

Assessing Exploitation of Nassau Grouper (*Epinephelus striatus*) Spawning Aggregations Through Fishers' Knowledge and Landings Data

Evaluación de la Explotación de las Agregaciones Reproductivas del Mero de Nassau (*Epinephelus striatus*) a Través del Conocimiento de los Pescadores y Análisis de los Desembarques

Évaluation de l'Exploitation des Agrégations de Frai de Mérou de Nassau (*Epinephelus striatus*) par les Connaissances des Pêcheurs et l'Analyse des Débarquements

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ABSTRACT

Historically, Nassau grouper (*Epinephelus striatus*) was a key component of fisheries in the Wider Caribbean Region. However, because of high fishing pressure particularly targeting spawning aggregations, populations of *E. striatus* have declined dramatically throughout its range and this iconic species is now regionally endangered. The Turks and Caicos Islands (TCI) have one of the healthiest remaining populations of Nassau grouper, possibly as a consequence of low fishing pressure on spawning aggregations, since local fishers predominantly target spiny lobster (*Panulirus argus*) and conch (*Strombus gigas*) specifically. In order to assess the extent of aggregation fishing, we conducted semi-structured interviews with local fishers (n = 40) throughout the TCI. In addition, during the presumed spawning period (December to February) we monitored landings in South Caicos, the main fishing island. All fishers interviewed were aware that Nassau grouper formed large schools seasonally, but only 38% of them had either seen or fished an aggregation. While all trap boat fishers targeted *E. striatus* spawning aggregations, only 19% of free-diving fishers did. Catch per unit effort from aggregations differed substantially between trap fishers (85 kg/person/day ranging from 4 to 425 kg) and spear fishers (30 kg/person/day ranging from 0 to 76 kg). Furthermore, over the spawning season trap boats caught 8 to 22 metric tons of Nassau grouper, while free-diving boats landed between 4 to 6 metric tons from aggregations. While these values are relatively low compared to historical records from other locations, spear fishing on aggregations appeared to be increasing. As a proactive measure, in 2015 a closed season (December 1 to February 28) was introduced with widespread stakeholder support following public consultations.

KEY WORDS: Small scale fisheries, fisher knowledge, Nassau grouper, spawning aggregations, Turks and Caicos Islands

INTRODUCTION

Nassau grouper (*Epinephelus striatus*) was a very important component of Caribbean fisheries both commercially and recreationally (Sadovy and Eklund 1999). However, life history characteristics (e.g. large body, late maturity, and longevity), and spawning in large aggregations at specific locations and times, have made this iconic fish particularly vulnerable to overfishing (Coleman et al. 2011, Sadovy and Eklund 1999, Sadovy and Domeier 2005). Since the 1970s Nassau grouper populations have declined dramatically throughout the region as a direct result of high fishing pressure, especially targeting spawning aggregations (Sadovy 1994, Sadovy 1997, Sadovy de Mitcheson et al. 2008), and several aggregations have disappeared or become commercially extinct (Aguilar-Perera 2006, Bush et al. 2006, Olsen and LaPlace 1978, Sadovy 1997, Sala et al. 2001). In the late 1990s *E. striatus* was declared regionally endangered by IUCN (Cornish and Eklund 2003), and it is currently considered locally extinct throughout most of its historical range (Albins et al. 2009, Sadovy de Mitcheson et al. 2013). Relatively high densities of Nassau grouper are found in only a few locations, which include Belize, Cuba, the Cayman Islands, and the Bahamas, with the highest densities recorded in the Turks and Caicos Islands (TCI) (REEF 2015).

Although TCI is a small country with only about 250 full-time fishers (Department of Environment and Maritime Affairs, TCI Government, unpublished data), it is a large regional player in the lobster and conch export fisheries (Béné and Tewfik 2001, Rudd 2003). This industry is primarily based on the small island of South Caicos, where over 75% of the working population is dependent on fisheries supported by the Caicos Bank (TCI Government, unpublished data). In the TCI, reef fishes were not regularly targeted until the 1990s when demand from tourism grew (Rudd 2003). Because the lobster and conch fisheries have been declining and becoming less profitable, fishers have been relying more on grouper and other fishes (Department of Environment and Maritime Affairs, TCI Government, unpublished data), and tourism-driven demand for these species has been growing.

In the TCI, Nassau grouper is predominantly fished commercially using spears and traps, although a relatively small recreational fishery using hook and line also exists. National landings statistics are currently not collected. In addition, data on local ecology are limited, and enforcement is minimal due to lack of resources. As a precautionary measure, starting in 2015, the Turks and Caicos Government implemented a ban on fishing, possession and sale of Nassau grouper during the presumed spawning months (December to February), and introduced size restrictions. Because of the relatively high density of Nassau grouper in the TCI compared to other locations in the region, it has always been assumed that fishing pressure on aggregations was low, and spawning sites were largely unknown. However, these assumptions had never been tested. Therefore, this study aimed to assess the extent to which spawning aggregations of Nassau grouper were targeted, and what factors determined the level of exploitation.

METHODS

Study Site

The TCI form the southeastern part of the Lucayan Archipelago, with the Bahamas stretching to the northwest (Figure 1). The islands' economy is primarily based on tourism, small-scale fisheries, and offshore banking (Tietze et al. 2006). Commercial fishers operate from all of the five main inhabited islands (Providenciales, Grand Turk, South Caicos, North Caicos, and Middle Caicos). However, South Caicos is the center of commercial fishing activities in the TCI. In South Caicos there are multiple landing sites: three processing plants that mostly focus on export, and two dock-side processing areas that predominantly supply the local market. Throughout the TCI, most fishers are free-divers operating from small vessels (< 25ft with 15 to 150 HP outboard engines), hooking spiny lobster, catching queen conch by hand, or spearing fishes, with limited use of traps and hook and line. A few large (> 30ft) diesel in-board trap boats also operate from the TCI (Department of Environment and Maritime Affairs, TCI Government, unpublished data).

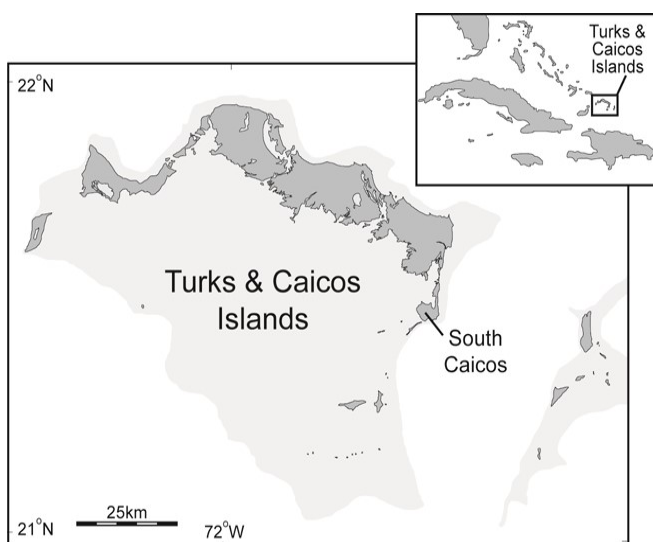


Figure 1. Map of Turks and Caicos Islands.

Interviews

We conducted semi-structured interviews with fishers from mid December 2014 to early March 2015. The majority of interviews were conducted in South Caicos, but surveys were also carried out in Providenciales, Grand Turk, North Caicos, and Middle Caicos. Interviews were spread across full-time, part-time, retired fishers working from both small vessels and trap boats. However, the majority of stakeholders interviewed were full-time fishers with over 15 years of fishing experience. We assessed whether fishers were aware that Nassau grouper formed large aggregations seasonally; if they knew locations and seasonality of aggregations; if they had seen them; if they had fished them, and, if so, what gears did they use.

Monitoring Landings

We monitored the landing sites in South Caicos between mid-December 2014 and the end of February 2015. This period was chosen because it corresponds with the peak spawning months for Nassau grouper from other locations in the region (Aguilar-Perera and Aguilar-Dávila 1996, Colin 1992, Olsen and LaPlace 1978, Sala et al. 2001, Smith 1972, Starr et al. 2007, Whaylen et al. 2004). Landings were monitored for evidence that spawning aggregations were being fished (e.g. catches dominated by large groupers with ripe gonads). In addition, when Nassau groupers were observed, fishers were asked where they were caught and if they came from aggregations. Fishing effort (as number of fishers per day) and landings (weight, kg) were also estimated.

Data Analyses

It was not possible to monitor all of the landing sites simultaneously on South Caicos. Therefore, only a sample of the total landings of Nassau grouper caught from spawning aggregations was recorded. Total estimates of landings (divided into trap vs. spearfishing boats) were estimated through a bootstrapping procedure to fill in the missing values, and 95% confidence intervals were generated from 1000 bootstrap replicates. Catch-per-unit-effort was estimated as kg of Nassau grouper per person per day. Estimated landings from separate spawning aggregations were compared to values from documenting biomass landed from Nassau grouper spawning aggregations during a single spawning season from other locations reviewed in Sadovy (1997). Data were transformed where necessary from number of individuals to biomass, using the mean weight per fish generated from data collected from South Caicos landings. In addition, landings for Cuba were estimated from the total annual catch of Nassau grouper, the proportion of annual catch estimated to be caught from aggregations, and the number of documented aggregation sites in Cuba (Claro and Lindeman 2003, SCRFA Fish Aggregation Database 2015).

RESULTS

Interviews

All fishers interviewed (n = 40) were aware that grouper formed spawning aggregations seasonally, which they described as “grouper schooling” or “when the grouper come up”. In addition, the locations of eight spawning sites were corroborated by fishers. Only 38% of all fishers interviewed had either seen or fished an aggregation. Among free-diving fishers, 10% had seen an aggregation on at least one occasion but did not fish it; the reasons given for this included poor visibility in the water, presence of a large number of sharks, and aggregations at depths beyond free-diving limits, but the most common explanation was that fishers were targeting lobster, and not fishes, on the day the aggregations were seen. All fishers working on trap boats, but only 19% of free-diving fishers, targeted spawning aggregations of *E. striatus*. Fishers referred to the aggregation period as the “grouper season”. This was described as occurring over a wide range of months from November to June (Figure 2). However, December,

January, and February were the months identified most frequently by fishers. Only one interviewee (who was a trap boat fisher) mentioned an association with the lunar phase, stating that he expected to catch more groupers around the full moon.

Catch-Per-Unit-Effort

The results from monitoring landings show a substantial difference between the catch per unit effort of spearfishers versus trap fishers. Spearfishers diving on aggregations landed on average almost 30 kg of grouper per person per day (ranging from 0 on unsuccessful trips, to 76 kg on very good days). Trap boats on average caught 85 kg per person per day (ranging from 4 to 425 kg; Figure 3).

Estimated Landings from Aggregations

From the fleet based from South Caicos, only five free-diving boats and two trap boats targeted spawning aggregations. Free-diving boats caught between 4 to 6 metric tons of Nassau groupers, while trap boats caught 8 to 22 tons (Figure 3). These landings were spread between four aggregation sites and appeared to be relatively low compared to historical landings from aggregations in other countries (Figure 4).

DISCUSSION

It is generally difficult to assess populations of reef fishes that form spawning aggregations (Sadovy and Domeier 2005), especially in tropical small island states char-

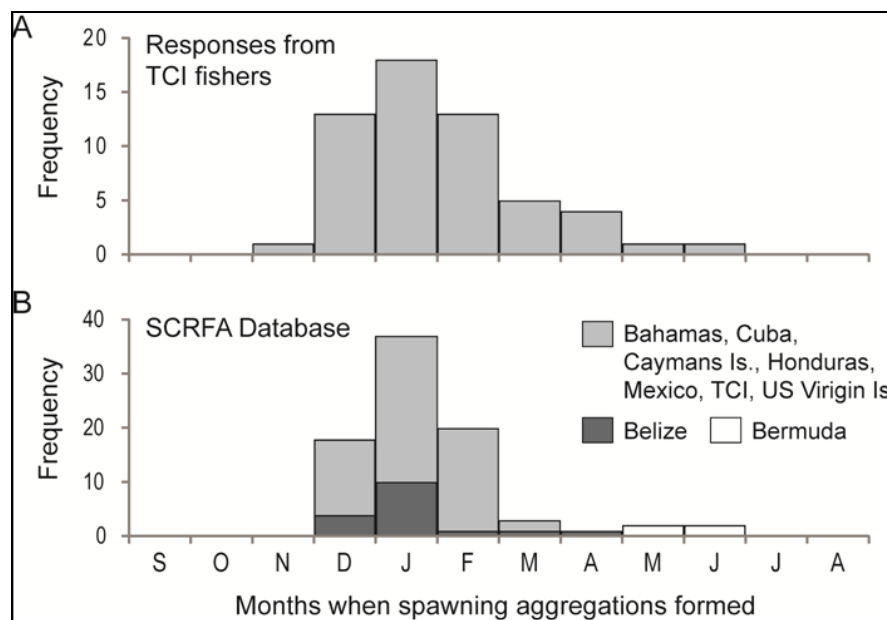


Figure 2. Season for *E. striatus* spawning aggregations. **A.** Frequency of months identified by fishers interviewed in TCI. **B.** Frequency of months documented in SCRFA Fish Aggregation Database (2015).

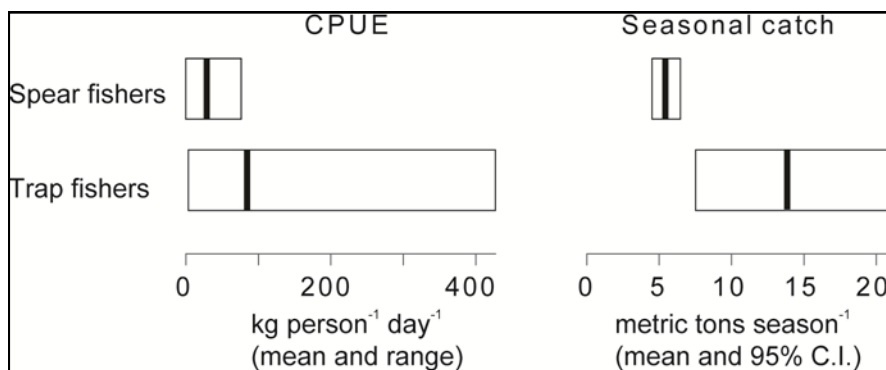


Figure 3. Catch per unit effort (CPUE; kg person⁻¹ day⁻¹) and total catch (metric tons) estimated from the South Caicos fleet over the 2014-2015 spawning season. Spear and trap fishers are displayed separately.

acterized by data-limited fisheries. In this study, fishers' knowledge complemented by landings data provided important insights into the level of exploitation of Nassau grouper spawning aggregations in the TCI. Even though many fishers interviewed identified locations and season of aggregations formed by *E. striatus*, only a small subset specifically targeted them. However, this seasonal practice seems to be increasing particularly among free-divers. While the biggest threat to Nassau grouper in the TCI is posed by the trap boats, the total catch from individual aggregations appears to be relatively low compared to historical records from other locations (Sadovy 1997). For three of the aggregation sites in the TCI, the low landings probably reflected a limited emergent fishery rather than a decline in the aggregations themselves. The fourth site has been exploited by a trap boat for over a decade, and the status of this aggregation is unknown.

Even if aggregations are predictable and recurrent in time and space (Claydon 2004, Domeier and Colin 1997), and their general season and some sites are known to TCI fishers, there are a number of reasons why spawning aggregations of Nassau grouper are not targeted more. In the TCI, there is a strong tradition of free-diving for lobster and conch (Béné and Tewfik 2001, Rudd 2003), and fishers are reluctant to change their fishing habits (i.e. gears and locations). For example, Turks and Caicos Islanders are typically unwilling to work on trap boats (most crew are foreign fishers), and commercial line fishing died out in the 1980s when it was replaced by free-diving (M.C., unpublished data). As most fishers sell directly to seafood processing plants, the focus on lobster and conch is rein-

forced by the industry's demand for these species even when Nassau grouper may be abundantly available. In addition, not all fishers can dive deep enough to target the aggregations and there are few trap boats operating; visibility is often poor and the abundance of sharks at aggregation sites deters many free-divers, and the few fishers who dive the aggregations often reported having to stop fishing because of sharks; sites may be inaccessible to small boats used by free-divers due to remoteness and rough weather conditions typical of the spawning months (shown to limit aggregation fishing in other locations; Bolden 2000, Matos-Caraballo et al. 2006, Robinson et al. 2008). Furthermore, the number of full-time fishers is generally low, and during the extended holiday season (which coincides with the spawning period) many local fishers move away from South Caicos, and foreign fishers (Haitian and Dominican) tend to return to their home countries (M.C., unpublished data). The absence of fishing during seasonal holidays has also been shown to provide some protection for grouper spawning elsewhere in the region (Matos-Caraballo and Padilla 2004).

Fisheries based on targeting spawning aggregations depend on a degree of local ecological knowledge (Robinson et al. 2014). Among TCI fishers, the general awareness of Nassau grouper spawning aggregations may mask a lack of intimate knowledge of these natural phenomena. For example, fishers identified eight months (November to June) over which aggregations were formed; however, the actual spawning season is likely to match that of neighbouring countries at similar latitudes (i.e. Bahamas, Cuba, Caymans, US Virgin Islands) where *E. striatus*

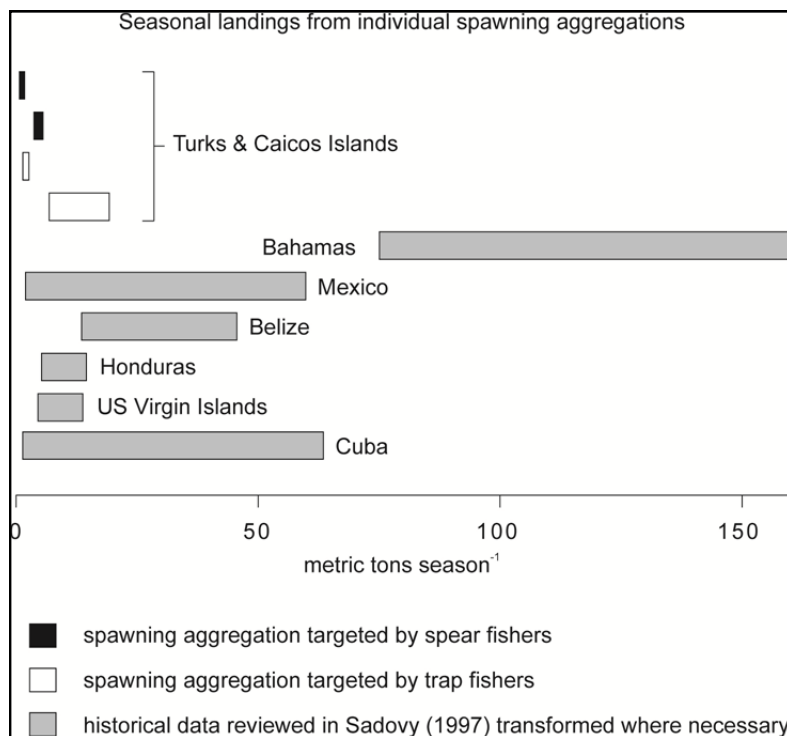


Figure 4. Total seasonal landings estimated from individual *E. striatus* spawning aggregation sites. Bars from TCI display 95% bootstrapped confidence intervals. Bars from other countries show range of landings.

spawning is restricted to December to February, with limited reports of spawning in March (SCRFA Fish Aggregation Database 2015). Furthermore, although regionally it is well known that Nassau grouper aggregates around the full moon (Aguilar-Perera and Aguilar-Dávila 1996, Bolden 2000, Claro and Lindeman 2003, Sala et al. 2001, Tucker et al. 1993, Whaylen et al. 2006), only one fisher interviewed mentioned this (or any) lunar association, which he learned from a foreign co-worker on a trap boat rather than through personal experience, or common local knowledge. Conversely, many local fishers referenced the lunar cycle when discussing aggregations of other species (e.g. *Mycteroperca venenosa* and *Lutjanus analis*; M.C., unpublished data). This provides further evidence that there is a limited tradition of fishing spawning aggregations of Nassau grouper among TCI fishers. Knowledge of spawning aggregations gained through experience may be restricted to the few local fishers who have been operating from trap boats for many years.

There is one demographic of commercial fishers in the TCI that the study did not specifically address: illegal foreign fishers, particularly those operating out of the Dominican Republic. Although the level of catch is undocumented, and the scale of the problem has not been quantified, operations are well organized and well equipped: mother-ships deploy 10 - 20 tenders, with fishers using hookah and working separate day and night shifts using spear guns and other gears. The most southern margins of the TCI fishing grounds are remote; the areas are less (or seldom) visited by TCI fishers who predominantly work closer to their home ports; and enforcement agencies have limited capacity for regular patrols. It is widely accepted by TCI fishers that these areas are better known to illegal Dominican poachers than to locals. In this context, it is likely that aggregation sites present in remote southern areas of the TCI may have been targeted by illegal fishers for decades, a conclusion also supported by TCI fishers during interviews.

This study supports the assumption that fishing pressure on spawning aggregations of Nassau grouper has been historically low in most of the TCI. However, this practice seems to be increasing among free-divers, and the level of illegal foreign fishing of spawning aggregations is unknown. The recent introduction of a closed season also includes a ban on possession and sale of Nassau grouper. As previously shown for spiny lobster in the TCI, the closed season is expected to be most effective through eliminating the market for Nassau grouper rather than through the ban on fishing itself. However, for comprehensive management of Nassau grouper it is critical to gain a better understanding of the grouper fishery beyond spawning aggregations, and within the multispecies context of TCI fisheries. As such, addressing illegal fishers operating from outside the TCI needs to become a management priority.

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