



Characteristics, preferences and perceptions of recreational fishers in northern Patagonia, Argentina

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ABSTRACT

This study aims to compare the characteristics, preferences and perceptions of fishers in the recreational fisheries of San Blas (SB), El Cóndor (EC) and La Ensenada (LE), using the roving creel survey technique. No difference was detected in fishers' characteristics (age, years of fishing experience, occupation), but the number of visits made per year was lowest in SB, which is located furthest away from large cities. The three fishing sites also showed significant differences in expenditure per trip. An inverse correlation between expenditure and number of visits per year in relation to distance travelled was observed only in SB. *Micropogonias furnieri* was the main target species in SB and EC fisheries, and *Odontesthes* sp. was the main one in LE. Most fishers in LE reported that fish size had not varied over time, while in SB and EC they considered that fish size had decreased in recent years. In all three sites, however, there was agreement on the decreasing trend observed in the number of fish caught per fishing trip. Between 70 and 90% of fishers agreed that there should be restrictions through daily quotas and minimum size, and recognized chondrichthyans as threatened species. It is concluded that the three fisheries presented fairly dissimilar profiles, suggesting that Patagonian recreational fisheries need to be assessed on a local scale instead of using a one-size-fits-all strategy, in order to recognize their differences and implement appropriate management measures. Understanding the preferences, motivations and demands of fishers is important if we are to update current regulations and improve the management of recreational Patagonian fisheries. This will contribute to their preservation as a valuable ecosystem service without compromising natural resources.

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1. Introduction

Recreational fishing is a leisure activity carried out by private individuals whose motives are not linked to subsistence or commercial gain (FAO, 2012). On a global scale, recreational fishing has attracted a high number of participants, estimated at between 220 and 700 million (Cooke and Cowx, 2004). Recreational fishing is carried out in more than 100 countries (Cisneros-Montemayor and Sumaila, 2010), and current estimates indicate that approximately 900,000 tonnes of fish are extracted per year (Cooke and

Cowx, 2004; Freire et al., 2020). Recreational fisheries are considered an ecosystem service that contributes to human well-being (Winfield, 2016); this activity is emerging as an important socio-economic factor for many local and regional economies, bringing social, cultural and health benefits to those who take part in it (Parkkila et al., 2010). Furthermore, the relationship between an environment and its resources and users allows recreational fisheries to be classified as an adaptive socio-ecological system (Arlinghaus et al., 2017). These systems are characterized by being complex, hierarchically structured and self-organized, with adaptive capacity (Ostrom and Ahn, 2008).

The problems associated with recreational fisheries have become increasingly important in recent years, with growing demand for biological, social, and economic data on this practice, as well as a review of assessment methods (National Research Council (NRC), 2006; Pitcher and Hollingworth, 2002). Unlike

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commercial fisheries, recreational fisheries exhibit visible information gaps, in part due to a lack of perception of their actual or potential impact on fish populations (Lloret et al., 2008) and the difficulties encountered in evaluating or monitoring them. There is increasing interest in recording recreational fisheries data on a global scale (Schroeder and Love, 2002), associated with the need to assess their potential biological, environmental and socio-economic impact (Cooke and Cowx, 2004, 2006). Furthermore, the establishment of guidelines for sustainable fishing practices (FAO, 2012) is considered necessary in each of these dimensions (Arlinghaus et al., 2010), as the contribution of recreational fisheries to the decline of fish populations is also recognized (Post et al., 2002; Coleman et al., 2004; Lewin et al., 2006, 2019).

Some of the major limitations encountered in the assessment of recreational fisheries are their diffuse nature, the lack of appropriate statistics, and the spatial and temporal complexity they present (Arlinghaus and Cook, 2009). One possible tool that could be used is the knowledge of older or more experienced fishers, given that fishers' perception of species abundance has proven accurate in studies where this source of information was contrasted with research data (Neis et al., 1999). Tournaments also provide valuable information on resource status and conflicts (eg. Travnichek and Doug Clemons, 2011; Mourato et al., 2016). In fisheries where long-term data sets do not exist, experienced users are often the only available source of information on historical changes in local populations (Johannes et al., 2000; Cunha de Moraes, 2011). Including users in fisheries management therefore makes it possible to understand and build on existing trends and patterns of resource use (St. Martin, 2001). These perceptions are particularly important in developing countries where recreational fisheries regulations are insufficient or information is scarce (Karnad et al., 2013).

Although marine recreational fishing is carried out intensely in northern and central Argentinean Patagonia, the activity has no formal regulations. Information in this region is still very fragmented, suggesting that recreational fishing is not yet sufficiently valued for its potentially significant impact on coastal ecosystems or fish populations. Only Buenos Aires Province has a regulation that defines minimum size and daily quotas, as well as the permitted species and seasons; it also prohibits the extraction of large sharks such as the sand tiger shark (*Carcharias taurus*), copper shark (*Carcharhinus brachyurus*); broadnose sevengill shark (*Notorynchus cepedianus*) and tope shark (*Galeorhinus galeus*), imposing catch and release practices (Venerus and Cedrola, 2017). Río Negro Province, on the other hand, has no legislation regarding recreational coastal or boat fishing marine fisheries, thus allowing the capture of any species. No restrictions apply if the capture does not take place within a Protected Natural Area (Venerus and Cedrola, 2017).

In northern Patagonia, most of the available information on recreational fisheries comes from San Blas Bay (Buenos Aires Province) (Llompert et al., 2011). Studies carried out on this fishery have concentrated on large shark fishing (Lucifora, 2003), coastal recreational fisheries (Llompert et al., 2011, 2017) and the biological features of fish species of recreational interest (Lucifora et al., 2005; Molina, 2012; Llompert et al., 2013). Information is also available on the structural characteristics of fisheries in Chubut Province (central Patagonia) (Bovcon, 2016). In contrast, there is no information on the socio-economic impact of recreational fishing or the state of exploited resources in El Cóndor and La Ensenada fisheries, located in Río Negro Province. This would make it difficult to adopt management measures taken from other fisheries, such as San Blas, without taking into account possible differences or contrasts among them.

The aim of this study was to provide, for the first time, a comparative assessment of the basic characteristics, preferences and perceptions of fishers who use three important recreational fisheries located in northern Patagonia.

2. Material and methods

The three study sites were located on the southern limit of the coastal sector called El Rincón, which is influenced by discharges from the Colorado River in the north and the Negro River in the south (Lucas et al., 2005) (Fig. 1). San Blas Bay (SB) is located 100 kilometres from Viedma, and lies within a natural, multiple-use protected area located Anegada Bay. SB encompasses several types of coastal environment; e.g., marshes, tidal flats, and sand and pebble beaches, and receives a large influx of shore- and boat-based fishing tourists, mainly in the summer. El Cóndor (EC) is located 30 kilometres to the southeast on the Negro River estuary, and is the closest fishery to Viedma. El Cóndor has some infrastructure for tourism, whereas La Ensenada (LE), located 75 km south of Viedma, is a coastal area of open sea with pebble and sandy beaches, and has no infrastructure for tourism.

2.1. Data collection and processing

A total of 287 structured surveys were conducted between March 2015 and May 2017, corresponding 177 to SB, 31 to EC and 79 to LE. To evaluate fishers' characteristics, preferences and perceptions, the "Roving Creel Survey" technique was followed, based on the interception of fishers during their fishing trips. (Malvestuto, 1996; Robson, 1991),

A total of 18 sample trips were carried out, 6 for each fishing site. We considered recreational fishers as those who fish for leisure or fun (e.g., Pitcher and Hollingworth, 2002). In the study sites all fishers used rods, lines and baits; other gears were not permitted. Samplings were undertaken at least once in each fishing area during the high and low fishing seasons, considering that fishing activity is not homogenous throughout the year, as was noted for SB by Llompert et al. (2011) being therefore necessary to stratify the sampling period according to fishers concurrence. On each sampling day between 10% and 20% of the coastal fishers were randomly surveyed. An estimate was made of the total number of fishers carrying out the activity by counting the fishing rods that were in use. Before each survey, time, location, tide, and weather conditions were recorded.

The survey was oriented to determine the basic social and economic characteristics of the fisheries, and to gather information about fishing site characteristics and fishers' preferences, target species, and perceptions of the resources and regulations. The survey questions referred to social characteristics (occupation, number of recreational fishers in the group, age, city of residence, experience, duration of fishing trip (days), number of visits per year), economic aspects (expenditure per fishing day, distance travelled to the fishing site), preferences (fishing site, target species, optimum number of fishes) and use of target and unwanted species caught. In addition, we investigated fishers' perception of the status and management of the resources in relation to variations in fish size and number caught in the fishing site, acceptance of management measures in terms of daily quotas and minimum size, and knowledge of threatened species in the area. The question about threatened species was open, and for analysis all the different types of rays and sharks mentioned in the answers were included in the category of chondrichthyans. Wales, sea lions and others taxa, were included into the category of others. Only fishers with more than 10 years of fishing experience in the fishing sites were included in the analysis of perception of temporal variations in fish size and number of fish caught.

Economic expenditure was converted to dollars, according to the value of the US currency on the sampling day. In order to compare social characteristics, economic aspects and fishing preferences, variables were first tested for normality and

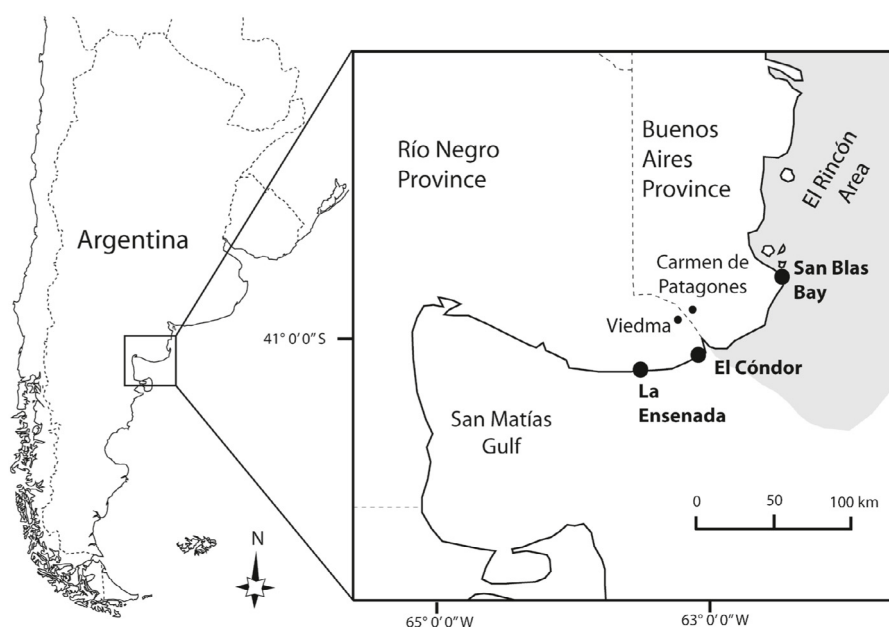


Fig. 1. Study sites from north to south: San Blas Bay (SB) in Buenos Aires Province, and El Cónдор (EC) and La Ensenada (LE) in Río Negro Province.

Table 1

Average fishers' age, years of fishing experience, duration of fishing trips, number of visits per year and expenditure per fishing site. Range of the values within parentheses.

	Age (years)	Fishing experience (years)	Duration of trip (days)	Visits per year	Expenditure (US\$)
San Blas Bay	45.4 (15–73)	27.9 (2–65)	3.2	6.5	79.3 (2.7–336)
El Cónдор	46.7 (23–75)	33.2 (5–62)	2.0	13.2	20.1 (3.3–47)
La Ensenada	43.4 (16–69)	27.3 (5–60)	1.3	15.9	41.3 (2.4–47)

homogeneity of variance, using the Shapiro Willks and Levene tests, respectively. As the variables departed from normality and heteroscedasticity, the Kruskal–Wallis test was applied. Post hoc comparisons were performed using the Conover-Iman test (Conover and Iman, 1979; Conover, 1999). In analyses where the information was clustered at intervals, the KruskalWallis test was applied to the original unclustered data. In addition, Spearman correlation tests were carried out for each fishery to establish possible relationships between assessed variables. All statistical analyses were performed with the programme InfoStat v. 2017, and a significance level of $P < 0.05$ was used.

3. Results

3.1. Fishers' characteristics

A higher percentage of male than female fishers was observed in the three sites sampled, with men accounting for approximately 91% of the total. The median age showed no difference between sites ($H = 0.60$, $p = 0.74$), the average age ranging from 43 years in LE to 47 years in EC (Table 1). No significant difference was observed in fishing experience ($H = 0.49$, $p = 0.77$) among sites. Fishers visiting both SB and LE had an average fishing experience of about 27 years, while those from EC had about 33 years. In terms of occupation, the most frequent response at the three sites was “employee”, followed in SB and LE by “self-employed” and in EC by “student” (Fig. 2).

Fishing trips were 2.5 times longer in SB than in LE, lasting around 3 days in SB (Table 1). The number of times per year that fishers visited each site ranged from 6.5 at SB to almost 16 at LE. It was noted that most visitors came from nearby locations (Fig. 3) and significant differences were observed in the distances

travelled to the fishing sites ($H = 142.69$, $p < 0.05$). Fishers surveyed in SB travelled about 334 km, while those from EC and LE only 97 and 107 km, respectively. Pairwise comparisons showed significant differences between SB and the other sites, but no difference was found between EC and LE. Significant negative correlations were also found between distance travelled and number of visits per year for SB ($\rho = -0.48$; $p < 0.05$) and for EC ($\rho = -0.47$; $p < 0.05$), but not for LE ($\rho = -0.06$; $p = 0.57$).

In EC and LE average expenditure per trip was 20.15 US\$ and 41.39 US\$, respectively, while SB was the fishing site with the highest and most variable average expenditure of 79.33 US\$ (range 2.7–350 US\$) (Table 1). Expenditure per fishing trip showed significant differences in the medians of all the fishing sites ($H = 41.3$, $p < 0.05$), and pairwise comparisons were significant between all sites. A significant but weak positive correlation was observed between distance travelled and daily expenditure only in SB, ($\rho = 0.22$, $p < 0.05$).

3.2. Fisher's preferences

SB was the favourite fishing site for fishers surveyed at SB and EC, while the fishers at LE chose LE as their favourite site. When asked if they knew a more productive fishing site in terms of catch than the one they were fishing in, the users of the three fishing sites selected SB as the one that offered the best catches (Table 2).

Whitemouth croaker (*Micropogonias furnieri*) was the main target species for both SB and EC fishers, and silversides (*Odonesthes* sp.) for LE. On average, 80% of the fishers said they kept everything they caught, for consumption; of the remaining 20%, between 80 and 90% of the fishers said they returned incidental (unwanted) catches to the sea (Table 3).

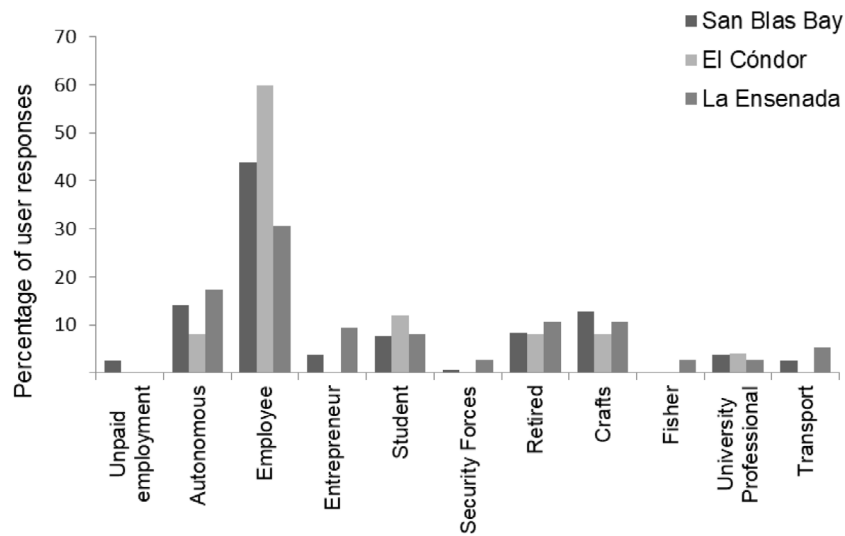


Fig. 2. Fishers' occupation by fishing site located in northern Patagonia.

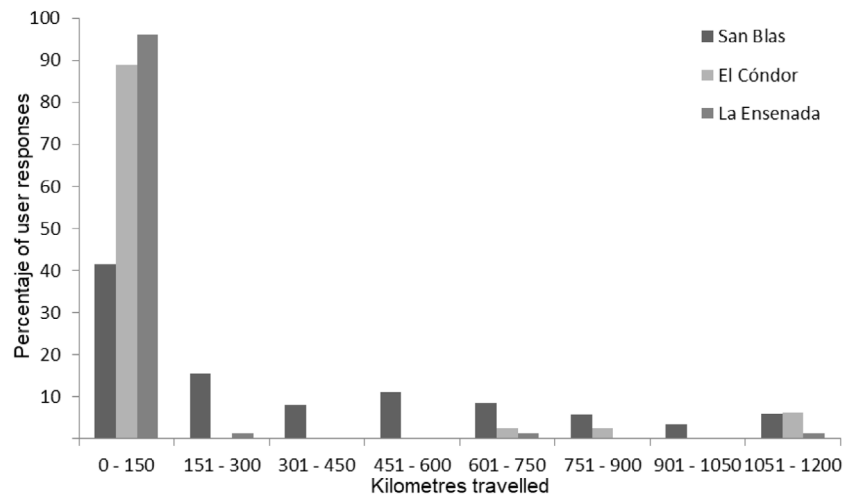


Fig. 3. Percentage of fishers and kilometres travelled to reach the fishing site.

Table 2

Percentage of fishers surveyed in each fishing site based on favourite fishing site selection and most productive fishing sites.

	Favourite fishing site (%)				Most productive fishing site (%)			
	San Blas Bay	El Cóndor	La Ensenada	Others	San Blas Bay	El Cóndor	La Ensenada	Others
San Blas Bay	60.4	1.0	4.0	34.6	59.4	0.0	3.8	36.8
El Cóndor	18.7	12.5	12.5	56.3	23.5	11.8	0.0	64.7
La Ensenada	17.6	5.9	23.6	52.9	17.6	0.0	17.6	64.8

Table 3

Main target species, percentage of fishers who retain all the catch, and percentage of released by-catch.

	Main target species				Retain all the catch (%)			Released by-catch (%)
	Whitemouth croaker	Silverside	Weakfish	Others	Yes	No	Did not answer	
San Blas Bay	57.3	17.9	14.5	10.3	75.4	20.2	4.4	89.3
El Cóndor	50.0	22.2	5.6	22.2	88.2	5.9	5.9	87.5
La Ensenada	34.5	41.8	12.7	11.0	90.7	9.3	0.0	80.4

Most of the fishers wished to catch 1–10 fishes per day in SB (40%) and EC (60%). Fishers in LE would mostly like to catch 11–20 fishes (50%). However, no significant difference was observed among the sites ($H = 5.47$, $p = 0.06$) (Fig. 4). The percentage of fishers who wanted to catch more than the 40-fish limit imposed

by Buenos Aires Province legislation was 22% in SB, 3% in EC and 8% in LE. No significant correlation was observed between the optimal number of fishes caught per day and years of fishing experience ($\rho = 0.04$; $p = 0.55$) or in relation to distance travelled to each fishing site ($\rho = 0.07$; $p = 0.28$).

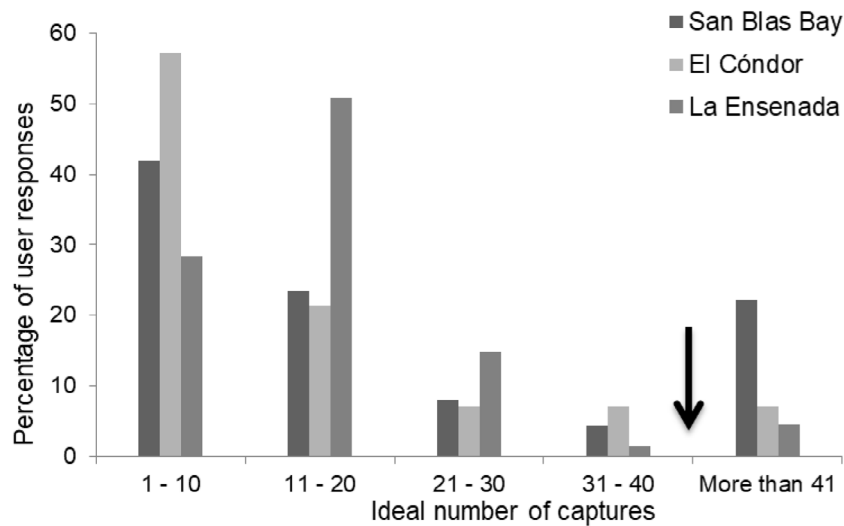


Fig. 4. Percentage of responses indicating the ideal number of fishes caught per fishing day by fishing site. The arrow indicates the catch limit imposed by Buenos Aires Province (40 fishes per day for each recreational fisher).

3.3. Fisher' perceptions and quality of fishing

Most of the visitors in all three fishing sites considered that the number of fish caught over time per fishing trip had decreased. A total of 77% of fishers in EC and 52% in SB considered that fish size had decreased in recent years, but 67% of LE fishers reported no change in fish size (Fig. 5).

Between 80 and 100% of interviewed fishers would be willing to accept the implementation of size limits, whereas 70 to 90% could accept restrictions on daily catch quotas (Table 4). Between 40 and 50% of fishers recognized the existence of threatened species, acknowledging chondrichthyans as the group with the greatest conservation risk (Table 5). No significant difference was observed among sites ($H = 2.18$, $p = 0.27$).

4. Discussion

This study analyses, for the first time, the characteristics, preferences and perceptions of fishers in three main recreational fisheries of northern Patagonia, and provides evidence of some important differences. Two of these sites, EC and LE, had no previous information about the activity or related socio-economic features. The results indicated that EC, due to its greater proximity to more populated cities (Viedma and Carmen de Patagones), presented greater frequency but shorter fishing trips (up to two days) than the other sites. Moreover, daily expenditure by EC fishers was the lowest, possibly because various tourist activities are combined within the site, fishing not being considered as the main one. In LE, although the number of trips per year was higher, they were of short duration; this is probably due to the lack of adequate infrastructure, which is reflected in the low expenditure per fishing trip. In this sense, Marta et al. (2001) and G mez Cabrera and Boncheva (2013) mentioned that fishers are more attracted and assign greater value to fishing sites with better infrastructure. San Blas was visited by the fishers only a few times a year, probably due to the greater distance to travel. This distance is reflected in higher travel expenditure, estimated as seven times higher than in EC and LE, and also in the duration of the fishing trip. This is consistent with behaviour observed in other fisheries where people are assumed to be travel cost-sensitive: a low number of visits resulted from high expenditure per fishing trip and distance to living sites (Grantham and Rudd, 2015; Ezebil, 2016).

Most of the fishers surveyed in the three fishing sites considered SB to be the fishery with the highest yield, which adds an additional incentive for selection of this fishing site. In this regard, Llompart et al. (2011) considered SB one of the most important fisheries in the South Atlantic due to its high catch per unit effort (CPUE), estimating 1.28 fish/angler/h, and representing a total annual harvest of 196 tons. Although the present study did not estimate CPUE, this variable may play a major role in determining the preference of recreational fishers (Beardmore et al., 2015). One of the main distinguishing features was the difference in target species. In SB and EC, the target species was the whitemouth croaker, in agreement with Llompart et al. (2011). However, LE fishers preferred silversides, and therefore can be considered a specialized fishery, where fishers give more value to the possibility of catching this species than having a local infrastructure (Salz et al., 2001; Beardmore et al., 2015). Differences in species preference are probably related to the fish assemblage at each fishing site, which is modulated by local habitat complexity based on substrate types, depth, currents, etc. (Brokovich et al., 2006; Ferrari et al., 2006). In general, fishers of SB and EC recognized a decreasing trend in both fish catch and size over the years, whereas in LE fishers mostly believed that while fish size had remained the same, the number of fishes caught had decreased. This may be because a variation in the length of silversides would not be easily perceived due to their small size, and fishers also have a particular interest in catching a higher number of fish rather than catching trophy sizes. It should be noted that at least four species of silverside, *O. argentinesis*, *O. platensis*, *O. smitti*, and *O. nigricans*, coexist on northern Patagonian coasts, which may not be easily distinguished by fishers. Some of these species have complex migration patterns (Carballo et al., 2012), and the status of their stocks is unknown.

Fishers expressed a high rate of acceptance for the application of regular management measures, based on minimum sizes and a daily quota. This may be related to their perception of the deterioration of fishing resources. Fishers living closer to the fishing site exhibit greater predisposition to participate in management (Camp et al., 2018). Only a low proportion of fishers would like to catch more than the quota of 40 fishes per day, as set by the Buenos Aires Province legislation, SB being the exception with 22%. This may be related to the higher travel costs that fishers face when visiting SB, due to distance and living expenses. However, differences in the optimum or ideal number of fish caught at each site are probably more influenced by the target species and their

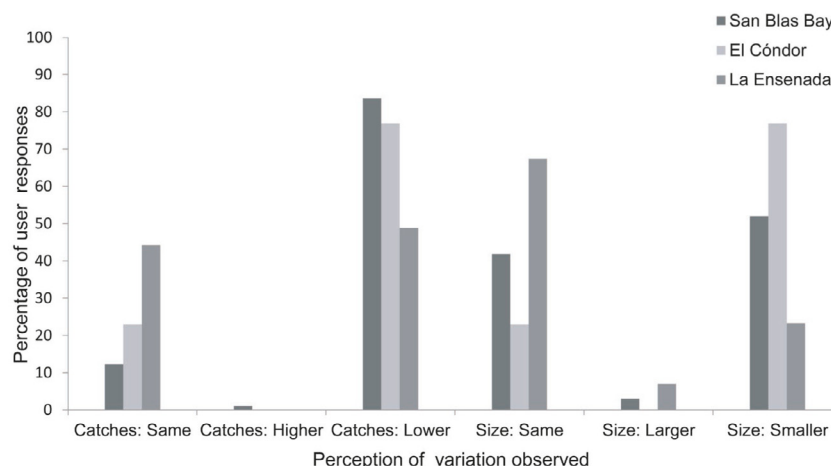


Fig. 5. Perception of recreational fisheries in relation to changes in fish catches (number) and size.

Table 4
Percentage of acceptance of minimum sizes and a daily catch quota by fishing site.

	Minimum size (%)			Daily catch quota (%)		
	Yes	No	Did not know/answer	Yes	No	Did not know/answer
San Blas Bay	92.8	4.1	3.1	89.2	10.8	0.0
El Cóndor	100.0	0.0	0.0	71.4	28.6	0.0
La Ensenada	82.1	17.9	0.0	86.5	13.5	0.0

Table 5
Percentage of fishers recognizing the presence of threatened species in the area, and percentage corresponding to Chondrichthyans.

	Do you know of any threatened species?			Which ones?	
	Yes	No	Did not answer	Chondrichthyans	Others
San Blas Bay	48.2	42.5	9.3	95.1	4.9
El Cóndor	40.0	40.0	20.0	66.7	33.3
La Ensenada	42.1	51.5	6.4	78.1	21.9

inherent biological characteristics. Whitemouth croaker is a much larger and heavier species than silverside, therefore the number that anglers accept or wish to catch can be quite different between species. This may explain why SB and EC fisheries differed to LE in this preference. The perceived decline in fish stocks may be related to the high fishing effort exerted by the commercial fisheries in the Rincón area, promoting the overexploitation of the weakfish stocks (Carozza and Fernández Aráoz, 2009; López Cazorla et al., 2014), and whitemouth croaker (Vasconcellos and Haimovici, 2006).

This study showed the importance of gathering information based on fishers' knowledge, a valuable source to complement scientific surveys (e.g., Neis et al., 1999; Leleu et al., 2011; Li et al., 2016). At present, few studies on marine recreational fisheries have provided information for management purposes in Patagonia (e.g. Cedrola et al., 2009; Llompарт et al., 2013; Barbini et al., 2015; Irigoyen and Trobbiani, 2016). When data on fisheries is scarce, as is the case of most of Patagonian recreational fisheries, the perception of fishers is often the only available source of information on historical population changes (Johannes et al., 2000; Cunha de Moraes, 2011). In this context, fishers revealed a high level of awareness of the existence of threatened species, recognizing the group of chondrichthyans as the most problematic for conservation purposes.

At least in Buenos Aires Province, perception of cartilaginous fishes problems can be associated with the high historical value of the catch of these species, and the subsequent prohibition of extraction and the mandatory release of large sharks such as

Carcharias taurus, *Carcharinus brachyurus*, *Notorynchus cepedianus* and *Galeorhinus galeus* (Lucifora, 2003). Rio Negro Province, on the other hand, has no legislation regarding the conservation of large sharks (Cedrola et al., 2011; Venerus and Cedrola, 2017), even though they are caught regularly along its coast. This could be a contrasting factor between provinces that enhances the importance of having or lacking regulations in the fisheries studied. Unlike other federal countries such as Brazil, where shark capture is regulated at a national level and the capture of several species is prohibited (Martins et al., 2018), each Argentinean province has their own regulations.

We conclude that the three fisheries present quite dissimilar features, based on their target species, infrastructure conditions and fishers' preferences. This is not surprising as fishers often exhibit diverse typologies, seeking different fishing experiences and fishing site features (Johnston et al., 2010; Fenichel et al., 2013). Also, distinctive attributes of the fishing sites can act as key factors in defining motivations, demands and preferences (Arlinghaus and Mehner, 2005, Hut and Bettoli, 2007). This information is important for the definition of management measures that accommodate fisher heterogeneity, maximizing benefits to fishers while at the same time preserving the resources (Dabrowska et al., 2017). The management of recreational Patagonian marine fisheries should therefore take not only regional characteristics into account but also local conditions, thus rejecting the one-size-fits-all approach (Arlinghaus et al., 2017; Carpenter et al., 2017).

Several studies have shown that the impact of recreational fishing on fish populations (Lewin et al., 2006) can be as significant as the impact of commercial fishing (e.g., Coleman et al., 2004; Arlinghaus et al., 2019). Assessment of recreational fisheries on a multi-dimensional basis is therefore essential. In addition to gathering catch and effort data, future efforts should be also oriented towards the understanding on how fishers perceive the fisheries in terms of preferences, motivations and demands. This information is critical for proposing regulations and management policies with the vision of preserving these fisheries as a valuable ecosystem service but without compromising the natural resources.

CRedit authorship contribution statement

C. Guidi: Investigation, Conceptualization, Methodology, Formal analysis, Writing - original draft, Visualization. **C.R.M. Baigún:** Conceptualization, Writing - original draft, Writing - review & editing, Supervision. **L.G. Ginter:** Conceptualization, Formal analysis, Investigation. **M. Soricetti:** Resources, Writing - review & editing. **F.J. Guardiola Rivas:** Formal analysis, Writing - review & editing. **S. Morawicki:** Resources, Writing - review & editing. **F. Quezada:** Resources, Writing - review & editing. **J.L. Bazzani:** Resources, Writing - review & editing. **P.J. Solimano:** Conceptualization, Methodology, Investigation, Writing - original draft, Supervision, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary material related to this article can be found online at <https://doi.org/10.1016/j.rsma.2021.101828>.

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