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Differences and similarities in local ecological knowledge about rays among fishers, residents, and tourists

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ABSTRACT

Ray species have been globally threatened due to high fishing pressure and habitat loss. In southern Brazil fisheries, despite many ray species are protected by law and usually non-targeted species, they are captured along with commercially important species. However, as in all of Brazil, there is evidence that rays are consumed, that is, there is a demand for meat from these animals, which intensifies the risk of extinction. Marine ethnobiology is an alternative approach to better understand these organisms, considering the traditional empirical knowledge of fishers and local communities. Our objective is to evaluate the knowledge of local residents, fishers, and tourists about the occurrence, distribution, reproduction, and feeding of ray species and also ray consumption among them. We hypothesized that fishers and locals have a deeper ecological knowledge about rays than tourists, and fishers should know more than residents. Individual interviews were conducted for three consecutive days at Armação beach, Florianópolis, Brazil. We asked people about ray biology and ecology based on questionnaires. Each respondent was categorized into three groups: fishers, locals, and tourists; and ranked according to an index of ecological knowledge of rays. The fishers had greater knowledge about rays, followed by residents and tourists. Additionally, fishers and locals consume rays, even the trade is prohibited locally, evidencing the need for legal enforcement. The fishers' knowledge may be essential for management of fish stocks, contributing to sustainable fishing and species conservation. In contrast, the tourists' lack of knowledge evidences the need to raise awareness of these animals.

Keywords: Rays; Marine Ethnobiology; Local Knowledge.

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SIGNIFICANCE STATEMENT

This study shows that the rays are perceived and consumed by fishers, residents, and tourists in different proportions and this consumption can contribute to impact the reduced populations of endangered species. Our results show the need for legal enforcement to mitigate this decrease and actions of these non-target species to raise public awareness about the problem. Lastly, the integration between fishers and the academic community may result in major advances for conservation and management plans for this group of species on the Brazilian coast.

INTRODUCTION

Rays, including skates, belong to the subclass Elasmobranchii, as well as the sharks. They have a cartilaginous skeleton and true bones where can be found at the bases of dermal teeth and denticles (Castro 1983). Globally, there are approximately 1112 species of elasmobranchs, and among them, 633 species are rays (Last et al. 2016). In Brazil, the number of ray species is about 70 (Rosa and Gadig 2014).

Many ray species are characterized by slow growth, late sexual maturation, and low fecundity compared to bony fishes (Stevens et al. 2000). These animals are among the major marine mesopredators, and they promote important links between upper and lower trophic levels, playing an essential role in the food chain (Ellis et al. 1996; Vaudo and Heithaus 2011). Due to these characteristics, the populations have limited potential to recover from overfishing and bycatch and still suffer population size reduction because of high pollution levels and habitat destruction (Camhi et al. 2009; Musick 2005). Several ray species are threatened, and 539 species are included in the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species (Camhi et al. 1998; IUCN 2010). Nowadays, 24 out of 70 ray species cannot be captured and traded in Brazil (Brasil 2014), that is in line with 35% of the ray species in Brazil are threatened with extinction, with about 7% critically endangered (IUCN 2014).

In southern Brazil fisheries, rays usually are non-targeted species, though they are common (Costa and Chaves 2006; Dias-Neto 2011; Vooren and Klippel 2005), and the catches occur along with commercially important species such as flounders (*Paralichthys* spp.), whitemouth croaker (*Micropogonias furnieri*) and weakfishes (*Cynoscion* spp.). In Santa Catarina, gill fishing accounts for about 43% of elasmobranch landings, including rays and sharks, and the other modalities (different types of trawlers) for 57% (SBEEL 2005). However, there is a difficulty in managing the stocks of these cartilaginous organisms because crucial information about basic biology and population dynamics are scarce (Aguiar and Valentin 2010; Heithaus et al. 2008; Palmeira 2012; SBEEL 2005). Alternative approaches can help better understand these marine organisms, such as marine ethnobiology, which focuses on studies of the relationships between human societies and marine biotic communities of ocean ecosystems (Thaman 1994). One of these human groups is the populations of fishers and residents of coastal regions with a close relationship with nature, related to their socio-cultural, religious, and economic reproduction, with empirical knowledge traditionally transmitted (Diegues et al. 2000; Pereira and Diegues 2010). In ethnoecology studies, the concept of Local Ecological Knowledge is widely used, being a set of accumulated beliefs and knowledge about the environment acquired through observation and direct experience, passed through generations (Berkes and Folke 2000). Several contributions to the ecological understanding of marine species are based on ethnobiological or ethnoecological approaches (e.g., about diet and reproduction of a particular group such as the snappers/Lutjanidae, Begossi et al. 2011; or about ecology of targeted fish species and possible changes in stocks, Martins et al. 2014, 2018), and environments (Begossi et al. 2012; Peterson et al. 2019). However, most of these studies focused on teleosts, and only a few analyzed sharks (e.g., Barbosa-Filho et al. 2014, 2021; Carvalho et al. 2018; Santos et al. 2019) and none about ethnobiological knowledge of rays, other than the consumption of rays (Bornatowski et al. 2015). Due to the limited number of published academic information on rays in Brazil and the lack of studies in southern Brazil with this approach, our objective is to evaluate the knowledge of the population of local residents, fishers, and tourists about the occurrence, distribution, reproduction, and feeding of ray species.

Thus, the ethnobiological approach allows for a dialogue and exchange between academia and traditional and local communities (Kimmerer 2002; Santos et al. 2019). These studies should also respect local culture and recognize the community's contribution without the imposition of the researcher's ideas, as well as the use of appropriate language and respect respondent dynamics (Hanazaki and Freitas 2011). Considering that locals and fishers have higher frequency of contact with marine resources, we hypothesized that the locals and fishers have more in-depth ecological knowledge about the rays than tourists, and fishers should know more about the rays than the res-

idents.

MATERIAL AND METHODS

Study site

This study was carried out at Armação beach in Florianópolis, Southern Brazil (Figure 1). Armação beach is a prominent neighborhood with traditional fishers within Santa Catarina Island, where Florianópolis is located. Armação was chosen due to this particular combination of a high concentration of artisanal fishers at one spot (an area in the southern part of the beach where fishing vessels are concentrated), the presence of local inhabitants, and the stable presence of tourists all over the year, although more concentrated during summer season and holidays. Unlike fishers, tourists and locals were found in different places of this neighborhood. According to the 2010 Demographic Census (IBGE 2011), the population of this neighborhood had around 2837 inhabitants, comprising 51.39% women and 48.61% men.

Data collection

Individual interviews were conducted for three consecutive days in November 2016, with an effort of about 8 hours per day. We approached all people found along the busiest streets and highways of Armação beach (including the area with fishing vessels) (Figure 2), and after explaining the objectives of the research, we individually asked for free and informed consent. This research was submitted and approved by the Ethics Committee of Research with Human Beings of Universidade Federal de Santa Catarina (CEPSH) under the number 52308116.9.0000.0121.

For the interviews, we used a protocol with open and closed questions (Table 1) based on structured questionnaires (Porcher et al. 2020). We asked questions about the interviewee's profile and ray biology and ecology (such as reproduction, feeding, and area of occurrence). We did not interview people who were relatives or lived in the same house. After the interviewees' acceptance to participate in the study, their answers were transcribed at the time of the interview. Question 6 was performed showing the ray egg

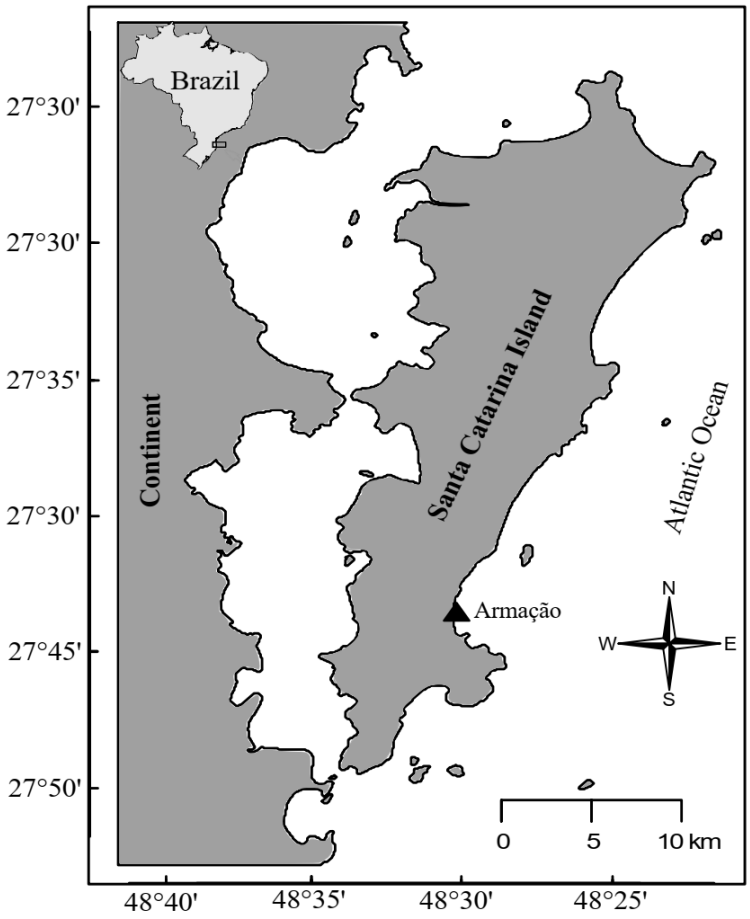

Figure 1. Map of Santa Catarina Island showing the neighborhood (Armação beach) where we carried out this study.

Figure 2. Ray egg capsules used during the interviews in Armação beach. Photo: Renato H. A. Freitas.

Table 1. The questionnaire used in interviews. The question numbers 5.1 to 5.5 were only asked if the answer of question 5 was "yes".

Number	Question	Answer
1	How old are you	
2	How it is your professional occupation	
3	How often do you come to Armação beach?	
4	Where do you live?	Armação ( ) Others ( )
5	Do you fish?	Yes ( ) No ( )
5.1	Is it professionally or for recreation? How often?	
5.2	How do you fish?	
5.3	Do you fish, or have you ever fished rays? Which species?	
5.4	Do you find rays or ray eggs in the fishing net?	Yes ( ) No ( )
5.5	How often do you find it?	
6	Do you know, or have you seen this structure (at that moment, an egg capsule of rays was shown – Figure 2) on the beach?	Yes ( ) No ( )
7	Do you know what this is?	
8	Do you know how many species of rays occur in Brazil?	
9	Do you know how the rays reproduce?	
10	Do you know how to differentiate between male and female?	
11	Where do rays occur?	
12	What do rays eat?	
13	Do you eat ray?	Yes ( ) No ( )

capsules for each interviewee (Figure 2). We divided the respondents into three groups: fishers, locals, and tourists. Regarding this last group, all the people who did not live in Armação were considered tourists. We asked additional open questions to fishers who mentioned rays, about morphological characteristics for each local name, to help in scientific identification. We showed ray pictures for the fishers in order to verify their local knowledge about these marine organisms. After that, we related the popular names cited by the fishers with their respective scientific species.

Data analysis

To check for scientific identification, we used fishers' descriptions and information from the literature (Bornatowski and Abilhoa 2012; Gomes et al. 2010; Hayata et al. 2018). To quantitatively analyze the

level of ecological knowledge of the rays regarding the groups (local residents, tourists, and fishers), each person was ranked according to an index of knowledge, reaching values from 0 (no knowledge) to 5 (highest knowledge). We assume that this index allows for an objective comparison among groups of respondents, even with the caveat of oversimplifying the amount of knowledge each person has. The index was composed by affirmative answers to questions 6 (recognition of the ray egg capsule shown), 7 (knowledge about the ray egg capsule), and 10 (knowledge about how to differentiate between males and females), and answers different from "do not know" for questions 11 (where do they occur?) and 12 (what do they eat?) (Table 1), each weighing 1 point.

To check for differences in knowledge levels among groups, we performed a Kruskal-Wallis test, followed by the Nemenyi a posteriori test (Zar 2010), once data were not homoscedastic (Levene's test). Goodman's test (for contrasts between and within multinomial proportions) was adopted to check differences between/among the proportions of the groups that eat (or not) ray meat (Goodman 1964, 1965). Besides, we assessed the relationship between respondents' knowledge of the ray egg capsules (response variable) and the different individual responses of the three groups of respondents (explanatory variables) using Generalized Linear Models/GLM (Zuur et al. 2009, 2010) with a binomial distribution, followed by a stepwise selection method using the ordistep function (vegan package; Oksanen 2015). Permutation and AIC (Akaike Information Criterion) tests were automatically achieved by the stepwise selection model. To identify the collinear covariates, we used the VIF (Variance Inflation Factor) function of R car package (v.2.0-20; Fox and Weisberg 2015), and through a stepwise procedure the covariates with VIF values < 4 were removed (O'Brien 2007). We used the bipartite package to analyze the possible correspondences between local names and scientific identification (Dormann et al. 2008). All analyses were conducted in the R environment (R Core Team 2016) in conjunction with vegan (Oksanen et al. 2013) and ade4 (Dray and Dufour 2007) packages. We used a value of 5% significance for all statistical tests.

RESULTS

We approached 132 people, of which 22 refused to participate in the research, summing 110 interviews. Most people who refused to participate were locals and tourists. We divided the respondents into 3 groups: fishers (n=25), local residents (n=43), and tourists (n=42). We interviewed 69 men between 21 and 80 years old and 41 women between 19 and 78 years old. All fishers were male. Respondents had different professions and occupations; the most recurring ones were fisher (25), student (8), salesman (6), housekeeper (5), self-employed (5), artisan (5), teacher (4), administrator (4), painter (4); and some interviewees were retired (9). Less mentioned professions and occupations (less than three persons per occupation) were considered in the "Other" category (35).

Among the tourists, 13 people were visiting Armação beach for the first time; 4 frequented the beach daily; 14 weekly; 7 monthly; and 3 annually. Among the local residents, 12 lived in Armação from 1 to 5 years; 6 from 6 to 10 years; 4 from 11 to 15 years; 3 from 16 to 20 years; and 41 have lived in Armação for over 20 years.

We considered fishers the interviewees who use fishing as a profession (25 people). Among them, the most common type of fishing gear was bottom trawl (10), line (15), floating seine (5), and cast net (5). The other 23 respondents (local residents or tourists) considered themselves fishers, but they did not depend on this economic activity, summing 48 fishers in a broad sense. When asked if they have ever fished rays, 34 said they had fished at least once, compared with 14 who said they had never fished. About 90% of fishers stated that the bottom trawl is the fishing gears that most catch rays, followed by the line.

Most fishers said they eat rays' meat (96%), followed by local residents (77%) and tourists (31%). There were significant differences in the proportion of respondents regarding the consumption of rays between and within groups (Figure 3).

Local knowledge about rays

According to the fishers, the most caught rays are "Jereva" (*Gymnura* sp.); "Ticonha" and "Boi", both belonging to the same taxon (*Rhinoptera* sp.) and "Amarela" (*Sympterigia bonapartii*) (Figure 4). Several local names cited by fishers correspond to the same taxa. For example, the rays of taxa *Atlantoraja* sp. can be recognized as "Emplastro" or "Chita/Pintada", and this latter was also cited as *Aetobatus narinari*. Local names were also corresponding to different taxa, as it occurs for *Dasyatis* sp. and *Hypanus guttatus*, which were also cited as "Manteiga or Prego". On the other hand, some local names are used more generically to refer to different species, such as "Emplastro", possibly referring to eight different taxa (Figure 4).

There were significant differences (Kruskal-Wallis: $H_{0.05;2} = 56.0$; $p < 0.001$) between the groups regarding the level of knowledge about rays. The average value of the fishers' knowledge index was significantly higher than the other two groups (Figure 5).

After applying the stepwise analysis in the GLM,

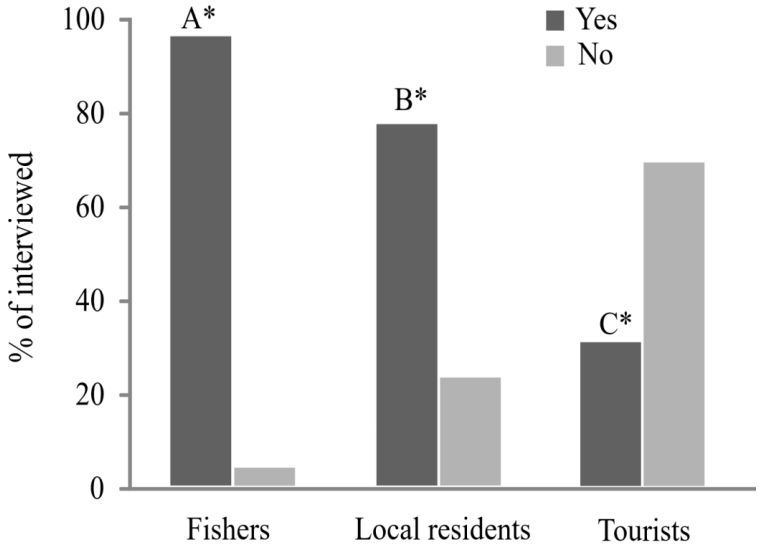

Figure 3: The proportion of respondents by groups that eat (or not) rays' meat. Different letters indicate significant differences between groups (Goodman's Test, 1964; Gcalculated > Gcritic = 2.39), while the asterisk (*) indicates difference within each group (Goodman's Test, 1965; confidence interval does not include the zero value for Acritic = 3.84).

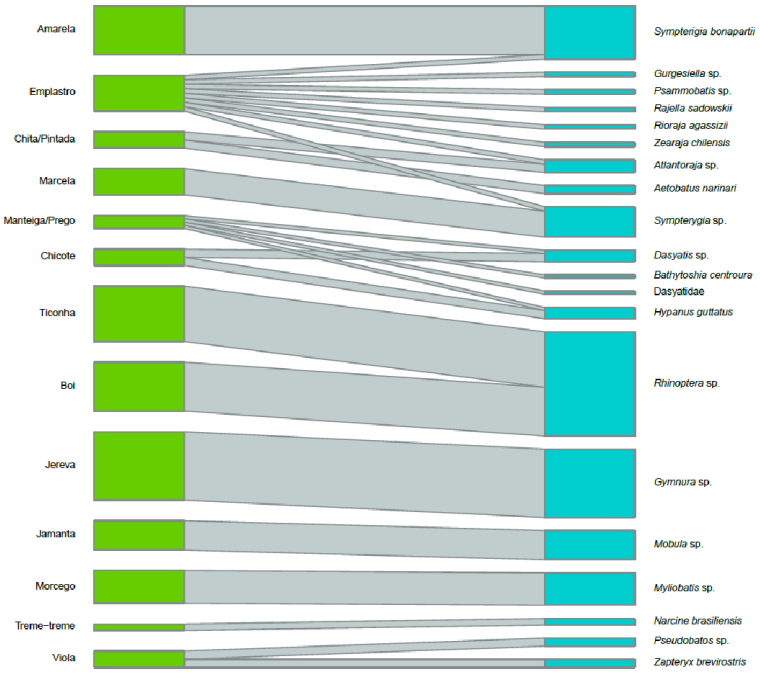

Figure 4. Number of correspondences between local names and scientific identification by the 25 fishers interviewed.

the explanatory variables "Gender" (men/women) and "Group" were the ones that most explained the model. The tourist group had a significantly lower ray egg recognition value than local residents and fishers. When it is considered the difference between genders, we have found that men (recognition value = 0.60 ± 0.06) is the variable that most explains the differences, with ray egg recognition values significantly higher than women (0.19 ± 0.06). Moreover, even when the group of fishers (composed only of men) was excluded from the analysis, we also found that men (0.34 ± 0.40) had significantly higher recognition

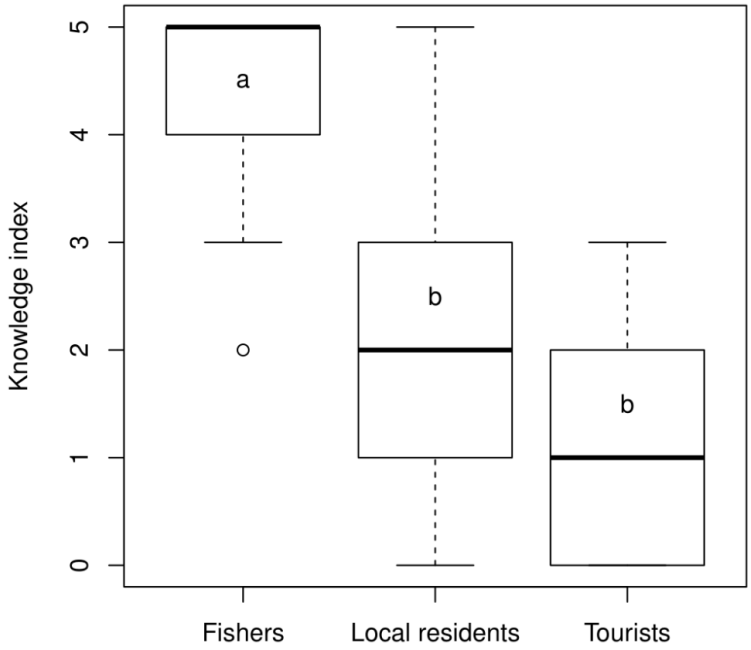

Figure 5. Values of knowledge index about rays between three different groups. Different letters indicate significant differences (Nemenyi; $p < 0.05$).

Table 2. Summary of the GLM for recognition of ray egg capsules (110 interviews).

Source	Standard error	z value	p
Intercept	0.4225	-2.217	*
Fisher	1.1063	2.731	**
Tourist	0.5724	-2.803	**
Gender; men	0.5522	1.980	*

Legend: $*p < 0.05, **p < 0.01$

values ($p < 0.05$) than women (Table 2).

The main answers about biological and ecological knowledge of the rays are summarized in Table 3. Fishers and local residents equally recognized morphological characteristics of male rays; however, no tourist mentioned such differences. Areas of occurrence usually refer to places far away from the Armação beach, such as open sea and deeper areas. Campeche Island is a coastal island close to Armação beach, widely known as a more preserved area than Santa Catarina island. Feeding habits were associated with fish, crustaceans, and other invertebrates.

DISCUSSION

Here, as expected, the fishers had a greater knowledge about the ecology and biology of rays than local residents and tourists. Although rays are not the target species of the local fishery, almost all fishers catch and consume rays. The differences observed concerning gender could be explained by the fact that all fishers were male and because they were closer to these animals daily. However, differences were observed even with the exclusion of fishers, and the male gender had greater knowledge. Even when fishers were excluded from the analysis, gender differences may be related to social roles men and women have regarding the domain of fish and the sea. For example, among tourists and residents in an area nearby the sea women can be more focused on aspects related to fish processing, selling, and food security (van Luijk et al. 2021). Additionally, our study was not designed to analyze gender differences in depth, but we may not ignore the fact that the interviews were made by two men authors, and the possible influence of this in the answers given by men or by women. The information that the interviewees gave regarding the feeding of the rays corroborated with the literature, which cites fish, crustaceans, and mollusks as the main components of their feeding (Carvalho-Filho 1992; Stehmann et al. 1978).

Another point to note is that the answers re-

Table 3. Main answers of 110 interviewees about ray biology and ecology.

Group	Differences between male and female rays	Knowledge about areas of occurrence	Knowledge about feeding habits
Fishers (N=25)	The sexual organ of males is visible (100%)	Campeche Island (44%), open sea (32%), deeper areas (16%), anywhere in the sea (8%)	Different invertebrates and fish (72%), crustaceans (28%)
Local residents (N=43)	The sexual organ of males is bigger (100%)	Deeper areas (43%), open sea (38%), Campeche island (19%)	Fish (36%), crustaceans (36%), different invertebrates and fish (28%)
Tourists (N=42)	Do not know	Open sea (68%), deeper areas (32%)	Fish (62%), different invertebrates and fish (38%)

garding rays' occurrence were very similar among the groups but were more diverse, complete, and in agreement with the scientific literature (Michael 1993) in the group of fishers. For the other two groups, the answers were vague and not detailed. Answers as "high seas" and "deep regions" were more common for residents and tourists than for fishers. Tourists were more unaware of rays in shallow regions and not as far from the human population as they believe. However, it is the case of the species *Gymnura altavela* (5-100 m deep), *Myliobatis goodei* (1-130 m), and Dasyatidae species (0-53 m) (Bernardes et al. 2005; Brito 1991; Uyeno et al. 1983).

According to the fishers, bottom trawling is the gear that captures most rays. However, these types of nets intercept neonates and juveniles' distribution areas, especially in shallow coastal waters and the continental shelf, respectively, with no refuge for elasmobranchs (Kotas et al. 2008; Vooren and Klippel 2005). As noted earlier, elasmobranchs' peculiar characteristics (e.g., slow growth, low fecundity, and late maturation) make them more vulnerable to overfishing, reaching the point of collapse if no measures are adopted (Camhi et al. 2009; ICMBIO 2016; SBEEL 2005; Vooren 1997). Also, fishers report that this type of net catches several other organisms (such as octopuses, squids, non-commercial fishes, and small invertebrates) that are sometimes thrown overboard dead, but they may also be consumed. Thus, the regulations for using this type of fishing gear must be more enforced by the Brazilian government, once it is well known the negative impacts for elasmobranch populations (Stevens et al. 2000; Zeller et al. 2018). This is even more worrying due to the high number of endangered species and the high level of endemism in this region (Dulvy et al. 2014; Lucifora et al. 2011).

Interestingly, many of these species cannot be captured according to Brazilian Ordinance 445/2014 (Brasil 2014), but environmental monitoring is ineffective. This seems to be true that in our work, both fishers and the resident population usually eat rays. Although the trade of ray species in Santa Catarina does not occur on a large scale compared to sharks (Almerón-Souza et al. 2018; Cruz et al. 2021), the present study shows that local consumption is appreciated. Due to the rays coming from bycatch and their sale is mainly restricted by the Brazilian law, they end up being for their own consumption and what they can sell they do. Furthermore, the sale and consumption may be occurring before the specimens arrive in large commercial markets, and these practices can impact some populations. It is important to note that the risk of extinction of all possible species analyzed in this study requires attention (out of 45 ray species, 7 are CR, 5 are EN, 13 are VU, 5 are NT, 4 are LC and 11 are DD; Hayata et al. 2018).

Increasing international demand for meat from several rays, such as the Rajidae family, has led to an increase in the fishing intensity of these "fish meat" (Mazzoleni and Schwingel 1999). Elasmobranch meat (rays and sharks) is sold as "cação" in both restaurants and markets (Bornatowski et al. 2013). Previous studies showed that fisheries, markets owners and restaurants generally omit information when they were selling "cação" meat (MPA 2011; Bornatowski et al. 2015). Moreover, the Brazilian markets often encourage people to eat this meat, due to its attractive price and to avoid meat waste (Bornatowski et al. 2018). Thus, the low value of 36% of tourists that eat rays is underestimated, and many people probably are unaware of which species they are really consuming. Bornatowski et al. (2015) also showed that most consumers do not know that "cação" is associated with shark and ray meat in a big city of southern Brazil. The consumers do not even know they had ever eaten shark or ray. In the neighboring state of Santa Catarina, Paraná, Bernardo et al. (2020) found that the ray *Pseudobatos percellens* was the most commercialized species under the label of "cação". Moreover, 62% of fish sold as groupers in two states of Brazil (São Paulo and Rio de Janeiro) are in fact sharks (Estrella et al. 2014). Independently, this mislabeling

can make it impossible for consumers to make decisions about the consumption of elasmobranch meat, interfering with efforts to reduce such consumption (Bornatowski et al. 2013). This meat also has high levels of heavy metals, bringing substantial risks for human health (Lopez et al. 2013). Our study showed that the sale of ray meat is an everyday activity in Armação beach. This situation is even more alarming because little is known about the conservation status of several species in Brazil, and an assessment of their fishing potential has not been made (Haimovici et al. 2008). It is important to note that in the state of São Paulo (near to Santa Catarina and with similar ray fauna and fishing characteristics), 44.3% of batoids species caught are threatened and included in IUCN Red List, and 57.47% were protected by law in Brazil (Ferrete et al. 2019). Hence, it is of great importance improve the knowledge of the people about the elasmobranch ecology and risks of consuming these organisms for human health (Bornatowski et al. 2015).

According to the Brazillian Ministry of Environment, several cited ray species (correlated to their folk names) are currently on the Official National List of Endangered Fauna Species, and they belong to the genera: *Atlantoraja, Dasyatis, Gymnura, Mobula, Myliobatis, Pseudobatos, Rioraja, Sympterygia, Zapteryx*. Species on the List are classified in the Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) categories and are fully protected, including the prohibition of capture, transport, storage, handling, processing, and the marketing (MMA 2014). Despite the existence of a legal instrument, there is a growing fishing effort due to the number of vessels, technological enhancement, and ineffective oversight by fisheries management bodies (Occhialini et al. 2012). In addition, the demand (consumption) of rays is mainly supplied by the bycatch (Dulvy et al. 2014; Ferrete et al. 2019) and therefore, even if fishing for rays is not the commercial target, they will still be impacted if not regulated and monitored according to the laws.

It is important to highlight the great knowledge that fishers have about the biology and ecology of the fish caught, since the information of this nature may be essential for fisheries control (Marques 2001) and management of fish stocks. This increased knowledge of such organisms is doubly adaptive because it can contribute to more cost-effective and profitable fishing (Barbosa-Filho et al. 2014) and sustainable fishing. On the other hand, there is a great lack of tourists' awareness on this group of animals, even in basic issues such as the differentiation between males and females, evidencing the need for knowledge about the role of elasmobranchs in the marine environment to be disseminated (Garla et al. 2015).

Since the integration of academic and locally constructed knowledge favors a contextualized analysis (Carlsson and Berkes 2005), the present study can accordingly be used. We found that several local names of rays correspond to the same taxon. The same situation also occurred with sharks in other states of the Brazilian coast (Barbosa-Filho et al. 2021; Carvalho et al. 2018). These authors found that approximately 3 to 5 local names of sharks belonged to the same taxon. In addition, Barbosa-Filho et al. (2021) highlighted that some sharks might have more than ten folk names, but usually, one or two are the most usual. A folk name can also indicate more than one species, as occurred for "Emplastro" in our work and "cação-panã" in the northeastern Brazilian coast (Carvalho et al. 2018). Once Fishery Statistics no longer exist in a controlled manner in Brazil since 2011, this problem is a major challenge. Because even using the folk names sold in fish markets will not accurately inform which species are being more or less captured, but it could help to provide a slightly more accurate picture than just a statistic based on local names such as "cação" and ray. It is suggested that the folk names of elasmobranch species may be a great way for the integration between fishers and government actions as well as in advances for conservation and management plans (Barbosa-Filho et al. 2021; Carvalho et al. 2018).

CONCLUSION

Our study showed that the fishers' group presented most knowledge regarding the ecology and biology of rays and was the group with higher awareness about the consumption of these organisms. The rays are part of a group of fish of interest for consumption, although not a target of local fishing. At the same time, due to their biological characteristics, the rays' conservation status requires attention since their stocks can be easily compromised. The gender related differences we found suggest that the topic should be further investigated, especially among the group of non-fishers (residents and tourists), for a better understanding on how people interact with rays and, if there are conservation concerns, how different segments of the public may be approached. To avoid the negative effects of ray catches on their populations, a better disclosure to society about the degree of conservation and the importance of rays on trophic balance and ecosystem health is needed. We also identified a need to avoid the mislabelling of ray meat that is probably being sold in restaurants to better understand the consumption pressure over these species.

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DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived of the presented idea: RFF, LPM, RHAF, NH
Carried out the experiment: RFF, LPM
Carried out the data analysis: RFF, LPM, RHAF, NH
Wrote the first draft of the manuscript: RFF, LPM, RHAF, NH
Review and final write of the manuscript: RFF, LPM, RHAF, NH
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