



Indicators of overfishing of snapper (Lutjanidae) populations on the southwest shelf of Cuba

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ARTICLE INFO

Keywords:

Fish spawning aggregations
Threatened species
Length-frequency data
Conservation
National park san Felipe Keys

ABSTRACT

Spawning aggregations are critical for the resilience of some coral reef fish populations and for the sustainability of many coastal fisheries. However, overexploitation of these aggregations is leading to a rapid decline of fish stocks. The fish aggregation site (FAS) associated with the San Felipe Keys National Park (in southwestern Cuba) is of great importance for the conservation of northern Caribbean snapper. An assessment of the pressure which fishing is placing on these populations, however, has not to date been conducted. To characterize the fishing use of San Felipe Keys FAS, data pertaining to five snapper species were evaluated in 2014. Samples consisted of 3879 individuals collected from 80 catch samples from commercial and sport fishing modalities. Catch assessment was performed using indicators based on length-frequency data (minimum legal size, length at first maturity, optimal length and average size of catch) and on fisheries effort data (seasonal and spatial yield by different modalities). To identify whether individuals were caught before or after spawning, the stage of gonads was analyzed. Individuals with sizes below the maturity length and with mature gonads before spawning prevailed in the five species, with *Lutjanus analis* and *L. cyanopterus* being the most affected. The government commercial fishing fleet had the highest volume of catches and the largest impact. The indicators suggest that the current use of this FAS may impede the effective preservation of reproductive capacity of the population. Therefore, management and conservation initiatives of this FAS are urgently needed to maintain the sustainability and resilience of the coralline social-ecological system.

1. Introduction

Spawning aggregations are a critical phenomenon for the resilience of some coral reef fish populations. Thus, the sustainability of coastal fisheries often depends on their proper functioning and health (Erisman et al., 2015). Spawning aggregations make fish populations more vulnerable and sensitive to exploitation, because their predictable concentration in time and space ensures high fishery yields encouraging, therefore increasing fishing effort (Sadovy de Mitcheson, 2016). The

mismanagement of these fisheries is of widespread concern and is a pressure that acts in synergy with other natural and human threats affecting the entire coral ecosystem (Pitcher and Cheung, 2013; Pontecorvo and Schrank, 2014; Defeo, 2015). Over-exploitation of aggregations is leading to a rapid decline in fish stocks and even to localized ecological extinctions (Jackson et al., 2001; Sadovy de Mitcheson et al., 2008; Sadovy de Mitcheson, 2016). Among the species of large coral reef fish that have been affected, snappers (Lutjanidae) are a notable example (Pauly et al., 2002).

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In Cuba, snappers are considered an iconic coastal group that is under intense fishing pressure throughout the marine shelf, with snapper fisheries generally focused on aggregations (Claro et al., 2009; Baisre, 2017). For example, the productivity of Cuba's largest fishing area, the Gulf of Batabanó in the southwest shelf, is widely supported by the existence of snapper aggregation sites (Claro and Lindeman, 2003). The most caught snapper species on this shelf have been *Lutjanus synagris* (Linnaeus, 1758) (lane snapper), *L. analis* (Cuvier, 1828) (mutton snapper), *L. griseus* (Linnaeus, 1758) (grey snapper), *Ocyurus chrysurus* (Bloch, 1791) (yellowtail snapper) and *L. cyanopterus* (Cuvier, 1828) (cubera snapper). The International Union for the Conservation of Nature (IUCN) classifies *L. cyanopterus* as vulnerable on the Red List of Threatened Species (IUCN, 2017). Landing data on this area indicate that in the 70s, about 35% of the total finfish catch was constituted by snappers, but in 1990 this percentage dropped to 18% (Claro et al., 2001). Recent studies also indicate that overfishing has had negative effects on snapper populations on this fishing locality (Aguilar-Ceruto, 2012; Valle and Ramos, 2012). Evidently, more research is needed to address the threats faced by fish aggregation sites (FAS) in the Gulf of Batabanó and to establish sound management and conservation strategies.

The western region of the Gulf of Batabanó in Cuba, adjacent to the National Park “San Felipe Keys”, contains a FAS for *L. analis* and *L. synagris* (Claro and Lindeman, 2003; Claro et al., 2009). Predictions derived from biophysical models show that fish larvae produced within the San Felipe Keys are likely to colonize the southern and northwestern regions of Cuba, the Yucatan, Bahamas and Florida (Paris et al., 2005; Kough et al., 2013, 2016). This connectivity supports the importance of preserving snapper stocks within Cuban and Caribbean waters. This FAS has historically been intensely fished and it is currently used by different fishing modalities that compete for the resource within the area. Due to this intensive use, the role of the FAS may be affected, hindering the maintenance of the fishery as well as the ecological balance of local coral reefs.

Therefore, the objective of this study was to assess the fisheries status of the five most commonly fished snapper species: *L. synagris*, *L. analis*, *L. griseus*, *L. cyanopterus* and *Ocyurus chrysurus* in the W Gulf of Batabanó, Cuba. This study used known overfishing indicators (Froese, 2004) to determine whether these species can be effectively preserved if the current level of exploitation continues and to identify the specific impact of the different fishing modalities operating in the region. The results of this study will allow fisheries and park managers to improve conservation measures to ensure FAS's protection, and by doing so, it will aid in maintaining the sustainability and resilience of associated coralline social-ecological systems.

2. Materials and methods

2.1. Study area

The study was conducted in the western Gulf of Batabanó (southwest region of Cuba). In this region, a FAS was described in 2001 (Claro and Lindeman, 2003) and later, the National Park “San Felipe Keys” (NPSFK) was established in 2010. The FAS was not included inside the NPSFK, it is located approximately 6 km from its western limit (Fig. 1). Fisheries is the only economic activity that occurs in the area, and it is primarily conducted by the commercial fishing fleet and some private fishers from La Coloma coastal community. This community is located some 40 km north of the NPSFK. To protect this FAS, national level regulations have been enacted including area closures, limits to fishing effort, and catch quotas (Claro et al., 2009).

The fishing sites identified in the study area were grouped in two main fishing areas (Fig. 1): 1) Coastal areas near La Coloma (from El Guamá to Bacunagua), characterized by coastal lagoons associated with mangroves and soft bottoms with seagrass and 2): Keys areas at the shelf edge (West of NPSFK to Isla de La Juventud), which include coral

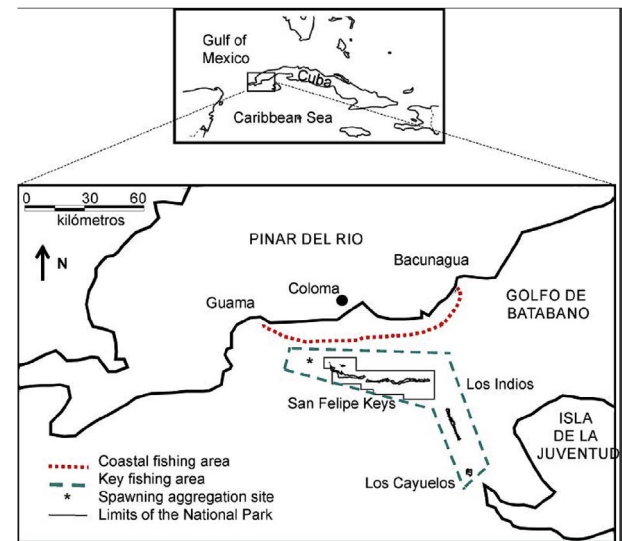


Fig. 1. Location of the study area in the Batabanó Gulf, the western part of Los Canarreos archipelago in Cuba. Map shows the Coastal and Keys fishing areas, the fish spawning aggregation site and the limits of the NPSFK (inside the Keys fishing area).

reefs, seagrass beds and mangrove habitats.

2.2. Fishing modalities

Government and private fishers in the study region were identified and grouped into four modalities according to their operational mode and their predominant fishing gear. The classifications included: 1) government commercial fishing; 2) government self-consumption fishing; 3) sport spear fishing and 4) sport non-spear fishing/private commercial fishing.

Government fisheries (commercial and self-consumption) have been operating for more than 50 years (Claro et al., 2009). Operations are undertaken using motor boats (15–25 m long) that cover extensive areas in the keys and are normally equipped with large-scale fishing gears (gill nets more than 300 m long with mesh sizes as small as 30–40 mm, 100 hooks long-lines, and fish traps). Government commercial fishing is conducted throughout the year, normally involving fishing trips of approximately 15 days. The vessels and their catches belong to the government and the catches are sold in local or foreign markets. Government self-consumption fishing is conducted only at specific periods of the year (usually during the summer). These fishing trips, also of about 15 days, are undertaken by government enterprise vessels, and the resulting catches are for the self-consumption of the government enterprises and those employed on the vessels.

Sport fishing (spear and non-spear fishing) was legally introduced in 1990, and their licenses allow for 72-h fishing expeditions on weekends. Private commercial fishing was introduced in 2009, and their licenses allow for fishing seven days a week throughout the year. It is carried out by state-hired sport fishers who sell fixed annual quotas to the government. These quotas are set based on the size of their vessels (Wielgus et al., 2014). For the purpose of this study, sport non-spear fishing was combined with private commercial fishing and treated as a single modality (despite having different licenses and regulations). They use small fishing boats (roughly 3–6 m long, with or without an engine) that remain mainly in coastal waters near La Coloma and generally fish with hook-fishing and lines, but also employ gill nets 50–100 m long with 40 mm mesh diameter. Sampling was conducted at the end of each fishing day, before the catch was separated into the portion to be sold to the government and the portion to be conserved for fishers' consumption. Spear fishing uses 6–11 m long motor boats and tends to target the Keys area.

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