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## Research Letters

# Landings of goliath grouper, *Epinephelus itajara*, in Brazil: despite prohibited over ten years, fishing continues



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## ABSTRACT

The goliath grouper *Epinephelus itajara*, a threatened fish has been protected from fishing in Brazil since 2002. However, poaching records have raised questions about the extent of compliance to the fishing moratorium. We compiled data of commercial landings figuring in official reports as well as episodes of apprehensions of illegal catches by environmental police. According to reports, national catches declined seventy percent after the moratorium establishment, with an average of 393 tons per year of poaching between 2003 and 2011. Although poachers are occasionally caught during environmental police raids along Brazilian coast, in Pará State catches are reported to continue and poachers have targeted aggregations. Data from those episodes do not reflect the real number of poaching, which is believed to be much higher, once fisher process fishes before landings to confuse the supervision and weak enforcement efforts. As management strategies, we recommend the continuity of the fishing moratorium, besides increase in surveillance and enforcement. The choice of priority areas for concentration of goliath grouper conservation efforts may be an effective approach.

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## Introduction

Groupers (Epinephelinae) represent typically apex-predators and one of the most important components of artisanal catches worldwide (Craig et al., 2011). On the other hand, groupers are among those species most vulnerable to fishing pressure because of life history traits such as longevity, late gonadal maturation and aggregation spawning (Sadovy de Mitcheson et al., 2012). The goliath grouper *Epinephelus itajara*, is the largest grouper (2.5 m length and > 400 kg) (Bullock et al., 1992) in the Atlantic Ocean and is widely distributed throughout the south-eastern United States to southern Brazil (Craig et al., 2011). The species is often a target of recreational, small-scale commercial and subsistence fisheries (Sadovy and Eklund, 1999). Decreasing population abundances due to fishing pressure and other anthropogenic stressors (e.g. habitat loss) have been reported (Rhodes and Graham, 2009). Consequently, the species is classified globally as Critically Endangered by the International Union for Conservation of Nature (Craig, 2011). In the USA, intensive exploitation of goliath grouper led to an economic extinction in the late 1980s, resulting in the protection of the species since 1990 (Koenig et al., 2011).

In Brazil, the decrease of goliath grouper catches led managers to establish a precautionary five-year moratorium on fishing of the species in 2002. Since then, the moratorium was renewed twice (2007 and 2012) once the species did not show signs of a population recovery. Currently, in Brazil goliath grouper catches are verified in incidental events, usually as a non-target species. Despite a ban on the fishing of goliath grouper in Brazilian waters, poaching, incidental catches and commercialization have been recorded along the coast (author's personal observation). This is in part due to the lack of awareness of the moratorium and incipient surveillance.

Goliath grouper catches in Brazil since 1995 are presented in this study, using commercial landings and illegal fishing apprehensions data. We aimed to: (1) to determine the landings frequency (weight and retail price) prior to the moratorium establishment, and (2) verify whether there has been a reduction in catches after the moratorium establishment.

## Materials and methods

### Landings data

We accessed records of annual goliath grouper landings from State and Federal Brazilian fisheries agencies between 1995 and 2011 (Fig. 1). To verify the economic importance and frequency of goliath grouper landings, we compiled data for the price of commercialization, total value of landings and representativeness on total income by State. Catches were assigned either as artisanal or industrial, whenever applicable.

### Poaching apprehensions data

Records resulting from goliath grouper poaching apprehensions by environmental agencies were obtained by

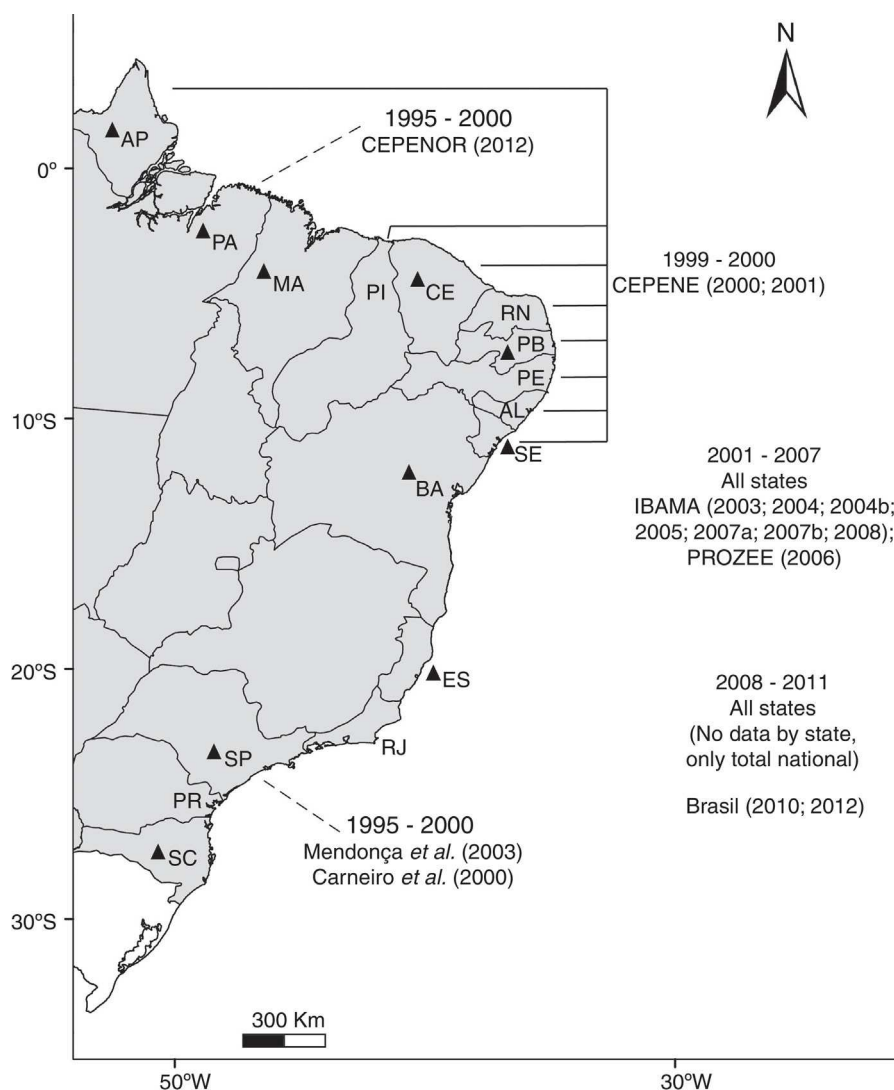
compiling information available on the web media and reported to authors by surveillance agencies. To collect information available on the web, we conduct a search using the Portuguese words “*apreensão + mero*” (apprehension + goliath grouper) and “*fiscalização + mero*” (surveillance + goliath grouper) through Google search tool. The accuracy of poaching apprehension reports (number of fishes and weight) was later confirmed by contacting the surveillance agency involved.

## Results

Landings data considered only two states from 1995 and 1998, while eight states provided information to 1999 and 2000. A national level agency reported landings from 2001 and 2011 (see Fig. 1). Between 2001 and 2011, we record 12,334 tons (t) of goliath grouper landings in Brazil (Fig. 2A). The peak occurred between 1998 and 2000, with 3,905 t in the Pará State, exceeding annual landings nationwide among 2001 and 2007. After the establishment of the fishing moratorium, the average national landings decreased from  $1,099 \pm 202$  t ( $\pm$ SE) to  $393 \pm 60$  t. This result was also influenced by reductions in the amount of catches in Pará ( $987 \pm 174$  t before to  $173 \pm 76$  t after the moratorium). Landings in Bahia ( $217 \pm 109$  t before to  $209.5 \pm 43$  t after) and Sergipe States ( $9.5 \pm 3$  before versus  $10.4 \pm 3$  t after moratorium) were virtually unaffected by the moratorium. We verified an increase to Maranhão State, where no landings were reported before, to  $24.6 \pm 8$  from 2002 on, and Amapá State ( $4.0 \pm 1$  t before to  $34.4 \pm 8$  t after moratorium establishment) (Fig. 2B–F).

The reported frequency of goliath grouper in total landings in each state remained below 1% of the total weight, with an overall average of 0.25% caught exclusively by the artisanal fleet, except in Amapá and Santa Catarina States, which presented 39% and 83% caught by industrial fishing (Table 1). Higher average prices of commercialization (price per kg) were observed after the moratorium establishment (Table 2). Paraíba (US\$ 3.54) and Bahia States had the highest mean values, while Amapá (US\$ 0.74) had the lowest. National average price before moratorium jumped from US\$ 0.98 to US\$ 1.65. However, prices before moratorium establishment were represented only by Ceará, Paraíba and Sergipe States. Landings with prices available (923.5 t) accounted to a revenue of US\$ 2,253,333, representing 0.23% of the total revenue of first commercialized fish.

Illegal catches were confiscated during enforcement raids (22.4 tons, approximately 314 specimens) occurred in ten states between 2004 and 2013 (Fig. 2G). Raids were led by the Brazilian Institute for Environment and Renewable Natural Resources ( $n=11$ ), the Chico Mendes Institute for Biodiversity Conservation (ICMBio;  $n=6$ ), by state inspection agencies ( $n=6$ ) and by the Federal Police ( $n=2$ ). Higher frequencies occurred in Pará (34% of cases and 86% of specimens), in which six events were characterized by catches larger than 15 large fishes. From total of confiscated fish, 90% had between 50 and 100 kg, caught by bottom longline, spearfishing and line and hook gears.



**Fig. 1 – Landings of goliath grouper in Brazil. States: AP = Amapá, PA = Pará, MA = Maranhão, PI = Piauí, CE = Ceará, RN = Rio Grande do Norte, PB = Paraíba, PE = Pernambuco, AL = Alagoas, SE = Sergipe, BA = Bahia, ES = Espírito Santo, RJ = Rio de Janeiro, SP = São Paulo, PR = Paraná, and SC = Santa Catarina. Period in bold represent sampled years and below, references. ▲ States with reported landings see ref. [Brasil and Ministério da Pesca e Aquicultura \(2010, 2012\)](#), [Carneiro et al. \(2000\)](#), [CEPENE \(2000, 2001\)](#), [CEPENOR \(2012\)](#), [IBAMA \(2003\)](#), [IBAMA \(2004a, 2004b, 2005, 2008\)](#), [Mendonça et al. \(2003\)](#) and [PROZEE \(2006\)](#).**

## Discussion

Our results revealed that there was an average reduction of 70% in goliath grouper catches in Brazil after moratorium establishment in 2002. However, annual catches kept an average of 393 tons and show no tendencies of expected declines in the last six years. It is mostly possible that the observed decrease in landings after 2002 does not reflect a real reduction in catches, it seems that poaching may have gone unreported after moratorium establishment. However this may have varied from state to state as well as compliance and also the general perception of illegality. In fact, it is common that new laws when followed by weak or absent enforcement are not perceived as valid. Studies have reported that goliath

grouper is still being captured and marketed illegally in Brazil (e.g. [Félix-Hackradt and Hackradt, 2008](#); [Giglio and Freitas, 2013](#)).

The value of goliath grouper commercialization showed a general increase after 2002. However, this effect may not be related to the moratorium itself, but to a general increase trend in values of fishes over the years (see [IBAMA, 2007a,b](#)). In Brazil, Epinephelinae species are recognized as top quality meat and of high commercial value. After the moratorium, goliath grouper is generally caught through opportunistic exploitation ([Branch et al., 2013](#)). To circumvent the scrutiny, it has been generally sold as any other Epinephelinae species. Methods such as “loquear” – remove fish skin, head at sea to mischaracterize the fish – are used by fishermen to confound surveillance and commercialize goliath grouper.

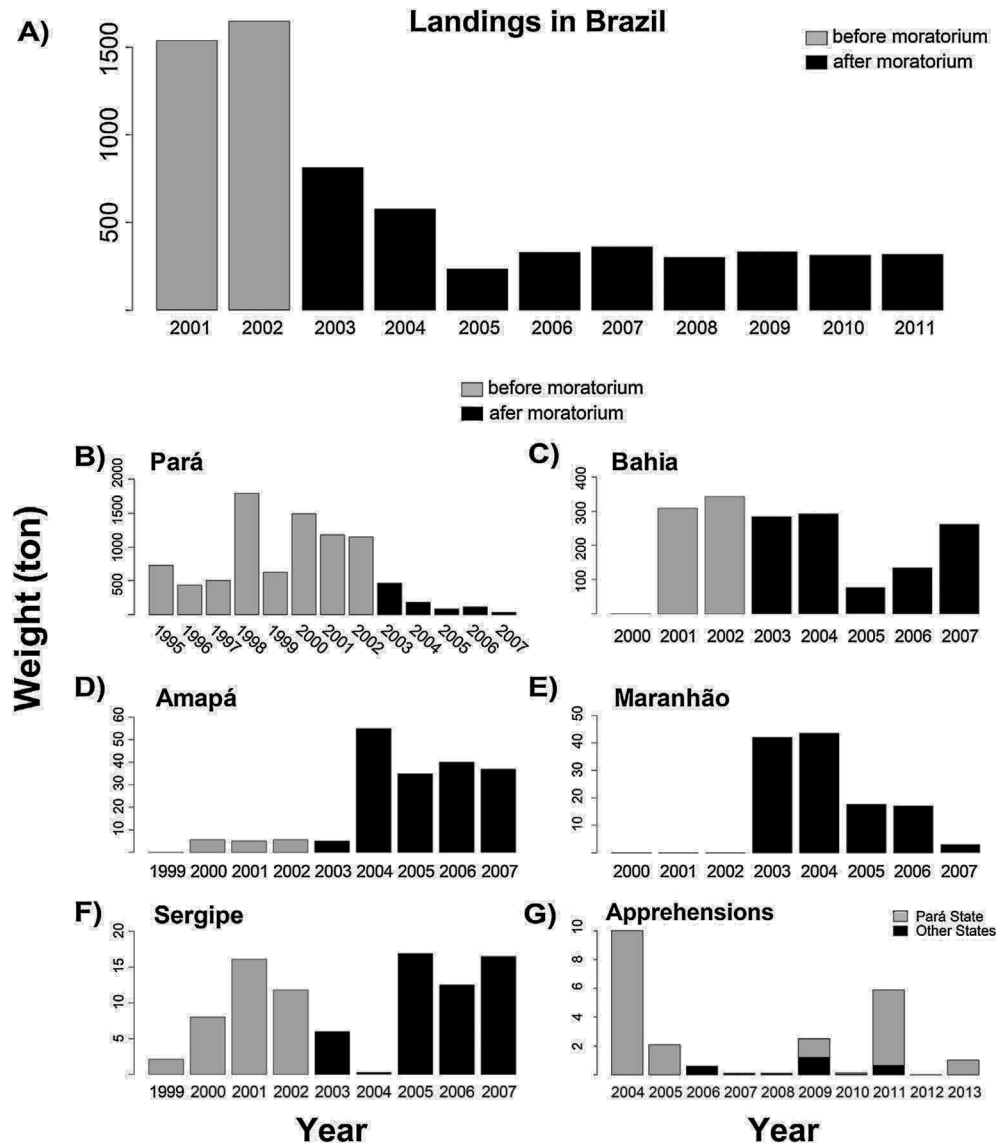


Fig. 2 – (A) Total volume of goliath grouper catches per year in Brazil. Landings of five most representative States: (B) Pará; (C) Bahia; (D) Amapá; (E) Maranhão and (F) Sergipe. (G) poaching apprehensions in Brazil.

Table 1 – Amount of goliath grouper catches and mean representativeness on the Brazil, published in reports between 1999 and 2007.

State	Year	Artisanal (%)	Industrial (%)	Weight (t)	Mean representativeness in total landings (%) by weight
Amapá	2002–2007	61	39	177.3	0.58
Pará	2001–2007	99	1	3191.1	0.85
Maranhão	2003–2007	100	0	123.1	0.03
Ceará	1999–2007	100	0	90.6	0.03
Paraíba	1999–2006	100	0	4	0.03
Sergipe	1999–2007	100	0	90.2	0.51
Bahia	2001–2007	100	0	1699.2	0.45
Espírito Santo	2001–2006	100	0	127.5	<0.01
São Paulo	2002–2005	100	0	2.5	<0.01
Santa Catarina	2002, 2003, 2005–2007	17	83	2.5	<0.01
Mean					0.25

**Table 2 – Average price commercialization and total landings value for goliath grouper along the Brazilian States, between 1999 and 2007. The values were adjusted in US\$ (quotation at 5/28/2014).**

State	Average price/kg (US\$)		Total value of landings (US\$)	Representation in total fishes revenues (%)
	Before moratorium	After moratorium		
Amapá	–	0.74	82,312	0.44
Pará	–	1.46	335,848	0.1
Maranhão	–	1.17	22,690	0.02
Ceará	0.87	1.13	45,863	0.03
Paraíba	1.28	3.54	6640	0.03
Sergipe	0.81	1.47	57,836	0.29
Bahia	–	3.53	1,700,800	1.15
Espírito Santo	–	0.95	448	<0.01
Santa Catarina	–	0.9	896	<0.01
Mean	0.98	1.65		0.23
Total			2,253,333	

Commercial landings data analyzed in this study have limitations (e.g. low sampling effort and discontinuity). However, these data are comparable, once agencies have standardized methodologies to compose a national scenario of fisheries. Results revealed that goliath never represents a significant fraction of national reported landings before and after moratorium establishment, showing that the species is found only sporadically in catches, minimizing the socioeconomic impact of the fishing moratorium. However, since 2008 Brazilian catches are not provided by state, making it even impossible to evaluate recent trends in catches. The fishing ban period was not considered sufficient to promote goliath grouper population recovery necessary to re-open fisheries for this species, and the endangered red list status was maintained in the recent evaluation organized by ICMBio. The goliath grouper low capacity to support heavy fishing pressure, enforcement difficulties to maintain the fish ban and fishing pressure over juvenile part of the population were accounted reasons for the slow recovery.

In the USA, only after 20 years of effective protection, initial evidence suggests that populations of goliath grouper in Florida are slowly increasing (Koenig et al., 2011). Such conservation efforts have focused on research and awareness of the importance of nursery habitats and spawning aggregation sites.

In Brazil, poaching is observed mainly on the Pará State, where it also represented the highest catches before and after the moratorium establishment. It can occur due to abundance of essential habitats for goliath grouper juveniles, such as mangroves, reflecting in higher abundance of juveniles, and therefore adults. The Amazonian coast (comprised by Maranhão, Pará and Amapá States) contains the largest continuous mangrove system in the world (Kjerfve and Lacerda, 1993). Another possible reason is the presence of turbid waters, that turn activities such as diving and spearfishing impossible, and hinders the aggregations localization. Consequently, aggregations may have undergone a lower fishing pressure in the past decades and show relatively higher abundances currently. Apprehensions in Pará were recorded mainly during aggregations in austral summer (December–March). This reproductive event can still attract fishers to catch goliath grouper,

once it provides large catches in places already known by fishers.

With Brazil's 8000 km coastline range, Brazil is a country tough to have fisheries monitored, because of geographical complexity and multi-specific fisheries. The choice of priority areas for goliath grouper conservation efforts may be an effective approach. Surveys are need to choose suitable areas. Today we known that Abrolhos Bank (Bahia), Formoso river (Pernambuco) and Babitonga bay (Santa Catarina) estuaries are nursery habitats for goliath grouper, suffering with high fishing pressure (Gerhardinger et al., 2006; Giglio and Freitas, 2013; Giglio et al., in press) and aggregation sites are known by fishers and researchers in the adjacent areas. The conservations efforts in priority areas should include environmental education programs, population monitoring and development of non-destructive goliath grouper uses, such as diving tourism. We also recommend the continuity of the fishing moratorium and the establishment of government national action plan to conserve the species. However, these regulations are moot without effective enforcement to deter illegal fishing. The use of new techniques to identify uncharacterized fish, such as DNA forensic analyses (Torres et al., 2013) are important tools to assist surveillance officers. The inclusion of stakeholders in all goliath grouper management processes is essential to achieve the common goal of population recovery.

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