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BIOLOGICAL SCIENCES

The marine catfish *Genidens barbus* (Ariidae) fisheries in the state of São Paulo, southeastern Brazil: diagnosis and management suggestions

JOCEMAR T. MENDONÇA, SAMUEL BALANIN & DOMINGOS GARRONE-NETO

Abstract: In this study we analyzed data on fishing landings of *Genidens barbus* in the state of São Paulo, Brazil, from 2000 to 2014. An estimation of the total production was obtained through the analysis of 781,856 landings, among which 87% were categorized as artisanal and 13% as industrial. The abundance index showed some stability in the period. However, due to the high number of production units, the fishing effort need to be maintained, given that there is a risk that increased production might affect the abundance of *G. barbus*. Thus, as alternatives to maintaining marine catfish exploitation in southeastern Brazil under control, the following management actions can be suggested: i) prohibition of fishing activity by the industrial sector; ii) strengthening of inspection of the fleet that is not allowed to participate in the marine catfish fisheries, with emphasis on purse seiners; and iii) maintenance of a closed season for *G. barbus*, performing an adaptive management of fishing prohibition according to the reproductive biology of the species and with the support of artisanal fishers. These measures have the aim of promoting sustainable exploitation of *G. barbus*, especially through small-scale fisheries in southeastern Brazil.

Key words: Catch per unit effort, artisanal fisheries, endangered species, fishing resources, conservation, sustainability.

INTRODUCTION

The marine catfish of the family Ariidae are distributed worldwide, and most of the species occur in shallow coastal areas and estuaries (Araújo 1984, 1988, Andreata et al. 1989, Marceuniuk 2005a). This group is considered to be abundant along the entire length of the Brazilian coast, where it represents 80% of the total number of fish caught through bottom trawls in estuaries of the western South Atlantic (Vieira & Musick 1994).

The species *Genidens barbus* occurs in the eastern coast of Brazil, in coastal waters, estuaries and lower course of rivers, from Rio de Janeiro to Rio de la Plata (Figueiredo & Menezes 1978, Marceuniuk & Menezes 2007). Its distribution can be extended to the south of the mouth of the Rio de la Plata and San Blas (Argentina) (Lopes & Bellisio 1965), although there are records of the species even further south in the estuarine region of the Río Negro, Patagonia (Argentina) (Gironde et al. 2018), and in Chilean waters, at the eastern entrance of the Strait of Magellan (Araújo 1988).

In the fisheries landings along the Brazilian coast, marine catfish are poorly differentiated at the species level, which causes difficulties in analyses on the population dynamics and fishery effort of Ariidae. According to Marceniuk (2005b), only two species of marine catfish

are common on the southeastern-southern coast: *G. barbus* and *G. machadoi*. Both species have been characterized morphologically (phenotypic plasticity, population variation or recent speciation), but studies using molecular markers have not found any differences between the two species, hence, the difference between them it is still uncertain (Silva et al. 2010).

According to Marceuniuk (2005b), *G. barbus* and *G. machadoi* are the main representatives of Ariidae in the commercial landings registered in the southeastern coast of Brazil, comprising about 80% of all fish landed as "catfish". However, although in the past notable abundance of Ariidae was observed in landings along the southeastern and southern coasts of Brazil, monitoring of marine catfish fisheries has shown clear signs of decline over recent years (Velasco et al. 2007).

The reproductive behaviour of *G. barbus* can be considered the most critical point for its conservation. Like other members of the family Ariidae, *G. barbus* uses the mouths of rivers and lagoons to spawn (Figueiredo & Menezes 1978, Mazzoni et al. 2000, Gomes & Araújo 2004a, Fávaro et al. 2005, Avigliano et al. 2015). The species is also a paternal mouthbrooder: after spawning, females move to adjacent areas and males remain in the estuary, carrying the fertilized eggs in the mouth until their hatching (Reis 1986, Espírito-Santo & Isaac 1999, Velasco & Reis 2004). These characteristics, combined with late sexual maturation and high longevity (up to 30 years), make the species estuary-dependent and particularly vulnerable to fishing at various stages of its life cycle (Reis 1986, Velasco et al. 2007).

Studies on the movements of *G. barbus* using otolith microchemistry have showed a high plasticity in habitat utilization by the species, from individuals that perform large migrations between the estuaries and the continental shelf to individuals with a higher degree of estuarine dependence and even freshwater residence (Avigliano et al. 2015, 2017). Otolith microchemistry also revealed the existence of different populations of *G. barbus* along latitudinal gradients, between Argentina, Uruguay and Brazil (Avigliano & Volpedo 2015, Avigliano et al. 2017). These findings suggested that the populations of *G. barbus*, although close to each other, represent different stocks that return to birth sites to complete their life cycle, reproducing in the estuary of origin (Avigliano et al. 2015, 2016, 2017).

Artisanal fisheries account for most of the catches of *G. barbus* along the southeastern and southern coast of Brazil, since both these small-scale fisheries and this fish are associated to shallow coastal areas near estuaries. However, the lack of continuous monitoring of the fisheries in several states of Brazil (Freire et al. 2015) and the existence of landing points in the state of São Paulo with restricted access and without fisheries monitoring coverage (Motta et al. 2014) make it difficult to properly assess the impact of catches on *G. barbus* and its congeners. Thus, in the present study we characterized the fisheries of *G. barbus* in the coast of São Paulo and discuss ways of managing this resource in the region and adjacent areas.

MATERIALS AND METHODS

This study was developed using data from fishing activities along the coast of São Paulo from 2000 to 2014 (Figure 1). The information was obtained through the Fishing Activity Monitoring Project (PMAP-SP), developed by the Fisheries Institute (SAA/SP), which collects data on commercial landings along the coast of São Paulo and provides basic information on these

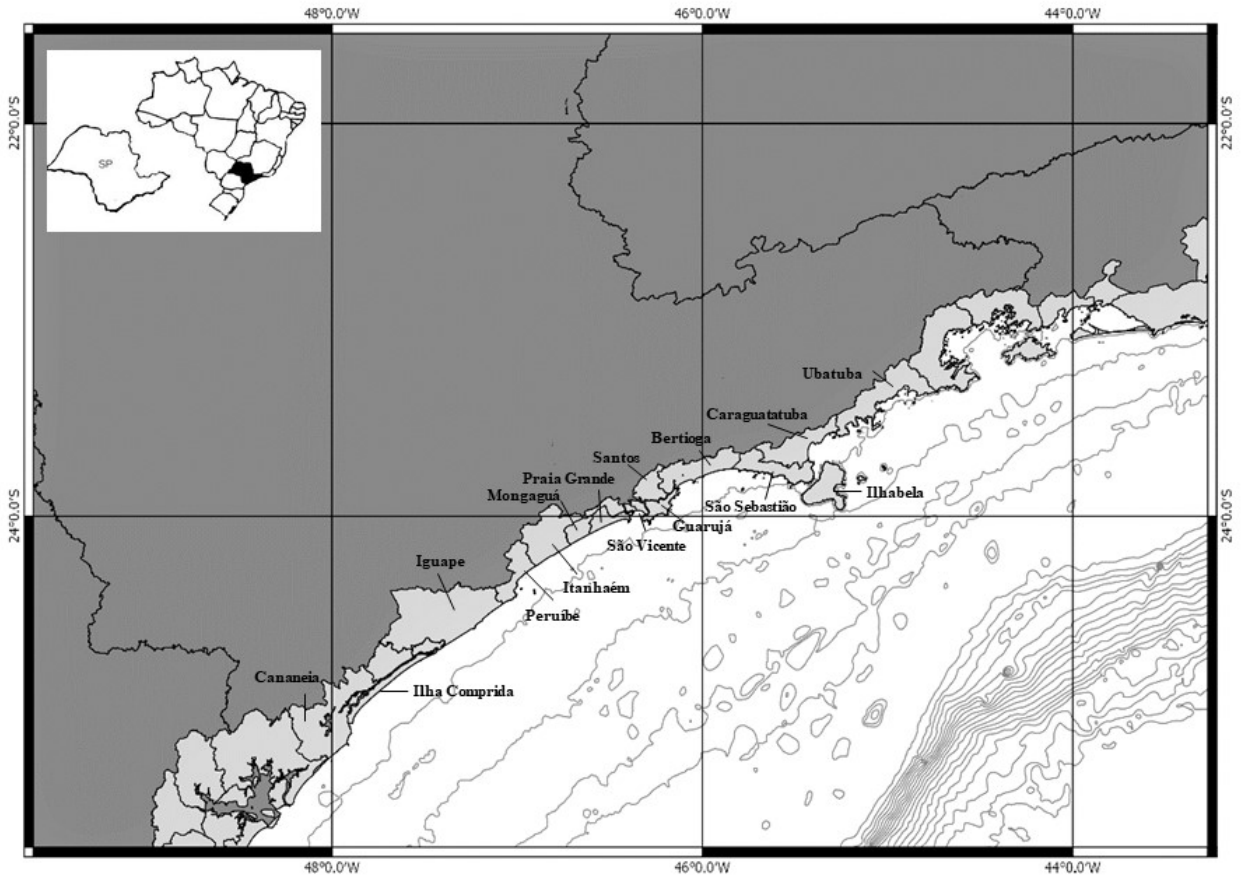

Figure 1. The coast of the State of São Paulo. Escala 1:2.000.000.

landings through an electronic portal: www.propesq.pesca.sp.gov.br.

The State of São Paulo is in the southeastern region of Brazil and has 16 municipalities distributed along 864 km of coastal line. The adjacent continental shelf is characterized by mainly sand and mud bottoms (Figueiredo & Tessler 2004), which favors the existence of areas of high productivity and a large-scale exploitation of demersal fish (Valentini & Pezzuto 2006). The inland platform comprises a multi-purpose territory where several protected areas are inserted, most of them dedicated to the sustainable use of fishery resources. The majority of these areas are related to estuaries, such as the Cananeia-Iguape-Paranaguá estuarine complex (south coast), the Santos-São Vicente estuarine system (north of the central coast) and the Barra do Una region, Peruíbe (in the south of the central coast) (Corrêa 2013).

For the catches of *G. barbus*, we calculated the total landed production, according to the equipment used, the municipality in which the catch was landed and the number of production units (fishers or boats) that worked with the resource over this period. Because catch per unit effort (CPUE) is widely used as an index of relative abundance for many fisheries resources around the world (Large 1992, Fréon & Misuno 1999, Gatica & Hernandez 2003), this indicator was also used in the present study. The index was calculated based just on the landings from fishing activities using bottom gillnets, conducted by the artisanal sector. This was adopted because

the data on fishing efforts using bottom gillnets presented the highest precision amongst the monitored landings. In this evaluation, it was decided not to mix different types of fishing gear or methods, given that their inclusion might have affected the CPUE estimates and might not have accurately reflected the abundance index. For the population analysis on *G. barbus*, we used data on the landings registered in municipalities along the south coast of São Paulo (Iguape, Cananeia and Ilha Comprida), because the data from these municipalities showed better consistency among the others and this region contributed more than 50% of the volume of *G. barbus* landed in São Paulo, from 2000 to 2014.

The CPUE (in kg hour^{-1} of fishing) was estimated by dividing the total production of the month (or year) by the total effort, in fishing hours, considering the number of active units in the month (or year). For this calculation, only the landings associated with full interviews (*i.e.* production data and fishing effort) were considered. For the analyses, the fishing effort in days was converted into hours. On average, the artisanal fisheries were operating for seven hours per day. The mean annual CPUE was obtained through the average of the monthly CPUEs.

Analysis of variance (ANOVA) was used to ascertain any significant differences in the numbers of vessels per trip over the years and months. To give greater reliability to the ANOVA, an F test was applied to ascertain any significant differences between the annual CPUEs, comparing the annual CPUE trend line with zero slope, with a significance level (α) of 5% (Zar 2008). Statistical differences between the monthly abundance indexes were verified using the Tukey test to indicate in which months these differences were more significant, taking a significance level (α) of 5% (Callegari-Jacques 2004). Because of the variation that was observed, the means were converted to their logarithm, to decrease the amplitudes.

For information on the number of fishers operating in the study area, we used data relating to 2012 that were obtained from the list of general fishery records of the Brazilian Ministry of Fishery and Agriculture (MPA; extinguished in October 2015). This list, which classified fishers as involved in either industrial or artisanal fisheries, ceased to exist in 2015. We opted to use data from 2012 to estimate the number of fishers who were registered with the MPA, due to distortions that occurred in subsequent years caused by a process of re-registration of fishers that has still not been concluded today. Hence, the 2012 information illustrates more clearly the situation of the fisheries in São Paulo.

Also, data on fishers who were benefited through safety-and-unemployment insurance provided by the federal government during the closed season for *G. barbus* in southeastern Brazil (January to March) were obtained through the "Transparency Portal" of the Presidency of the Republic (Controladoria Geral da União 2014). Data on the number of beneficiaries, amount received per fishers, and totals according to states and municipalities were consulted, following the rules that exist for such consultations (Portaria SUDEPE 10/1984). Data on those benefiting from the insurance payed during the closed-season for *G. barbus* were obtained for 2014, since this was the year with the most up-to-date data within the study period.

RESULTS

A total of 781,856 landings over the period from 2000 to 2014, in the 16 municipalities that form the coastline of São Paulo, were analyzed. From

this total, 75,295 landings included the marine catfish *G. barbus* in their composition, thus representing 9.6% of the fish landings analyzed.

Production and number of production units in the *G. barbus* fishery

The production of *G. barbus* landed in the coast of São Paulo increased over the period, reaching more than 500 tons in 2012 (Figure 2a), with the period of greatest production between October and December. The number of production units (fishers or vessels) in the marine catfish fisheries reached 1166 units in 2010 and remained above 750 units in the subsequent years, on the coast of São Paulo (Figure 2b). The landings of *G. barbus* in São Paulo presented a marked seasonality, with the highest volumes in the period from October to December. Artisanal fisheries increased their contribution to landings of *G. barbus* over the years. From 2011 onwards, artisanal fisheries accounted for over 76% of the volume of *G. barbus* landed in the coast of São Paulo (Figure 2c). The landings from the industrial fisheries did not show any marked seasonality. However, due to the higher contribution presented by artisanal fisheries, the seasonality of this category was reflected in the total volume of *G. barbus* landed in the coast of São Paulo, with a peak in the period from October to December.

On average, the municipalities that contributed the highest volumes of *G. barbus* in the coast of São Paulo were Iguape, Santos/Guarujá and Cananeia, which represented 85.7% of all landings (Figure 3). Along the coast of São Paulo, the south (Iguape, Cananeia and Ilha Comprida) represented 58% of all the production observed over the period from 2000 to 2014.

Eleven types of fishing gear were found to have been used to catch *G. barbus* along the coast of São Paulo. Gillnets, paired trawl nets, longlines and purse seines were the most important types of fishing gear in terms of production, accounting for 92.8% of the total catch landed (Figure 4). The "multi-gear" category, which includes use of more than one type of fishing gear during the fishing activity (typical of the artisanal fishing), contributed 4.8% of the total catch landed.

Analyzing each fishing gear it is observed that longlines and gillnets were most important for landing, and showed significant increases in the volumes landed from 2006 and 2008 onwards, respectively. Regarding the other types, paired trawl fishing had a peak in landings in 2007 and purse seine fishing in 2009 (Figure 5a). Over the course of each year (average monthly landings), different types of fishing gear presented higher volumes at different times, such that the volumes landed using gillnets were highest between October and December, longlines from June to August, and paired trawl nets and purse seines from January to April and from October to December (Figure 5b).

Artisanal fisheries accounted for 87% of the production units, while industrial fisheries accounted for approximately 13%. The municipalities that presented the highest numbers of production units relating to this resource were Cananeia and Iguape. On average, both were responsible for 68.6% of all production units that caught *G. barbus* along the coast of São Paulo, and the majority of these production units were within the artisanal fishing sector. From 2008 onwards, the number of production units registered along the entire coast of São Paulo increased significantly, such that the number of production units registered for artisanal fishing became higher than in previous years. Considering all the municipalities located along the coast of São Paulo, an average of 19.6% of the production units landed *G. barbus* during the study period.

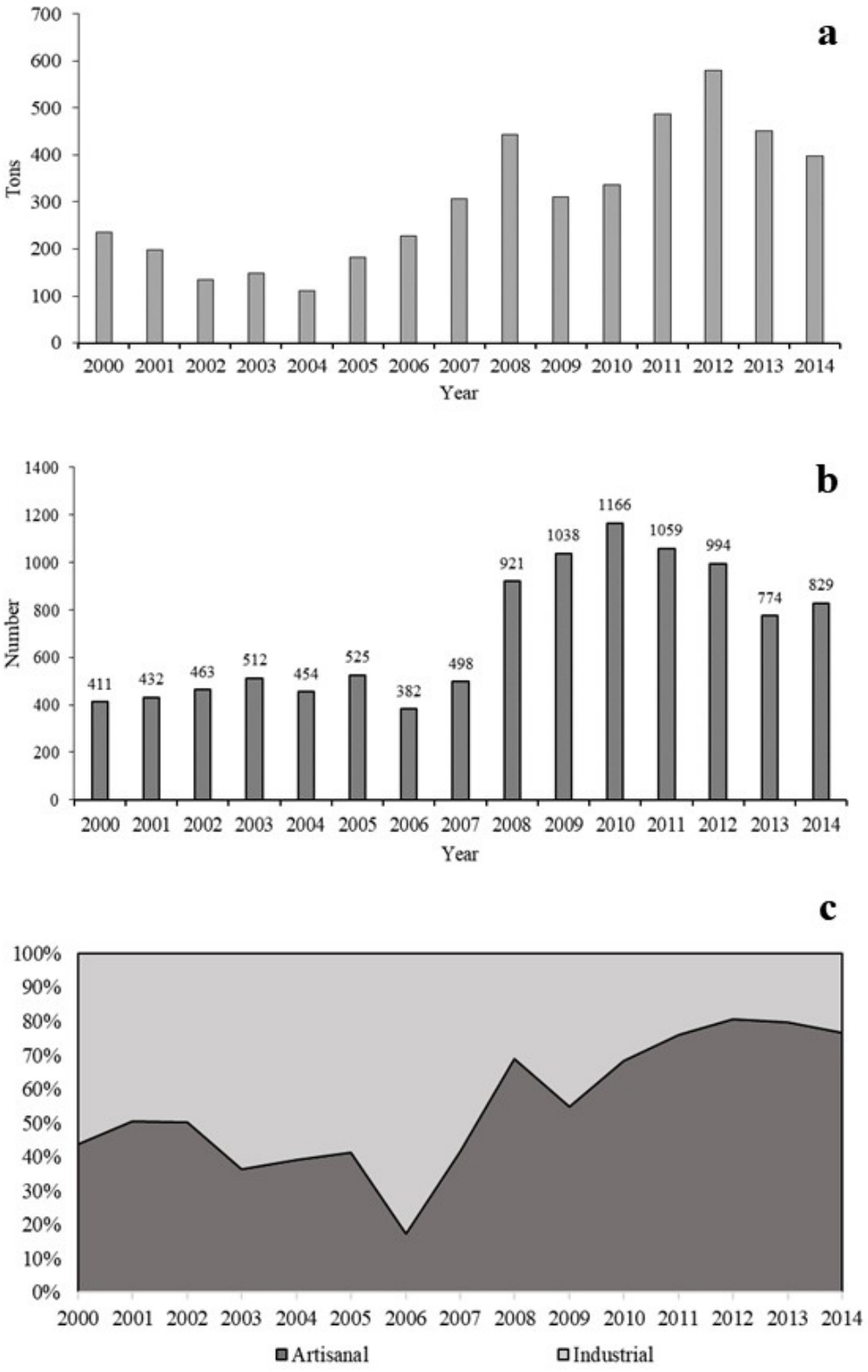

Figure 2. (a) Total production lanced of marine catfish, (b) Annual number of productive units (anglers or boats) that worked in the marine catfish catch and (c) percentage contribution in the volume landed by fishing category (artisanal and industrial) of marine catfish (*Genidens barbus*) on the coast of the State of São Paulo from 2000 to 2014.

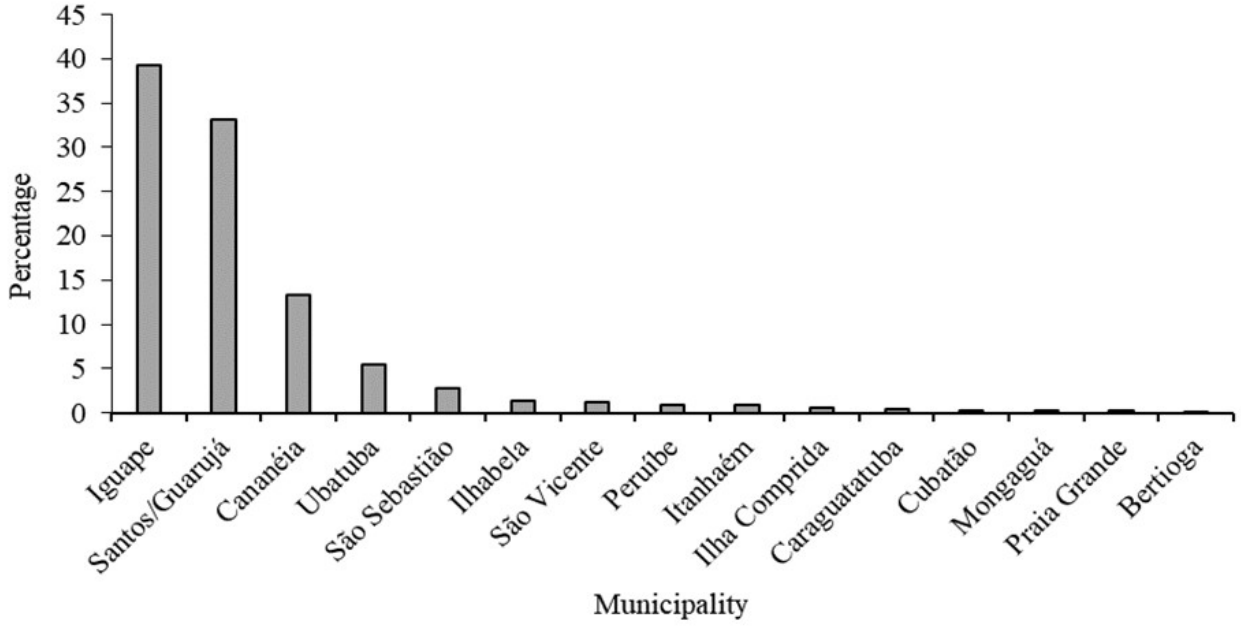

Figure 3. Municipal contribution in the landed volume of white catfish (*Genidens barbus*) from 2000 to 2014 on the coast of São Paulo.

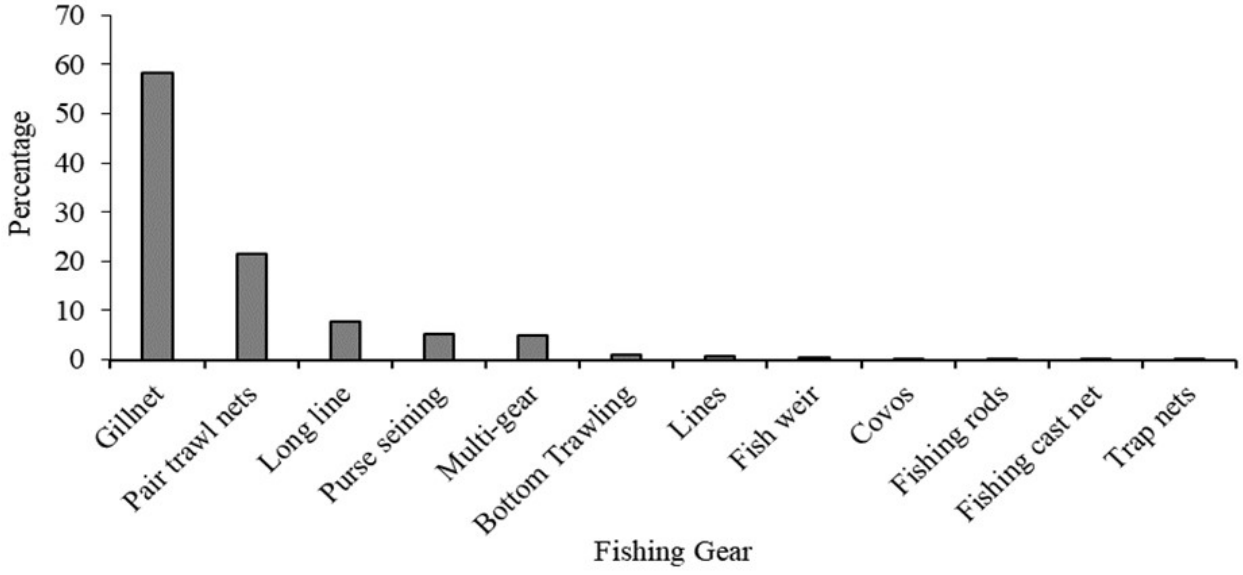

Figure 4. Contribution by fishing gear on the landed volume of marine catfish (*Genidens barbus*) from 2000 to 2014 on the São Paulo coast.

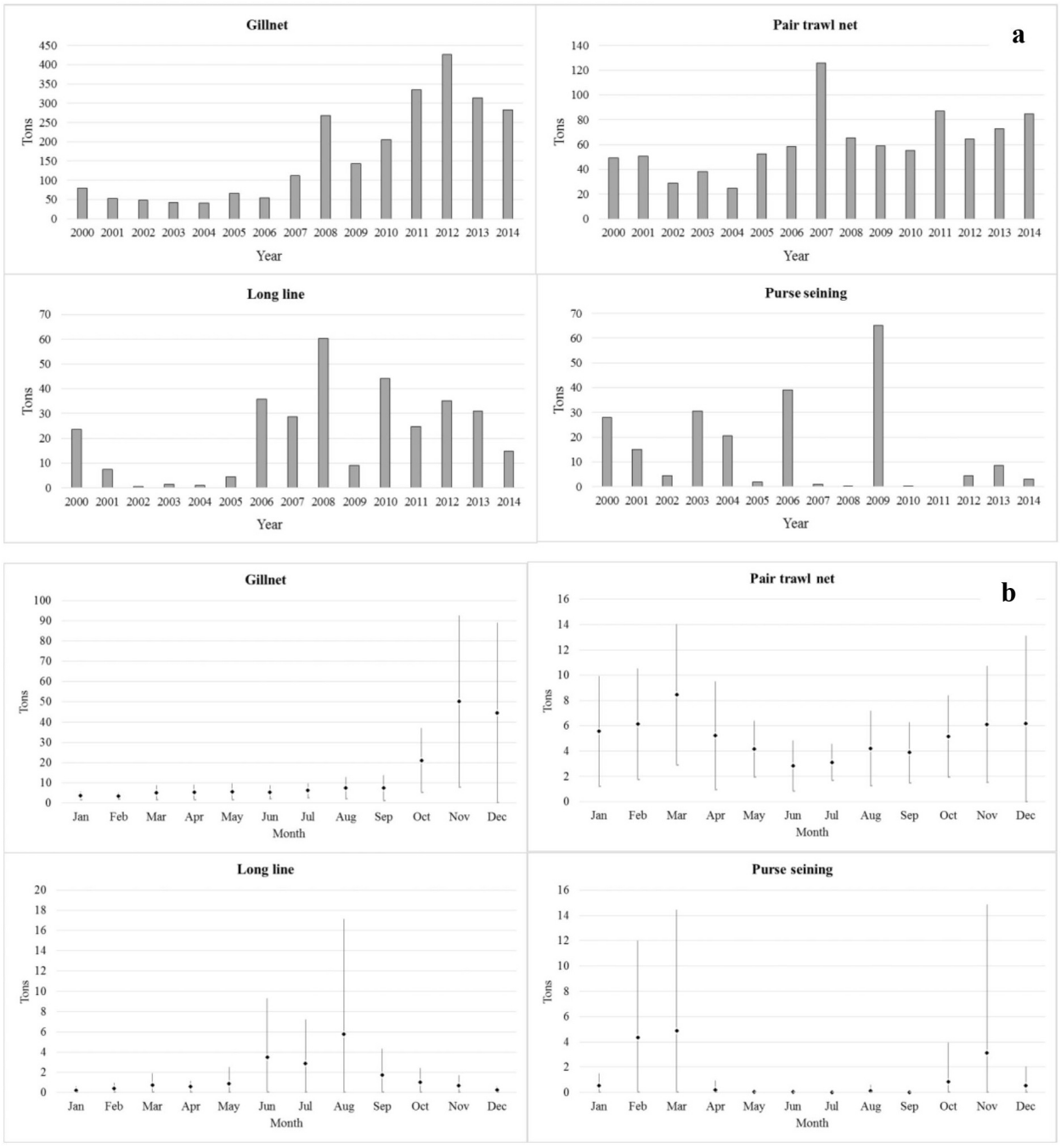

Figure 5. Annual (a) and average months (b) production of marine catfish (*Genidens barbus*) from the main gear fishing of this fishery from 2000 to 2014 on the coast of São Paulo.

Abundance index for *G. barbus* on the south coast of São Paulo

The annual CPUE ranged from 3.8 to 16.3 kg hour^{-1}, with the highest productivity in 2008 and the lowest in 2006 (Figure 6). Monthly CPUEs with lower productivities occurred from June to September, with average values of up to 3 kg hour^{-1}. In the other months, the values were

above 4 kg hour^{-1}, with peaks in November and December (9.1 and 10.1 kg hour^{-1}, respectively) (Figure 7). According to the Tukey test, the months of February, March, April and June to September (lower yields) showed significant differences about November and December (higher yields). Analysis on the mean annual CPUE did not show any significant differences (p = 0.05), according to the ANOVA test, and this was corroborated by the straight slope test.

Number of fishers ("RGP") and insurance closures for fisheries ("defeso")

In 2012, 9,476 fishers were registered to work along the coast of São Paulo. The municipalities of Santos/Guarujá and Iguape contributed the highest numbers to these records, with 24.7% and 17.4%, respectively. In 2014, 4,169 fishers received some type of insurance closure along the coast of São Paulo. Among these, 361 fishers accessed the insurance that was paid during the closed season for *G. barbus*. This totaled 8.7% of the total paid out as insurance by the government over this period. Cananeia was the municipality with the highest number of requests for insurance payouts during the closed season for *G. barbus*, and 91.1% of all insurance processes in this municipality related to this species. The other municipalities that received requests for insurance payouts relating to *G. barbus* were Iguape, Ilha Comprida, Itanhaém, Peruíbe and Praia Grande (Table I).

In 2014, the total amount disbursed as insurance payouts for fishers in the state of São Paulo was 3.8 million US dollars (10.05 million reais), and 7.7% of this value (US$ 290.692,83) related to the closed season for *G. barbus* (Table II). Since Cananeia contributed with 91.1% of the requests for insurance payouts during the closed season for *G. barbus*, this municipality also received the largest contribution of funds derived from marine catfish insurance, which amounted to US$ 265.284,53 (about 700.000 reais). This amount corresponded to 77.7% of the total received by Cananeia for payment of insurance to fishers. The remainder of this financial resource (22.3%) in Cananeia comes from the insurance premiums paid for other

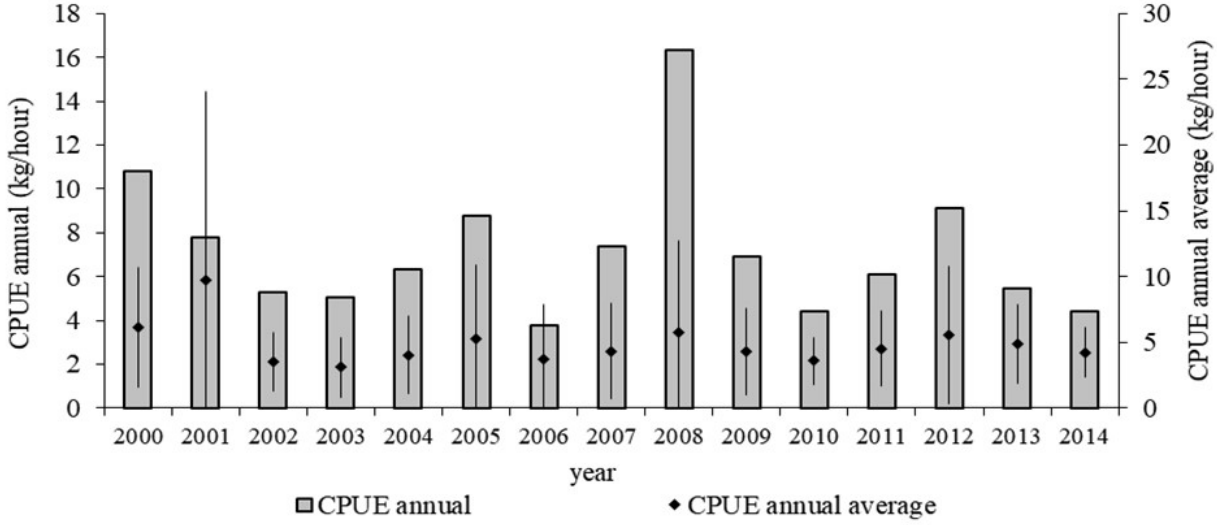

Figure 6. Annual capture per unit effort (kg * h^{-1}) and annual average (bars is standard deviation) of marine catfish landings (*Genidens barbus*), in the artisanal fisheries, from 2000 to 2014 on the south coast of São Paulo (Cananeia, Iguape and Ilha Comprida city), with use bottom gillnets.

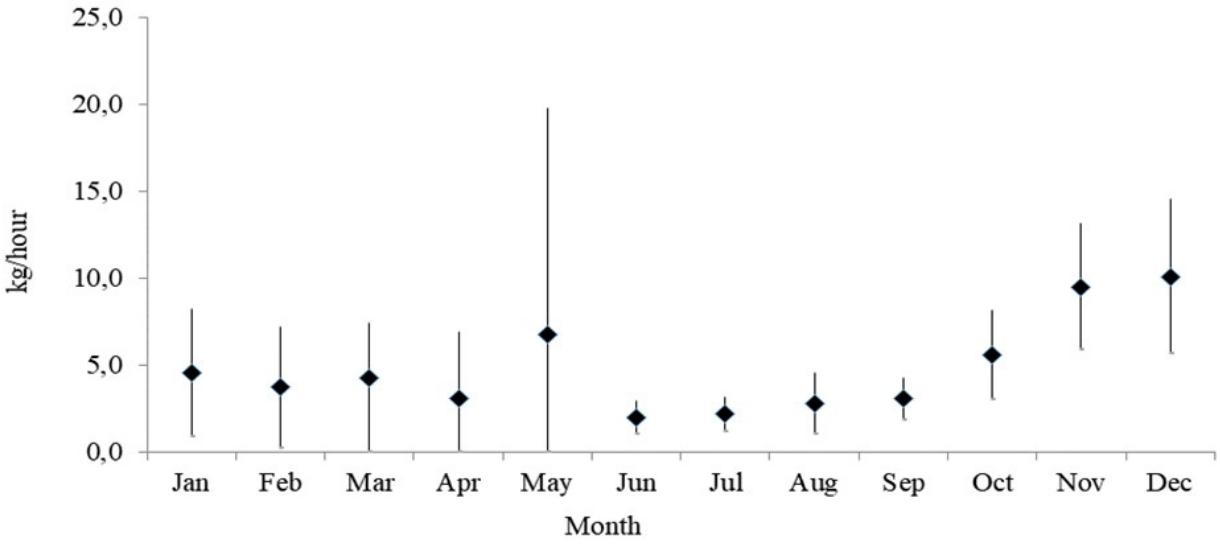

Figure 7. Monthly catch per unit effort (kg * h^{-1}) (bars is standard deviation) of catfish (*Genidens barbus*), in the artisanal fisheries, derived from landings on the south coast of São Paulo (Cananeia, Iguape and Ilha Comprida city), during the period 2000 to 2014, with use bottom gillnets.

Table I. Total number of anglers insured according to the product of the closure on the coast of São Paulo in 2014.

Municipality	Catfish	Shrimp	Crab	Mussel	Oyster	Spawning period closed	Total	%
Bertioga		99	5	20	1	12	137	3,3
Cananéia	329	39	1	22	42	1	434	10,4
Caraguatatuba		25		3		2	30	0,7
Cubatão		2	19	6		1	28	0,7
Iguape	1					1265	1266	30,4
Ilha Comprida	16	2				38	56	1,3
Ilhabela		154					154	3,7
Itanhaém	11	61		20		177	269	6,5
Mongaguá		7		9		44	60	1,4
Peruíbe	3	26	4	209		54	296	7,1
Praia Grande	1	12	4	76		22	115	2,8
Santos/Guarujá		577	55	171	4	4	811	19,5
São Sebastião		167		2			169	4,1
São Vicente		13	1	108	1	6	129	3,1
Ubatuba		212		1		2	215	5,2
Total	361	1396	89	647	48	1628	4169	

Table II. Costs of insured persons and total numbers of insured persons in the State of São Paulo in 2014 discriminated by municipality and the contribution of closed marine catfish fishery.

Municipality	Total number of insured	Values total in insurance closed	Number of anglers insured of catfish	Values in insurance closed in catfish	% of values in catfish at insured total
Bertioga	137	R$ 308.826,00			
Cananéia	434	R$ 904.264,00	329	R$ 703.004,00	77,7
Caraguatatuba	30	R$ 64.390,00			
Cubatão	28	R$ 52.576,00			
Iguape	1266	R$ 3.464.734,00	1	R$ 2.172,00	0,1
Ilha Comprida	56	R$ 162.762,00	16	R$ 32.580,00	20,0
Ilhabela	154	R$ 309.148,00			
Itanhaém	269	R$ 630.406,00	11	R$ 23.892,00	3,8
Mongaguá	60	R$ 157.958,00			
Peruíbe	296	R$ 755.268,00	3	R$ 6.516,00	0,9
Praia Grande	115	R$ 286.684,00	1	R$ 2.172,00	0,8
Santos/Guarujá	811	R$ 1.798.748,00			
São Sebastião	169	R$ 359.058,00			
São Vicente	129	R$ 354.414,00			
Ubatuba	215	R$ 445.846,00			
Total	4169	R$ 10.055.082,00	361	R$ 770.336,00	7,7

products, such as oysters, marine shrimps, mussels, crabs and some freshwater fish during the "piracema": a closed season that is designed to ensure fish reproduction in rivers of Brazil.

DISCUSSION

According to Marceuniuk (2005b), only two species of marine catfish are common on the southeastern-southern coast: *G. barbus* and *G. machadoi*. Nevertheless, *G. barbus* and *G. machadoi* represent more than 80% of the marine catfish landed by the commercial fishing fleet operating in southeastern Brazil. Both species are large, and they can reach lengths of 1200 mm and 700 mm, respectively.

On the other hand, some studies have shown that *G. barbus* and *G. machadoi* do not always predominate in landings in southeastern Brazil. A third species of Ariidae (*G. genidens*) has been shown to predominate in estuarine fisheries (Azevedo et al. 1998, Gomes & Araújo 2004b, Queiroz et al. 2007, Absolon & Andreata 2009). However, while there is no consensus on the dominant species of Ariidae in the landings monitored in southeastern Brazil, it can be accepted that *G. barbus* comprises the majority of the production of this group that is observed along the coast of São Paulo, given that it has frequently been quoted in several studies conducted between the 1980s and the present day (e.g. Mishima & Tanji 1981, 1982, 1983, Schmidt et al. 2008, Marceuniuk 2005a).

Although species of the family Ariidae are very important for both industrial and artisanal fisheries in Brazil, the inefficiency of the national fishery monitoring system has contributed towards underreporting of marine catfish production over the years. The experience of the state of São Paulo, which since 2008 has expanded the coverage of fishing monitoring along the entire coast, has shown that *G. barbus* is one of the main species in the landings, thus indicating that its production had been greatly underestimated for decades.

According to the data collected, the main occurrence of *G. barbus* in landings is from October to December. This period coincides with part of the spawning period for this species (Reis 1986, Baigún et al. 2012a). Although landings of *G. barbus* decline at the beginning of the year due to the closed season for marine catfish in southeastern Brazil, fishing for this species continues at an average rate of 20 tons per month between January and March. Several studies indicated the complexity of the life cicle of the species, where adults perform reproductive migrations in spring to regions of relatively low salinity (Reis 1986, Velasco & Reis 2004, Velasco et al. 2007, Avigliano et al. 2015). Males return to estuarine waters with the eggs inside their oropharyngeal cavity, releasing the juveniles into the lower estuary waters, after females' spawn in estuarine or freshwater environments (Reis 1986, Velasco & Reis 2004).

Baigún et al. (2012b) in the La Plata River (Argentina) classified the species as vulnerable to fisheries due to its complex life cycle, with restricted distribution into fresh or estuarine waters during the reproductive period and unknown environments during the non-reproductive period. Thus, the observation of a great number of landings of *G. barbus* and its congeners during the spawning period is a critical point, since the biological characteristics of these species such as low fecundity, slow growth and presence of parental care by males (Mishima & Tanji 1982, Reis 1986, Velasco & Oddone 2004) mean that special care needs to be taken when fishing efforts focusing on these resources coincide with the reproductive period of the species.

In the state of Rio Grande do Sul, in southern Brazil, *G. barbus* was one of the main fishery products targeted by artisanal fisheries until the 1990s (Antero-Silva 1990), but signs of decline in the catches have been observed over recent years (Velasco et al. 2007). Analyses on *G. barbus* in Rio Grande do Sul had already indicated that the stock was slow to recover because of the reproductive behaviour, late sexual maturation and great longevity of this species (Velasco et al. 2007).

Based on otolith chemistry, Avigliano et al. (2017) indicated the presence of at least four stocks of *G. barbus* in the southewestern Atlantic, between the Guanabara Bay (State of Rio de Janeiro, Brazil) and the mouth of the La Plata River (in the border between Argentina and Uruguay). These authors also suggested that due to the existence of different stocks along this area, a fisheries management of *G. barbus* should be done independently. Although Avigliano et al. (2017) did not analyze samples of *G. barbus* from the coast of São Paulo, it is possible to believe that there may be different populations along the estuarine areas of this region, such as the Cananeia-Iguape-Paranaguá estuarine complex and the Santos-São Vicente estuarine system. This is particularly important because analyzes of site fidelity, philopatry and stock differentiation along the coast of São Paulo are not available in the literature. Given the evidence of these characteristics in neighboring areas, where *G. barbus* showed signs of population decline, these topics should be a priority for the correct management of the fisheries that affect the species.

Among the four types of fishing gear that accounted for 92.8% of the volume of *G. barbus* landed, gillnets presented the highest catch rates.

The explanation for this is that gillnets are the main fishing gear used in estuarine fisheries in São Paulo, where *G. barbus* is commonly present (Alves et al. 2009, Mendonça & Lucena 2014a). However, it should be noted that landings from the industrial fleet, using pair trawling, longline fishing and bottom trawling, have contributed significantly to the volume of *G. barbus* landed over recent years.

Pair trawling is an effective technique for the capture of demersal species. Within the distribution area of *G. barbus*, it is often used for catching this species (Araújo 1988, Marceuniuk 2005b). Since 2006, longline fishing has been contributing significantly to production of *G. barbus*, especially in the state of Santa Catarina, where 40% of the entire volume of marine catfish were caught using this technique, between 2009 and 2012 (Univali 2013a, b). Lastly, since 2000, purse seining has systematically been used for landings of *G. barbus* along the southeastern-southern coast of Brazil.

This last case is particularly alarming, since purse seiners are highly efficient and work on shoals and in areas that over recent years have been more productive in relation to demersal and benthic products. Given that purse seining involves surrounding large schools with a net, Hostim-Silva et al. (2009) proposed that there should be a ban on fishing for marine catfish by this fleet in Brazil. Velasco et al. (2007) observed catches of large individuals of *G. barbus* by purse seiners in Rio Grande do Sul and also suggested that greater strictness should be applied to inspections on this fleet, with the aim of curbing its activity about a resource that is important for several sectors and for which signs of overfishing have been seen in other states in Brazil.

The data observed for São Paulo indicate that *G. barbus* is of great importance for the artisanal fleet, which accounts for 87% of the production units (fishers or vessels) and over 68% of the volume of marine catfish landed over recent years (from 2008 onwards) in this state. This is common along the Brazilian coast about landings of catfish, as observed in the states of Rio Grande do Sul, Paraná and Rio de Janeiro (Reis 1986, Antero-Silva 1990, Azevedo et al. 1998, Gomes & Chaves 2006, Velasco et al. 2007, Queiroz et al. 2007), thus highlighting the predominance of this species of Ariidae within artisanal fisheries.

Using the south coast of São Paulo as a model for the marine catfish fisheries, where three municipalities (Cananeia, Iguape and Ilha Comprida) contribute with 68.6% of the production units and 58% of the volume of *G. barbus* landed in the state, it was observed that the abundance index (CPUE) did not present significant differences over the last 15 years. The CPUE indicated that this resource presents some stability regarding its abundance. Nevertheless, because of the high number of production units actively fishing for this resource (close to 750), the current fishing effort relating to *G. barbus* need to be maintained, given that increased activity may affect its abundance. Another topic that emphasizes the need to maintain the current efforts relating to *G. barbus* is the fact that the fisheries focusing on this species are concentrated on its reproductive period, which is a critical period for teleosts with the characteristics of K-strategists (Reis 1986, Velasco & Oddone 2004, Velasco et al. 2007). However, one of the difficulties encountered in attempting to better organize fishing activity relating to *G. barbus* and its congeners is that the basic information available on its biology and population dynamics mostly comes from Rio Grande do Sul. This may lead to distortions in making assessments relating to the southeastern coast of Brazil. Thus, evaluations of the resource in other states, such as Rio de Janeiro, Espírito Santo, Paraná and Santa Catarina, as well as updates on the reproduction of this species in these areas are urgently needed.

The closed season for *G. barbus* and other marine catfish seems to cover an important period for these species, and at the same time it promotes a significant increase in the income of fishers, especially in the south coast of São Paulo, where insurance payouts contribute close to 27.9% of the income of many families, such as those in Cananeia, between January and March (Mendonça & Lucena 2014b). Therefore, changes to fisheries policies such as reviews of the closed season for *G. barbus* and its congeners or even its suspension need to take into account the negative consequences for the economies of the municipalities along the coast of São Paulo. Thus, as alternatives to keep the fishing activities relating to *G. barbus* under control and/or possibly to decrease them, the following management actions can be suggested: i) prohibition of any fishing activity by the industrial sector about this resource, since this sector has a huge fishing capacity and does not give access to the insurance policy for marine catfish for its fishers; ii) strengthening of the inspection of the fleet that is not allowed to participate in the marine catfish fisheries, with emphasis on purse seiners; and iii) maintenance of the closed season for *G. barbus*, although it is suggested that new studies on the biology, taxonomy and ethnoecology of the species should be carried out, to bring in new analyses on this resource and to provide support for possible adjustments to the catch periods. These strategies may promote sustainable exploitation of the resource, thereby contributing towards perpetuation of the species while allowing continuity of small-scale fisheries along the coast of São Paulo (and possibly in adjoining areas of southeastern Brazil).

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JOCEMAR T. MENDONÇA[1]
https://orcid.org/0000-0003-2797-3091

SAMUEL BALANIN[2]
https://orcid.org/0000-0001-8692-1529

DOMINGOS GARRONE-NETO[3]
https://orcid.org/0000-0001-9134-595X

[1]Instituto de Pesca - Núcleo de Pesquisa e Desenvolvimento do Litoral Sul, Avenida Professor Besnard, s/n, Morro São João, 11990-000 Cananeia, SP, Brazil

[2]Fundação Florestal, Avenida Professor Besnard, s/n, Morro São João, 11990-000 Cananeia, SP, Brazil

[3]Universidade Estadual Paulista/UNESP, Campus Experimental de Registro, Avenida Nelson Brihi Badur, 430, 11900-000 Registro, SP, Brazil

Correspondence to: **Jocemar Tomasino Mendonça**
E-mail: jocemar.mendonca@gmail.com

Author contributions

Mendonça JT developed this study, processed the data, performed the analysis, interpreting the results and worked on the manuscript. Balarin S worked on the manuscript. Garrone-Neto D interpreting the results and worked on the manuscript. All authors discussed the results and contributed to the final manuscript and revisions.