



## Shore-based recreational fisheries on beaches of a tropical bay of the southwest Atlantic

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**Abstract:** The aim of this paper is to characterize the recreational fishing (angling) on inner beaches from Sepetiba Bay (Rio de Janeiro State, southeastern Brazil), regarding the socio-economic profile of the fishers, the composition of the species caught, and fishing productivity. Ninety-one samplings were carried out by 83 fishers aged between 11 and 72 years old between March 2009 and March 2011. Most of them (95.2%) were male, employed (75.0%), with complete high school (61.0%), and without fishing license (95.4%). The main motivations pointed out by fishers for fishing were “relaxing”, “staying outdoors”, and “getting out of the routine”. Seventeen-fish species (11 families) were registered, 11.9% of the local richness. The most abundant and frequent species were *Diapterus rhombeus* (27.7% and 25.3%, respectively) and *Chloroscombrus chrysurus* (21.3% and 16.5%). *Diplectrum radiale* and *Micropogonias furnieri* had the highest proportions of individuals captured below Lt50 (71.4% and 40.0%, respectively). The total production recorded was 13.5 kg in 205.8 hours of fishing, which represents a yield of 0.1 kg/hour or 0.2 kg/fisher. The results suggest that this fishing modality has a low impact on local fish populations. Despite this, the growing number of anglers and the capture of individuals below their reproductive size may pose risks.

**Key words:** Coastal fishery, angler, catch composition, release, Sepetiba bay.

### **Pesca recreativa desembarcada nas praias de uma baía tropical do atlântico sudoeste.**

**Resumo:** Este trabalho tem o objetivo de caracterizar a pesca recreativa desenvolvida em praias internas da Baía de Sepetiba, quanto ao perfil socioeconômico dos praticantes, composição das espécies capturadas e produtividade pesqueira. Entre março de 2009 e março de 2011 foram acompanhadas 91 pescarias realizadas por 83 pescadores entre 11 a 72 anos de idade. A maioria era de homens (95,2%), assalariados (75,0%), com ensino médio completo (61,0%) e sem licença de pesca (95,4%). As principais motivações apontadas pelos pescadores para a pesca foram “relaxar”, “ficar ao ar livre” e “sair da rotina”. Foram registrados 17 espécies de peixes (11 famílias), 11,9% da riqueza local. As espécies mais abundantes e frequentes foram *Diapterus rhombeus* (27,7% e 25,3%) e *Chloroscombrus chrysurus* (21,3% e 16,5%). *Diplectrum radiale* e *Micropogonias furnieri* apresentaram as maiores proporções de indivíduos capturados abaixo do Lt<sub>50</sub> (71,4% e 40,0%, respectivamente). A produção total registrada foi de 13,5 kg em 205,8 horas de pesca, o que representa um rendimento de 0,1 kg/hora ou 0,2 kg/pescador. Os resultados sugerem que esta modalidade de pesca exerce baixo impacto nas populações locais de peixes. Apesar disso, a crescente quantidade de praticantes e a captura de indivíduos abaixo do tamanho reprodutivo podem representar riscos.

**Palavras-Chave:** Pesca costeira, pescador, composição de captura, soltura, Baía de Sepetiba.

## Introduction

Recreational fishing is a popular activity in many parts of the world, with at least 220 million people participating and capturing billions of fish each year (Arlinghaus *et al.* 2015). In 2014, about 0.9 million tons of fish were extracted from marine waters by recreational anglers (Freire, Nascimento & Rocha 2020). This activity is considered an important hobby, especially in countries with large lakes and extensive coastlines, involving a large number of participants and generating a considerable economic contribution (Hyder *et al.* 2018).

The recreational fishing segment in Brazil has shown vigorous growth in the last decades, however, due to the scarcity of information and available data sources, the recreational catch estimates contain high uncertainty (Freire, Nascimento & Rocha 2020). That leisure activity has turned into a complex socio-ecological system that is rapidly evolving (Ward *et al.* 2016), annually moving millions of dollars in segments as diverse as the import and export of fishing materials, aquaculture, tourism, and the specialized media. Brazil has great importance in this segment. It has 12% of all freshwater in the world and high heterogeneity of habitats and climate (Freire *et al.* 2016), offering considerable possibilities for recreational fishing.

Some recent studies suggest that recreational fishing, hereafter angling, previously considered a non-impacting activity, may be causing negative ecological impacts, mainly through the overexploitation of fish populations and dissemination of non-native species (Brownscombe *et al.* 2019). On the other hand, anglers provide economic benefits, sustaining a value chain that includes fishing equipment, boats, licenses, trips, and accommodation (Pita *et al.* 2018). Therefore, the development of conservation-oriented fishing practices could minimize impacts on natural populations, and it is critical to achieving sustainable fisheries (Brownscombe *et al.* 2017).

Like fishing practiced by other sectors (artisanal or industrial), angling has a wide variety of modalities, exploring different environments and populations. Information on the specific composition of catches, as well as the fishing effort used in this activity and the costs involved, are fundamental elements in the construction of a still incipient knowledge, which may serve as a basis to guide the adoption of management strategies capable of ensuring the sustainability of exploited stocks (Primitivo, Schiavetti & Freire 2021).

In this paper, we seek to understand if the shore-based angling activity carried out on beaches of Sepetiba Bay is potentially impactful concerning the species caught. We are considering the hypothesis that the low values of fishing effort and production recorded in this activity, associated with the possibility of returning the captured individuals, represent factors that result in a low impact on fish populations in studied area.

In this sense, our objective is to describe the shore-based recreational fisheries activity practiced inner the Sepetiba Bay regarding the practitioners' profile and the fisheries' characteristics. Precisely, characterize the socioeconomic profile of fishers, define the motivational profile of them, identify the species caught and their frequencies in the sampling catches, estimate the release rate of individuals, define the variations in the sizes of the species caught, estimate the effort and fishing yield.

## Materials and Methods

Sepetiba Bay (22°54' to 23°04'S / 43°34' to 44°10'W, Figure 1) is one of the most important bays on the Brazilian coast, because it supports a rich and diversified fish fauna and is used as rearing grounds by several coastal fish species (Araújo *et al.*, 2018a). It has an area of approximately 305 km<sup>2</sup>, limited to the north and east by the continent, to the south by the Restinga de Marambaia and the west by the Ilha Grande Bay (Araújo *et al.* 1998).

Between March 2009 and March 2011, a continuous monitoring program was performed on the angling carried out along the coastal region of the district of Itacuruçá, municipality of Mangaratiba (Fig. 1). During this period, daytime fisheries were monitored, seeking to respect regular monthly intervals. Interviews were conducted with as many anglers as possible, based on a semi-structured questionnaire. Aspects related to the socioeconomic and motivational profile of anglers were addressed during the interviews. The motivational profile was investigated based on the methodology proposed by Schramm & Gerard (2004).

The fishes caught by each sampled angler were identified out in the field at the lowest possible taxonomic level according to the specialized literature (Figueiredo & Menezes 1978, , 1980, 2000, Menezes & Figueiredo 1980, 1985), weighed with the aid of a precision scale and measured in centimeters over the total length using an ichthyometer.



**Figure 1.** Map of Sepetiba Bay. Monitoring point for recreational beach fishing (ellipse).

The collected data were used to characterize the species composition of catches, frequencies of occurrence (FO) and abundance, as well as release rates. In addition, we estimate total production (P), effort (E), and fish yield (R) values. The total production (P) was calculated considering the total weight of the catches, and the fishing yield (R) was estimated considering the fishing time in hours as the unit of effort (E) from the catch per unit of effort (CPUE), dividing the production by the catch time.

Release rates were expressed as a percentage according to the number of individuals released, considering the total number of individuals caught from each category or species. FO was calculated based on the number of fish caught in each category or species by the total number of fisheries. Relative abundance was calculated based on the number of individuals caught from each category or species concerning the total number of fish caught from all categories or species.

The proportion of individuals caught above the average length of first sexual maturation ( $L_{50}$ ) was calculated taking as reference the values of this parameter recorded in the literature for each species.

To verify the differences between the average sizes of the captured individuals concerning the maximum growth size ( $L_{max}$ ), we used values available in the literature and calculated the proportion over it.

## Results

During the sampling period, 91 fisheries were carried out by 83 anglers aged between 11 and 72 years (79 male and 4 female) (Table I). Regarding the level of education, more than half of anglers said they had completed high school (61.0%). When asked about their main occupation, most of them claimed to be employed (74.7%), while others were classified as retired, student, civil servant, or military (Table I).

When asked about the purpose of fishing, almost all anglers answered as leisure and consumption. Only two anglers claimed to go fishing exclusively as leisure, releasing all individuals caught in any situation. Most of the anglers have less than ten years of practice. The average frequency of fishing recorded for the group of anglers interviewed was 1.8 days a week. Just over half of them claimed to go fishing only once a

**Table I.** Socioeconomic and motivational profiles of shore-based recreational anglers in Sepetiba Bay.

Parameter	Values
Gender	Male (95.2%); Female (4.8%)
Age	11 to 72 years (mean = 45 ± 14)
Level of education	Complete high school (61.0%); Complete elementary school (24.0%); Incomplete elementary school (8.0%); Complete higher education (7.0%)
Occupation	Employed (75.0%); Retired (17.0%); Student (5.0%); Civil Servant (2.0%); Military (1.0%)
Purpose of fishing	Leisure and consumption (97.6%); Just leisure (2.4%)
Fishing experience	Less than 5 years (28.9%); 5.0 to 9.9 years (18.1%); 10.0 to 14.9 years (9.6%); 15.0 to 19.9 years (6.9%); 20.0 to 24.9 years (16.9%); 25.0 or more (20.4%)
Fishing frequency	1 day (51.8%); 2 days (24.1%); 3 days (19.3%); 4 to 7 days (< 5.0%)
Fishing behavior	Prefer to fish accompanied (91.6%); Prefer to fish alone (8.4%)
Recreational fishing license	No (95.4%); Yes (4.6%)
Link to a fishing club or association	None (0%)
Fishing cost (US\$)	0.89 to 21.46 (average = 5.28 ± 4.97)

week. The vast majority prefer to practice fisheries accompanied (Table I).

According to the legislation, all recreational anglers over 18 years of age must have a fishing license (Decree-Law No. 221) issued by an official agency. Otherwise, among the 83 anglers interviewed, only three had a fishing license. On several occasions, the anglers showed complete ignorance regarding the relevant legislation. When asked if they were part of fishing clubs and/or associations, all of them responded negatively. The average cost of fishing was US\$ 5.28 and standard deviation 4.97.

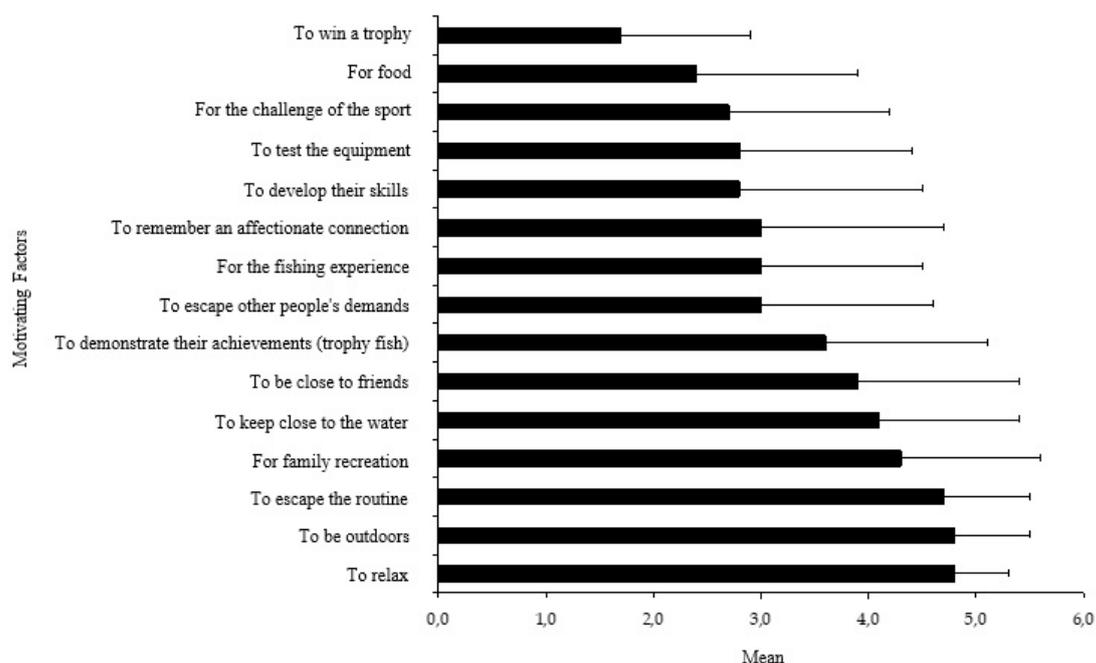
As for the motivational profile of the anglers, the data obtained indicated that the most motivated reasons were, respectively: “to relax”, “to stay outdoors”, and “to get out of the routine”. Others cited with lower importance were: “to win a trophy”, “for food”, “for the challenge of the sport”, “to test my equipment”, and “to develop my skills” (Fig. 2).

Considering the species caught, 141 specimens of bony fish belonging to 17 species (or categories of species) distributed in 11 different families were recorded (Table II). The caitipa mojarra (*Diapterus rhombeus*) had the highest relative abundance (27.7%), followed by the Atlantic bumper (*Chloroscombrus chrysurus*) and the grunts (*Orthopristis* sp., *Boridia* sp., *Haemulon* sp., and

*Pomadasys* sp.), 21.3 and 20.6%, respectively. The fishes with lesser abundance were Southern kingcroaker (*Menticirrhus martinicensis*), South American silver porgy (*Diplodus argenteus*), and burrfish (*Chilomycterus spinosus*). The species with the highest frequency of occurrence were respectively: *D. rhombeus* (25.3%), followed by *C. chrysurus* and grunts (16.5%, each one).

The species with the highest releasing rates were the green puffer *Sphoeroides greeleyi*, and the flying gurnard *Dactylopterus volitans*, all specimens released. Releases of pond perch *Diplectrum radiale* and *D. rhombeus* were also observed, at a rate of 12.5% and 2.6%, respectively. The species recorded with the highest average size in the catches were catfishes (*Cathorops* sp. and *Genidens* sp.) and whitemouth croaker *Micropogonias furnieri*, with 30.3 and 29.4 cm in total length, respectively. The smallest means were verified for *D. radiale* and *M. martinicensis*.

The average length captured was equal or greater to their respective Lt50 values (Table III). However, only *D. radiale* and *M. furnieri* showed high proportions of individuals captured below the length of first sexual maturation. For *D. rhombeus* and grunts, proportions of less than 5.0% of individuals with lengths shorter than the first maturity were observed (Table III).



**Figure 2.** Distribution of mean values (horizontal bars) and standard deviation of motivational factors specified by shore-based recreational anglers in Sepetiba Bay.

**Table II.** List of species recorded in the catches of the shore-based angling in Sepetiba Bay. The common name, scientific name, family, total of individuals, relative abundance (Ab%), frequency of occurrence (FO%), release rate (%), mean total length (TL) and standard deviation (SD).

Common name (regional / FAO name)	Scientific name	Family	Total	Ab (%)	FO (%)	Release (%)	Mean TL ± SD (cm)
Carapeba / Caitipa mojarra	<i>Diapterus rhombeus</i>	Gerreidae	39	27.7	25.3	2.6	17.7 (± 3.3)
Palombeta / Atlantic bumper	<i>Chloroscombrus chrysurus</i>	Carangidae	30	21.3	16.5		19.0 (± 2.1)
Cocoroca / Grunts	<i>Orthopristis</i> sp./ <i>Haemulon</i> sp./ <i>Pomadasys</i> sp./ <i>Boridia</i> sp.	Haemulidae	29	20.6	16.5		20.0 (± 4.3)
Bagre / Catfish	<i>Cathorops</i> sp. / <i>Genidens</i> sp.	Ariidae	10	7.1	8.8		30.3 (± 2.3)
Michole / pond perch	<i>Diplectrum radiale</i>	Serranidae	8	5.7	8.8	12.5	15.6 (± 1.7)
Baiacu-pinima / Green puffer	<i>Sphoeroides greeleyi</i>	Tetraodontidae	7	5.0	4.4	100.0	
Carapicu / Silver mojarra	<i>Eucinostomus argenteus</i>	Gerreidae	6	4.3	5.5		17.7 (± 3.4)
Corvina / whitemouth croaker	<i>Micropogonias furnieri</i>	Sciaenidae	5	3.5	5.5		29.4 (± 6.6)
Coió / flying gurnard	<i>Dactylopterus volitans</i>	Dactylopteridae	2	1.4	2.2	100.0	
Xerelete / blue runner	<i>Caranx crysos</i>	Carangidae	2	1.4	1.1		26.0 (0.0)
Baiacu-espinho / burrfish	<i>Chilomycterus spinosus</i>	Diodontidae	1	0.7	1.1	100.0	
Marimbá / South American silver porgy	<i>Diplodus argenteus</i>	Sparidae	1	0.7	1.1		27.0 (0.0)
Papa-terra / Southern kingcroaker	<i>Menticirrhus martinicensis</i>	Sciaenidae	1	0.7	1.1		16.0 (0.0)
Total			141	100.0			
Release			12			8.5	

**Table III.** List of species recorded in the catches of the shore-based recreational fisheries in Sepetiba Bay. The common name, scientific name, the average total length of capture (cm), length at first maturation (Lt50) recorded in the literature (cm), the proportion of individuals captured above Lt50 (%), maximum total length recorded in the literature (TL, cm), the proportion between the average length recorded in recreational fishing concerning the maximum length in the literature (%).

Scientific name	Average TL of capture (cm)	Average TL of 1 <sup>st</sup> sexual maturation (Lt <sub>50</sub> )		Max. length recorded in the literature (cm TL)	Proportion of average length of recreational fishing compared to maximum length in the literature (%)
		Lt <sub>50</sub> recorded in the literature (cm)	Proportion of individuals captured above Lt <sub>50</sub> (%)		
<i>Diapterus rhombeus</i>	17.7	8.5 a	97.3	40.0	44.3
<i>Chloroscombrus chrysurus</i>	18.7	15.4 b	100.0	65.0	28.8
<i>Orthopristis sp.; Haemulon sp.; Pomadasys sp.; Boridia sp.</i>	20.6	15.6 c	95.2	40.0	51.5
<i>Cathorops sp.; Genidens sp.</i>	30.3	12.0 d	100.0	42.5	71.3
<i>Diplectrum radiale</i>	15.6	16.3 e	28.6	26.0	60.0
<i>Eucinostomus argenteus</i>	17.7	13.4 f	100.0	21.2	83.5
<i>Micropogonias furnieri</i>	29.4	29.0 g	60.0	60.0	49.0
<i>Caranx crysos</i>	26.0	26.0 h	100.0	70.0	37.1
<i>Diplodus argenteus</i>	27.0	20.3 i	100.0	37.8	71.4
<i>Menticirrhus martinicensis</i>	16.0	15.4 j	100.0	50.0	32.0

Source: a) Costa *et al.* 2012; b) Magro, Cergole & Rossi-Wongtshowski 2000; c) Vianna & Verani 2002; d) Melo & Teixeira 1992; e) Froese & Pauly 2021; f) Pacheco, Paramo & Sánchez 2010; g) Carneiro *et al.* 2005; h) García-Cagide, Claro & Koshelev 1994; i) David *et al.* 2005; j) Haluch 2008.

## Discussion

The range of age recorded among fishers in the present study indicates the participation of different age groups. The results found are similar to those recorded in fisheries on beaches in other regions. Basaglia & Vieira (2005) recorded anglers aged between 12 and 78 years (mostly between 40 and 45 years). Condini, Garcia & Vieira (2007), reported anglers between 17 and 65 years old (average of 43). Schork, Mottola & Silva (2010) found older anglers, aged between 41 and 50 years. Freire, Nascimento & Rocha (2020) and Freire & Rocha (2021), in competitive fisheries and coastal recreational fisheries events, observed ages in the intervals of 7 to 70 years and 10 to 79 years, respectively.

As for the anglers' education level, the predominance had only complete high school, which indicates a level of average education, which differs from Brazilian official data with reports that more than half (51.2%) of adults did not complete this educational step (IBGE 2020). As for the main occupation of the interviewed anglers, most fall into

the employed category. Harayashiki, Furlan & Vieira (2011) observed a similar pattern for beach fishing anglers in the extreme south of Brazil, where the vast majority is composed of 82.0% of students, civil servants, military personnel, and professionals from other areas, and only 18.0% retired.

The main purposes of anglers interviewed were recreation and fish consumption. A small portion of them declared fishing exclusively for leisure, adhering to the practice of the "catch-and-release" type. Harayashiki, Furlan & Vieira (2011) reported the fact that anglers return some individuals, considering the species and quantity of fish previously caught, implying that the practice has a marked leisure characteristic.

Regarding the fishing experience time, the categories of the highest frequency were those less than 5 and over 25 years of experience, suggesting that the activity is developed by different generations of anglers, pointing to a process of activity renewal. Schork, Mottola & Silva (2010) found a different pattern, with the most part of anglers with experience between 7 to 10 years.

The Brazilian legislation pertaining to recreational fishing requires that the recreational fishers possess an annual licence duly paid. Among the anglers approached, only 4.6% had this license. Freire & Rocha (2021), in a similar study in Bahia State (northeast Brazil), reported only 10% of anglers with fishing license. In another study, carried out in the same state, but approaching anglers in championships, Freire, Nascimento & Rocha (2020) verified that all had the license, as a mandatory requirement to competitive events.

Regarding the motivational profile, the results obtained revealed a pattern of responses very similar to those recorded by Schramm & Gerard (2004). The highest averages for the motivational factors "to relax", "to stay outdoors", "to get out of the routine", and "for family recreation" clearly indicates a greater link between the angler and the practice of the activity than with the object of the activity, which is the capture of a specific fish. The similarities observed in the two sets of data allow us to suggest that reef fisheries, typically on the beachfront, are mainly motivated by factors related to leisure.

Only 5 species had some restriction on the minimum catch size according to Normative Instruction MMA, No. 53 of 2005: *Cathorops spixii*, *Genidens genidens*, and *G. barbatus*, *Micropogonias furnieri*, and *Chloroscombrus chrysurus*. Although there are records of the catches of *M. furnieri* at sizes lower than minimum legal size, its occurred at low frequency. However, the possibility of increasing the number of anglers, as well as the fishing effort resulting from, must be considered as risk factors.

When comparing the composition of the catches with the lists of fish species that occur in Sepetiba Bay available in the literature (Araújo *et al.* 1998, Pessanha *et al.* 2000, Andrade-Tubino *et al.* 2020) - 135 species, we found that the shore-based angling caught only 11.9% of them. This value suggests that its practice affects a small portion of the total fish richness of the system.

The most abundant species in Sepetiba Bay are the highest frequency of occurrence in the catches, which are *Diapterus rhombeus*, *Chloroscombrus chrysurus* and grunts, respectively, indicating that the pattern of catches was quite homogeneous, showing few variations. This pattern may be related to some factors, such as, for example, the selectivity of the gear (the size and type of hooks, line, sinker) and also bait. Another important aspect to be considered is the fact that catches were

concentrated in shallow waters, especially those located near estuarine areas, important as breeding sites, as they accumulate juvenile individuals (Araújo *et al.* 2016, 2018b).

The high release rates recorded for *Chilomycterus spinosus*, *Sphoeroides greeleyi* and *Dactylopterus volitans* may be related to no interest as food. The release rates recorded for *Diplectrum radiale* (12.5%) and *Diapterus rhombeus* (2.6%) were possibly related to the small size of the individuals captured.

The species *D. radiale* and *Micropogonias furnieri* had the highest catch rates of individuals with size below the  $L_{t50}$  (71.4% and 40.0%, respectively). However, the low values of abundance and frequency of those species in the catches, minimize the potential impact on those populations. Despite this, Costa & Araújo (2003) and Vincentini & Araújo (2003) indicated that *M. furnieri* is found in different stages of development at Sepetiba Bay, presenting a differentiated spatial distribution throughout its extension. The same authors also suggest that the largest individuals of this species are concentrated in the central and external zone of the bay, while the smallest occur in the innermost zone, where the study area is located.

Three species recorded in the catches presented smaller size proportions in relation to the maximum size recorded in the literature (<40%). According to Bauchot (2003), *Chloroscombrus chrysurus* can reach 65 cm, however, the average catch size reached only 28.8% of this value. *Menticirrhus martinicensis* and *Caranx crysos* presented values of 32.0% and 37.1%, respectively (Froese & Pauly 2021). The incidence of catches on young or newly adult population strata, even if the average sizes are above  $L_{t50}$ , are contributing to the removal of individuals that could still grow and eventually participate in new reproductive events.

As for monitored production (13.5 kg in 205.8 hours of fishing) and fishing yield (only 0.1 kg/hour and 0.2 kg/fisher), we can consider these values to be low when compared to other authors. Dunlop & Mann (2012) and Barbosa (2015) in offshore fisheries recorded a yield of 0.18 kg/hour and 0.06 kg/hour, respectively. Schork *et al.* (2010) in shore-based fisheries recorded a total of 25 kg per fishery. The comparison between the yield values observed in shore-based fisheries and offshore fisheries indicate a big difference between them.

## Conclusion

Our study allows some conclusions: practitioners of shore-based fishing in Sepetiba Bay present a pattern similar to that found in other regions of Brazil, with a predominance of male anglers in a wide age range. Furthermore, the motivational profile confirmed recreational fishing as a form of leisure or escaping from routine, taking advantage of the environment in an open area to be close to family and friends, situations also observed in the other authors presented in this study. The species more captured occurred in sizes above the length of first sexual maturation. The captures focus only on a small number of species, not including any endemic species. Our hypothesis that the activity's low fishing effort and production values result in a low impact on fish populations in Sepetiba Bay can be partially accepted. In this sense, the monitoring of this activity and the dissemination of relevant information for the conservation of species represent important points for fisheries management in coastal environments.

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#### Ethical statement

No animals were collected or harmed for the purpose of this investigation. Animal welfare regulations do not apply in this case.

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