

CURRENT STATUS OF THE TIGER GROUPER (*Mycteroperca tigris*)
FISHERY AT VIEQUES ISLAND, PUERTO RICO

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ABSTRACT

The tiger grouper (*Mycteroperca tigris*) is reported to occur from Bermuda, Florida, Campeche and the West Indies to the northern coast of South America. There is little information on local abundance around Puerto Rico and the U.S. Virgin Islands. In fact, the available information indicates that the species is nowhere abundant and only harvested at the spawning aggregation sites. Other spawning aggregated groupers, as the Nassau grouper (*Epinephelus striatus*) have been heavily fished during the aggregations periods and become commercially extinct caribbeanwide.

The tiger grouper spawning aggregation site off Vieques (Puerto Rico) have been studied since 1992, gathering data on landings, catch per unit of effort and size distribution. Recently (1996), a tag and recapture project was initiated to gather information on spawning aggregation size and site fidelity. The broad purpose of these studies is to keep a permanent monitory program of the fishery, pointing toward the sustainable use of the resource.

The current status of the tiger grouper fishery at Vieques Island was determined by analyzing the effort, the landing data (estimated and reported), and the biostatistical information collected between 1995 and 1998. In spite of the decline in landings (more associated with a decrease in fishing effort), a series of positive tendencies, related with the number of active fishing boats, the kind of gears used and the size of the caught individuals, suggest that we are in the presence of a healthy and well managed fishery.

Key words: Aggregations, Groupers, Fisheries, Puerto Rico, Management.

RESUMEN

La presencia del mero tigre (*Mycteroperca tigris*) ha sido registrada desde las Islas Bermuda hasta la costa nororiental de Suramérica, pasando por la Florida, Campeche y las Antillas Menores. Existe muy poca información sobre su abundancia en las aguas de Puerto Rico y las Islas Vírgenes Americanas. En efecto, la información disponible indica que la especie es poco abundante y solo se le captura en los sitios de agregación reproductiva. Otros meros con similar comportamiento reproductivo, como el mero de Nassau (*Epinephelus striatus*), han sido intensamente pescados durante tales agregaciones y hoy se les considera comercialmente extintos en la región del Caribe.

La agregación reproductiva del mero tigre en la Isla de Vieques (Puerto Rico) ha sido estudiada desde 1993, obteniéndose información sobre los desembarcos, la captura por unidad de esfuerzo y la distribución de las tallas. Recientemente (1996), se inició un programa de marcaje y recaptura con el propósito de obtener información sobre el tamaño de la agregación y la existencia de fidelidad por el sitio de la agregación. El objetivo general de estos estudios es el de mantener una evaluación permanente de la pesquería, con el fin de lograr el uso sostenido del recurso.

El estado actual de la pesquería del mero tigre en la Isla de Vieques ha sido determinado mediante el análisis de los datos sobre esfuerzo, desembarcos (estimados y registrados) y bioestadística colectados entre 1995 y 1998. A pesar del declive observado en los desembarcos (asociado con una disminución en el esfuerzo pesquero), se pueden percibir una serie de tendencias positivas relacionadas con el número de botes activos en la pesquería, el tipo de artes de pesca utilizados y el tamaño de los individuos capturados, que sugieren que estamos en presencia de una pesquería saludable y bien manejada.

INTRODUCTION

Groupers (Pisces, Serranidae) landed in the Caribbean area have contributed substantially to the world commercial fish catch (Heemstra and Randall 1993). However, the latest large declines observed in landings and catch composition as a result of intensive fishing pressure (see Bannerot et al. 1987, Butler et al. 1993, Sadovy 1994) have alerted biologist and fisheries managers to the needs of effective management strategies, better stock monitoring and the acquisition of life-history data.

The tiger grouper (*Mycteroperca tigris*) is reported to occur from Bermuda, Florida, Campeche and the West Indies to the northern coast of South America, in coral reef areas from the shoreline to depths of at least 30 meters (FAO 1978). The tiger grouper, as several western Atlantic groupers species, forms spawning aggregations at specific times and locations each year (Fine 1990, Sadovy et al. 1994). Since intensive fishing on spawning aggregation areas is one of the primary causes for overexploitation and stock collapse, protection of aggregation have been recommended as an important and probably the most practical management strategy for aggregating groupers (see Bannerot et al. 1987, Auil-Marshalleck 1993, Sadovy 1994).

Reports from Vieques, an island lying east of Puerto Rico, of an aggregation and considerable catch of tiger groupers began in 1982, but no scientific reports document landings until 1992 (Sadovy et al. 1994). General information concerning to its fishery (landings, catch per unit of effort, size distribution) has been recorded, with increasing success, by the personnel of the Fisheries Research Laboratory of the Department of Natural and Environmental Resources of the Commonwealth of Puerto Rico (Padilla and Matos 1993, Lilyestrom 1994, Padilla and Matos 1995). A tag and recapture project was initiated in 1996 (Luckhurst 1996), to gather information on spawning aggregation size and site fidelity. Also, this program provides precise data on fishing effort and links the offshore fishing activities with the information collected at the landing sites (Posada 1997, 1998).

The objectives of these regular evaluations are to obtain biological data on this species (of which little is known), gather information on the fishing pressure to which it is annually submitted, detect changes in the population indicative of stock depletion, interact with local fishers and prevent the tiger grouper population from becoming economically extinct. The objectives of the present paper are to explore the natural tendency of the fishery, after 6 years of the monitoring program and to diagnose the actual status of the fishery. Emphasis will be put on the last 2 fishing seasons (1997 and 1998).

MATERIALS AND METHODS

The annual trips to Vieques are scheduled according to a well known behavior of the fishery, which established that the aggregations start approximately two days after the full moons of February and March, and last for about 5 to 6 days (Sadovy et al. 1994). Monitoring takes place every day, with Fisheries Research Laboratory personnel visiting the two most frequently fishing landing areas of Vieques (located in Isabel Segunda and La Esperanza; Fig. 1) and stay there until they have confirmed that every fisher has arrived from his fishing trip. The field work consists in the collection of landing data (kilograms and number of individuals caught), catch per unit of effort data (kg/boat/day) and biostatistical data (length, weight and sex).

Offshore activities include the active capture of specimens for the tag and recapture program, and the careful collection of information on weather conditions, fishing effort (number of boats and fishers) and all other pertinent information (i.e., interval of fishing, kind of bait used, shark attacks on preys, etc). A Vieques fisher (Julio Manuel Ilarraza) is hired to conduct fishing operations. Geographic coordinates at the fishing site are taken with a GPS (Global Positioning System). See Posada (1997) for details on fishing operations, as well as on fish handling and tagging.

All individual are measured (TL, in millimeters) and weighted (whole body weight, in grams). Sexual dichromatism is very marked in recent caught individuals (females displaying a reddish coloration in the upper body and a red/orange pectoral fin, while males exhibit a yellow to bronze coloration in the upper body and a distinctive yellow outer edge in the pectoral fin). However, landed specimens have to be sexed by macroscopical examination of the gonads. Lack of time made it impossible in some cases and the individual has to be process unsexed.

RESULTS

The aggregation site:

The aggregation site is a well-defined promontory of deep reef, known locally as “El Seco”. It was described by Sadovy et al. (1994) as a site about 8.8 km (4.7 nm) east of Vieques, near the edge of the Puerto Rico-Virgin Islands insular platform at depth of 36-40 m (Fig. 1). The bottom type is coral, mostly *Montastrea annularis*. “El Seco” was officially discovered in 1982 by a local diver-fisher (Sadovy et al. 1994). However, local fishers and CFMC records indicate that the tiger grouper has been landed in Vieques since the 1970’s.

Other neighboring spots have been reported by Vieques fishers as being excellent as aggregation areas for this species (e.g., La Iglesia and Caletas, both in Vieques waters or Sail Rock located southwest of St. Thomas; Lilyestrom 1994, Padilla and Matos 1995). However, all the fishing activities have been concentrated at “El Seco” during the last 2 seasons.

Based on the distribution of fishing boats, Sadovy et al. (1994) and Luckhurst (1996) estimated the extent of the “El Seco” aggregation in the order of 0.25 km² and 0.625 km², respectively. Figure 1 shows the distribution of the coordinates recorded by Lilyestrom (1994), Sadovy et al. (1994), Luckhurst (1996) and the present study, as well

as the coordinates of the points considered, by Julio Manuel Ilarraza, as the extremes expanses of the aggregation (*; see Fig. 1). The connected outer points yield an area of 1.24 km² (Fig. 1).

The study fishery:

Tiger grouper are only infrequently taken outside of the aggregation and are not taken by fish traps in the area (Sadovy et al. 1994). Traditionally, harvesting is done with hook and line (1 hook per hand line) or by spearing fish while SCUBA diving (up to 3 divers per boat).

Most of the boats departure from the harbors of "La Esperanza" (handline fishers) and a few from "Isabel Segunda" (mostly divers). Fishing related activities are initiated at around 5:00 am, equipping the boats with gasoline, fishing gears, scuba gears or live baits. The "El Seco" aggregation site is located 32 km (17 nm) from "La Esperanza" and 29 km (15.5 nm) from "Isabel Segunda". In average, it can take 1 hr and 30 min to get there; time varying according to the power of the outboard engine and the weather conditions. Once at the aggregation, the handline fishers spend approximately 4 hr and 30 min devoted to fish. Divers return to the harbor earlier (by 11:00 am), than the handline fishers (by 1:30 pm).

Fishers use boats ranging from 18 to 25 feet long and outboard motors with 25 to 70 HP. Table 1 compares the number of boats per day and the distribution of fishers during the seasons of 1997 and 1998. The number of boats and fishers at the aggregation site range between 0 and 15 boats (average: 7) and 0 to 27 fishers (average: 11), respectively. Contrarily to previous years, all the fishers involved in the 1998 tiger grouper fishery were equipped only with hooks and lines (no divers).

Table 2 show the effort data (number of boats and days of fishing), the average daily catch (kg/boat), and the estimated catch and reported landings (kg/months and kg/season) recorded during the last four years of the monitory program (1995-1998). The number of days advocated to fish have been decreasing from 7 (1995) to 3 days (1998).

Average daily catch oscillated between 30 (February 1995) and 67 kg/boat (March 1995) during the last 4 seasons, with captures ranging between 0 to a maximum of 113, 153 and 140 kg/boat/day in 1996, 1997 and 1998, respectively. Both, the estimated and the landed reported catch have been consecutively decreasing between 1995 and 1998 (from 4753 to 2016 kg/season and from 4962 to 1719 kg/season, respectively).

Handline fishing need of live bait. The variety of species use for live bait is listed in Table 3. Members of the families Scaridae and Labridae are of the most common use, followed by Acanthurids, Haemulids, Mullids, Chaetodontids and Holocentrids. A very limited group of fishers have succeed catching tiger groupers with sardines (*Harengula* spp.), but their rate of catch is slower compare with the other fishers.

There are natural and environmental conditions that raise difficulties in the fishing activities. Severe weather conditions may discourage fishers to be at the aggregation site in any particular day. Also, the attacks by sharks are quite common and the losses of tiger groupers by this mean could be considerable. The intensity of the attacks decrease along the week, but in average each boat is able to loose up 3 tiger groupers per day. Quite often, barracudas (*Sphyraena barracuda*), mackerels (*Scomberomorus* spp.) or nurse sharks (*Ginglymostoma cirratum*) prey on the baits and cut the fishing lines.

The study fish:

A total of 406 specimens were examined at the landing sites in 1997 (269 males, 42 females and 95 unknown/unsexed), followed by 457 specimens in 1998 (407 males, 34 females and 16 unknown). The average length and weight were 509.3 ± 56.4 mm (TL) and 2294.7 ± 698.9 g in 1997 and 535.4 ± 43.3 mm (TL) and 2649.9 ± 648.8 g in 1998.

As in previous years (Padilla and Matos 1993, Lilyestrom 1994, Padilla and Matos 1995), males were significantly larger than females for both 1997 ($t = 9.831$; $P < 0.0001$; $n = 311$) and 1998 ($t = 7.932$; $P < 0.0001$; $n = 441$) (Fig. 2). In 1997 and 1998, females averaged 462.0 ± 26.6 mm TL (1710.5 ± 320.7 g) and 481.8 ± 33.9 mm TL (2032.0 ± 443.3 g), respectively. During the same period of time males averaged $534.2 \pm$

45.9 mm TL (2562.0 ± 687.8 g) and 539.6 ± 41.3 mm TL (2700.6 ± 639.7 g), respectively. The female to male ratio was 1:6.4 in 1997 and 1:12.0 in 1998.

The tagging program:

A total of 182 tiger groupers have been captured, tagged and released (86 in 1997 and 96 in 1998). At the moment, none of them have been recaptured. Release sites are shown in Figure 1. Once fish were released, they all oriented themselves toward the "El Seco" aggregation site.

DISCUSSION

Aggregation area appears to be larger than previously estimated by Sadovy et al. (1994) and Luckhurst (1996) (0.25 km² and 0.0625 km², respectively). Discrepancies could be related to methodological differences. The present study used the most extreme recorded coordinates (GPS) from several studies to calculate maximum linear distances (length and width), while these of Sadovy et al. (1994) and Luckhurst (1996) are punctual estimations based on a particular day boat distribution (both) or diving observations (Sadovy et al. 1994).

In spite of the characteristic seven-day fishing period, the peak of fishing activities is restricted to a period of three days, during the months of February and March. There is a high cost involved in this fishery (in terms time and money) and fishers will participate on it, only if there are perspectives of substantial revenues. In the case of risky benefits, the fishers prefer to target toward other fishing alternatives in more accessible areas (i.e., the yellowtail snapper fishery; close to "La Esperanza"). There is also a main reason that establishes a limit in the daily interval of fishing (approx. 4hr, 30min): fishers want to sell their catch fresh and most of the brokers leave toward Puerto Rico in the ferry of 1:30 pm. Most of the tiger grouper is not consumed in Vieques because it is

said to be ciguatoxic, but is highly appreciate in Puerto Rico. Cancellation of fishing activities due to rough weather or seasonal holidays (i.e., Easter) have been reported by Padilla and Matos (1995), Luckhurst (1996) and Posada (1997) and may represent a natural protection for the resource.

A series of positives tendencies have been confirmed during the 1998 fishing season, all of them suggesting that we are in the presence of a healthy and well managed fishery. These tendencies are related with the number of boats, the kind of gears used, the capture per unit of effort and the size of the caught individuals.

The owners of 28 boats have ratified their involvement in the tiger grouper fishery (Jesús León, unpubl. questionnaire). However, Sadovy et al. (1994) observed 7 to 8 boats at the aggregation site in February of 1992. Padilla and Matos (1993) and Lilyestrom (1994) reported the maximum presence of 12 boats in April (1993) and March (1994), respectively. The 1997 and 1998 monitory programs have recorded an average of 7 boats per day (Table 1). Therefore, it could be inferred that the effort has not increased during the last 7 years. The maximum number of fishers involved in the fishery do not overcome the 30 reported by Padilla and Matos (1995). In fact, the number have been decreasing during the last 2 seasons (Table 1).

Fishers reported that by the 1980's, the tiger grouper was fished mostly by SCUBA divers. A decreasing tendency in the number of divers involved in the tiger grouper fishery was reported by Padilla and Matos (1995) and Posada (1997). During the 1998 season, the tendency reached the bottom when no divers participated of the aggregation. In fact, some of the current hook and line fishers are former divers frighten of diving accidents (bends). This is a significant and positive change in the traditional fishing practices related to the fishery, but more important is that the decision was taken by the own fishers, unfortunately based on a painful experience.

The sustained decline of both, the estimated and the landed reported catch appears to be a consequence of a reduction in the fishing effort (i.e., number of active fishing days, number of boats/fishers, kind of gear used) and no due to a diminution on fish abundance.

Also, the capture by unit of effort obtained by the tag and recapture program has remained constant during the 2 years of observations, ranging from 0 to 7.4 ind/hour in 1997 (average: 3.6 ind/hour) and 0.3 to 7.7 ind/hour in 1998 (average: 3.04 ind/hour). These numbers are important to reflect the situation of the fishery, because these came from a standardized situation (same fisher, boat, gear, bait, period of time and locality).

There is a tendency to catch larger individuals in every progressive tiger grouper monitoring program. Specimens sampled by Padilla and Matos (1993) ranged between 352 and 576, while the successive average sizes reported in 1994 (Lilyestrom 1994), 1995 (Padilla and Matos 1995), 1996 and 1997 (Rosario and Matos 1998) have been 467.0, 499.0, 500.0 and 509.7, respectively. The average length recorded during the 1998 study is inclusively higher (535.4 mm; present study). However, a two-sample Kolmogorov-Smirnov test showed no differences between the last and present year length frequency distribution (Fig. 2).

Predation on tiger groupers by sharks, at the time of capture is high (1 for every 6 tiger grouper caught during the seasons of 1997 and 1998); this was also observed by Padilla and Matos (1995). This situation should be considered as an important element in the estimation of the number of fish that are being removed, directly or indirectly, from the fishery. The reduction in the intensity of the shark attacks along the week has been connected by the handline fishers with the presence of divers (Posada 1997). However, since divers were not active during the 1998 season, this event can not be linked to them, but to a satiation effect.

Live bait is an important factor in the fishing success. The only problem is that the fishers are using small coral reef fishes as bait, including some juveniles of important commercial species, specially the grunts. However, the use of small coral reef fishes as bait is limited to the period of the tiger grouper spawning aggregation. Fishers check their traps every day and some are prepared several weeks before the aggregation forms. They classify their bait according to type (quality) and size. If necessary, live bait is fed with

bread or filamentous algae adhered to small rocks. Fishers preferred to use small-size fish as large ones are not completely swallow by the groupers.

The tag and recapture project will continue and we expect to get some recaptures during the following monitoring programs. There are plans to implant acoustic tags in some tiger groupers. It should provide information on the presence, arrival and departure (time and direction) of acoustically tagged fish. An acoustically tagged fish does not have to be recaptured for its presence to be detected.

The cooperative atmosphere between the fishers and the scientific personnel of this project is rendering benefits. Fishers are showing interest in our activities and have been attending informal meetings organized with the aim to present the results of the monitoring program and get their feedback. The fishers were particularly cooperative during the 1998 monitoring program and kindly provided all the data needed. The fishers are assuming some changes in their fishing habits and the positive tendencies suggest that we are well approaching toward the sustainable use of the resource.

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Table 1. Number of fishers and boats involved in the tiger grouper fishery during the aggregations of 1997 and 1998.

Month/ day of the aggregation	1997*				1998**				
	Number of boats with			No. boats (total)	Number of boats with			No. boats (total)	
	1 fisher	2 fishers	3 fishers		1 fisher	2 fishers	3 fishers		
Feb. 1	1	0	0	1	4	6	0	10	16
Feb. 2	4	10	1	15	1	1	0	2	3
Feb. 3	4	8	1	13	1	1	0	2	3
Feb. 4	6	3	1	10	4	6	0	10	16
Feb. 5	0	0	0	0	4	8	0	12	20
Mar. 1	3	1	0	4	3	0	0	3	3
Mar. 2	3	1	1	5	4	1	2	7	12
Mar. 3	1	5	1	7	7	2	0	9	11
Mar. 4	5	4	1	10	4	6	1	11	19
Mar. 5	4	3	0	7	3	0	1	4	6

* including handline fishers and scuba divers

** only handline fishers (divers did not participate)

Table 2. Effort (number of boats, days of fishing activities), average daily catch (kg), estimated catch (kg/month, kg/season) and reported catch (kg/month, kg/season) in the tiger grouper fishery at Vieques Island (Puerto Rico), between 1995 and 1998. One season = two month (February/March).

Month/Season	Average number of boats	Days of fishing activities	Average daily catch (kg/boat)	Estimated catch (kg/month)	Estimated catch (kg/season)	Reported catch (kg/month)	Reported catch (kg/season)
Feb. 1995	7	7	30	1470		1544	
Mar. 1995	7	7	67	3283		3418	
total ¹					4753		4962
Feb. 1996	7	6	52	2184		1245	
Mar. 1996	7	6	58	2436		1334	
total ²					4620		2579
Feb. 1997	7	3	57	1197		1769	
Mar. 1997	7	5	38	1330		423	
total ²					2527		2192
Feb. 1998	7	3	42	882		585	
Mar. 1998	7	3	54	1134		1134	
total ³					2016		1719

¹ Padilla and Matos (1995)

² Rosario and Matos (1998)

³ present study

Table 3. List of species used as live bait for handline fishers in the harvesting of tiger grouper.

Family	Scientific name	Common name
Scaridae	<i>Scarus taeniopterus</i>	princess parrotfish
	<i>Scarus iserti</i>	striped parrotfish
	<i>Sparisoma aurofrenatum</i>	redband parrotfish
	<i>Sparisoma radians</i>	bucktooth parrotfish
Labridae	<i>Halichoeres bivittatus</i>	slippery dick
	<i>Halichoeres garnoti</i>	yellowhead wrasse
	<i>Halichoeres pictus</i>	rainbow wrasse
Acanthuridae	<i>Acanthurus bahianus</i>	ocean surgeon
	<i>Acanthurus chirurgus</i>	doctorfish
	<i>Acanthurus coeruleus</i>	blue tang
Mullidae	<i>Mulloidichthys martinicus</i>	yellow goatfish
	<i>Pseudopeneus maculatus</i>	spotted goatfish
Chaetodontidae	<i>Chaetodon capistratus</i>	four-eye butterflyfish
	<i>Chaetodon ocellatus</i>	spotfin butterflyfish
Haemulidae	<i>Haemulon flavolineatum</i>	french grunt
	<i>Haemulon plumieri</i>	white grunt
	<i>Haemulon sciurus</i>	bluestriped grunt
Holocentridae	<i>Holocentrus adscensionis</i>	squirrelfish
	<i>Holocentrus rufus</i>	longspine squirrelfish
	<i>Myripristis jacobus</i>	blackbar soldierfish
Lutjanidae	<i>Ocyurus chrysurus</i>	yellowtail snapper

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