing gear used,
iv) The periodicity of such aggregations (months), and
v) The approximate locations where the fish form (information used with extreme confidence avoiding to reveal precise positions to public).

Also, special attention is given to document how the fishermen perceive the fish spawning aggregations. As such, it is important to know which elements the fishermen take into account to know how the sites in coral reefs are structured as to serve as spawning ground, environmental clues related to moon phase, currents, winds, and wave exposure immediate to spawning grounds, and the relative value some sites may have in case serving for multi-specific (various fish species) purposes (results of this are still to be obtained). Fishermen from various fishing towns (Progreso, Telchac, Dzilam, San Felipe), along the northern coast of northern Yucatan Peninsula, who commonly travel to Alacranes reef for fishing were considered. The idea was to identify the veteran, consequently, expert fishermen who know better, and fished more, on Alacranes. Special attention is paid for confidentiality to avoid revealing the precise location of unprotected FSAs.

RESULTS AND DISCUSSION

A total of 13 fish species (6 groupers, 5 snappers, 1 grunt and 1 triggerfish in 4 families) were reported by local fishermen as to form spawning aggregations (all fish except one having commercial importance, Table 1) in Alacranes reef. At least 8 sites, along the periphery of the reef (5 along leeward, Table 2), are referred as showing FSAs during various periods of the year. At least two species (*Epinephelus striatus, Mycteroperca bonaci)*, occur in three or more aggregation sites and use these sites almost simultaneously, mainly from December through February. For most species, spawning activity concentrates mainly from December to May (winter and spring, Table 1). The spawning season for groupers in Alacranes reefs shows a similarity to those displayed by same species in other areas of the region, such as Cuba (Claro and Lindeman 2001) and Puerto Rico (Ojeda-Serrano *et al.* 2007). Groupers tend to restrict their spawning to winter while snappers do it during summer. However, in the case of *Epinephelus itajara* in Alacranes reef, the spawning season is during summer.

In Alacranes reef, the aggregation sites are mostly located along leeward (six sites) and those sites exhibiting a multi-specific activity (various species using them sequentially) are the Sandwich, Camaronero, and Marisol. Other sites, where some spawning activity takes place, are Caribbean, Las Columnas, Tabasco, and H4 (with one species each), and El Puente (with two). Sandwich and Camaronero (sites holding most of the species) are located at the northern part of Alacranes along windward and leeward, respectively. The oldest, and consequently most fished, site is Sandwich which is used by at least 6 fish species through December and May mostly. About 200 fishermen commonly travel to Alacranes, from fishery ports of Progreso, Dzilam and Telchac, for fishing lobster (*Panulirus argus*), but they also take advantage on catching fish from aggregation sites. For aggregating fish they use spearguns exclusively. Many fishermen are aware of the timing the fish species aggregate which is related to moon phases of different months according to species.

Table 1. Fish spawning aggregation seasonality in Alacranes Reef, off northern Yucatan Peninsula.

Species	Common name		Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	English	Local Spanish												
Epinephelus guttatus	Red hind	Payaso			■									
Epinephelus itajara	Goliath	Cherna								■	■	■		
Epinephelus striatus	Nassau grouper	Mero sandia	■	■										
Mycteroperca bonaci	Black grouper	Negrillo	■	■	■									
Mycteroperca venenosa	Yellowfin grouper	Guacamaya					■	■						
Mycteroperca tigris	Tiger grouper	Guajil			■	■								
Lutjanus jocu	Dog snapper	Pargo perro		■	■									
Lutjanus apodus	Schoolmaster	Kanxik									■			
Lutjanus griseus	Gray snapper	Mulato									■			
Lutjanus mahogoni	Mahogani	Ojón									■			
Ocyurus chrysurus	Yellowtail snapper	Canané				■	■							
Anisotremus virginicus	Porkfish	Chabelita								■				
Canthidermis sufflamen	Ocean Triggerfish	Cochinita										■	■	

Table 2. Fish species according to aggregation site in Alacranes, off northern Yucatan Peninsula.

Species	Sites							
	Sandwich	Caribbean	Las Columnas	El puente	Camaronero	Marisol	Tabasco	H4
Epinephelus striatus	■				■	■	■	
Epinephelus guttatus	■					■		
Epinephelus itajara					■			
Mycteroperca bonaci	■			■	■	■		
Mycteroperca venenosa	■				■			
Mycteroperca tigris					■	■		
Lutjanus apodus		■						
Lutjanus jocu			■	■				
Lutjanus griseus						■		
Ocyurus chrysurus	■							
Anisotremus virginicus								■
Canthidermis sufflamen	■							

Worldwide, the knowledge the fishermen have on FSAs is progressively being considered by researchers (Johannes 1997, Sadovy and Domeier 2005). This has led to create communication channels between fishermen and scientists for finding better ways to obtain mutual benefits. Consequently, the empirical knowledge on FSAs can be translated into a scientific protocol for studying the spawning aggregation dynamics (Colin *et al.* 2003, Heyman *et al.* 2005). Commonly, fishermen use with discretion and secrecy the precise locations of given sites. This would be a way to keep some FSAs relatively "protected" from an unregulated fishing. Some fishermen hesitate to reveal precise positions unless they consider the fishery is experiencing declines demanding the expert participation of scientist. This latter is the case of Belize, where fishermen requested to the government to establish management regulations for protecting FSAs (Government of Belize 2003).

In Mexico, the knowledge the managers and government have on FSAs is not substantial as to incorporate regulations (CNP 2006). Scientists are progressively finding opportunities to study FSAs and advice managers and government on the importance of establishing conservation and management strategies. In the Yucatan Peninsula, specifically in the Mexican Caribbean, there are some efforts to determine, based on traditional ecological knowledge of fishermen, how many species and sites are currently present (Sosa *et al.* 2002). Many of the official documents related with fishery management do not have information on FSAs (CNP 2006); only some management plans consider FSAs (mainly for groupers) within given zones; this are the management plan (MP) for Banco Chinchorro (SEMARNAT 2000) which establishes that the speargun is prohibited during FSAs season; the MP for Xcalak (northern Belize), which includes the protection of grouper spawning aggregations within the "zone for sustainable use of marine natural resources" catalogued as special use (SEMARNAT 2004); the MP for Alacranes reef considers the "subzone for sustainable use of marine resources II" for protecting "various species of groupers."

In Mexico, The Nature Conservancy (TNC) is progressively highlighting the importance of protecting FSAs. A first step has been taken in the Mexican Caribbean, within the MesoAmerican Reef, for supporting studies on FSAs. Now, TNC is willing to support studies on FSAs in Alacranes reef with the intention of being a bridge between fishermen, science, management, and government to find ways to incorporate FSAs for conservation.

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