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Economic, social and ecological attributes of marine recreational fisheries in Galicia, Spain

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ABSTRACT

There are growing concerns about the impact of Marine Recreational Fishing (MRF) on marine ecosystems and its combined effects with other human activities, such as commercial fishing, especially on the higher trophic levels. Conversely, recreational fishers provide considerable economic benefits through their expenditure on many things including fishing tackle, boats, licenses, travel, and accommodation. However, research on MRF in Europe is limited, particularly in Southern countries. In Galicia (Northwest Spain) detailed information on MRF is still needed to support management and to reduce growing conflicts between recreational fishers and other stakeholders including the commercial fishing sector. This paper provides the first comprehensive analysis of MRF in Galicia including the economic, social, and ecological impacts, from a survey of 363 recreational fishers. It was estimated that there are 60 000 recreational fishers, comprised of 45 000 shore anglers, 12 000 boat anglers and 3000 spear fishers. Each year, they spend 86 €M on fishing gear and other expenses, while boat owners spend another 11 €M. Fishers' activity is higher in summer and spring, especially in the case of boat anglers. Recreational fishers reported catching 38 species, but the most common were ballan wrasse (*Labrus bergylta*), European seabass (*Dicentrarchus labrax*), and white seabream (*Diplodus sargus*). Annual recreational catch is about 7 500 t (5–13% of commercial and recreational landings of the same species); shore anglers are responsible for 50% of total MRF catches, boat anglers for 40%, and spear fishers for 10%. The results are discussed in the context of management that could improve the socio-ecological sustainability of MRF.

1. Introduction

Marine recreational fisheries have been defined as the activity aimed to the capture of aquatic resources mainly for leisure and / or personal consumption (ICES, 2013). Fishing to meet people's' dietary needs, or for commercial purposes is not usually considered Marine Recreational Fishing (MRF) (FAO, 2012). MRF is a very important pastime in most countries with a coastline, involving high numbers of participants and making a considerable economic contribution (FAO, 2012; Arlinghaus et al., 2014; Hyder et al., 2017b). In Europe, MRF is an activity with high socioeconomic importance, involving almost 9 million fishers and generating annually around 6 € billion in direct expenditures (Hyder et al., 2017b).

Although commercial fishing has been traditionally blamed for overfishing, there is a growing concern about the potential of MRF to impact on fisheries resources (Schroeder and Love, 2002; Cooke and Cowx, 2004). Estimates of global annual catch by recreational fishers may be as high as 47 billion fish, with two-thirds of those fish estimated to be released (Cooke and Cowx, 2006). In the European Union (EU), recreational catches of Atlantic cod *Gadus morhua* (Linnaeus, 1758), European seabass *Dicentrachus labrax* (Linnaeus, 1758), or seabreams (*Diplodus* spp.), are considerable in some areas and should be accounted for in the stock assessments to improve accuracy of the estimates (Veiga et al., 2010; ICES, 2011; Hyder et al., 2017a, b). In fact, the inclusion of

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recreational catch data where it exceeds 10% of commercial catches can considerably affect the assessment outcomes for a particular stock (Griffiths and Fay, 2015). Exclusion of MRF from stock assessment may affect the ability to manage fish stocks sustainably (Hyder et al., 2014, 2017a; b).

Recreational fishing is recognized as an economically important activity, generating jobs and high revenues (Lovell et al., 2013; Veiga, 2013; Hyder et al., 2017a, 2017b). In this sense, it can contribute to the EU 'Blue Growth' initiative that aims to provide policy-makers at European, regional, national, and local management levels with a comprehensive, robust and consistent analysis of possible future policy options to support smart, sustainable, and inclusive growth from the oceans, seas, and coasts (European Commission, 2012). The EU has developed basic indicators to assess the economic contribution and performance of fishing fleets (Scientific, Technical and Economic Committee for Fisheries, STECF, 2017), aquaculture (STEFC, 2015) and processing (STECF, 2013) sectors in Europe. These indicators are based on the current economic information collected under the Data Collection Framework (DCF) (European Commission, 2001).

The latest data needs for MRF in the DCF (European Commission, 2016) vary between regions and specify that annual estimates of catches and releases are required for Atlantic cod, European sea bass, European eel *Anguilla anguilla* (Linnaeus, 1758), Atlantic bluefin tuna *Thunnus thynnus* (Linnaeus, 1758), Atlantic salmon *Salmo salar* (Linnaeus, 1758), and all elasmobranchs. Despite of the increased effort in data collection in the EU, several studies emphasized the need for gathering and including information on MRF in fisheries management to ensure the sustainable use of common fishery resources (Rocklin et al., 2014; Kleiven et al., 2016; Lloret et al., 2016). Accurate data needed for assessment is generally lacking in Europe (ICES, 2011; Veiga, 2013; Veiga et al., 2013; Hyder et al., 2017a), which may impact on the ability to manage sustainably (ICES, 2017a, b). Both harvest related and socioeconomic information about MRF is still far from being complete for most regions, in particular for Southern countries (Hyder et al., 2017a, b; Pita et al., 2017).

The lack of knowledge about MRF is particularly problematic in Galicia because the region is highly dependent on marine ecosystem services, e.g., shellfisheries, industrial, small-scale and recreational fisheries, aquaculture and tourism (Villasante, 2012; Surís-Regueiro and Santiago, 2014; Villasante et al., 2016). Furthermore, the development of MRF (Pita and Freire, 2016), combined with the cumulative impacts of the aforementioned activities, is contributing to the increase of human pressures on Galician marine ecosystems, putting the sustainability and resilience of marine social-ecological systems at risk (Pita and Freire, 2014). In addition, factors such as poor governance (Freire and García-Allut, 2000), unsustainable patterns of exploitation of aquatic resources (Villasante, 2009), increases in the consumer population (MAGRAMA, 2016), growing demand from aquaculture (Villasante et al., 2013), and drivers such as recurrent oil spills (Monaco et al., 2017) and other extensive pollution (Beiras et al., 2003; Franco et al., 2006; Bellas et al., 2008), habitat degradation and destruction (Pita et al., 2008; Doldán-Garcia et al., 2011), and climate change (Bode et al., 2009; Otero et al., 2009) are accelerating the negative impacts of human activities on the Galician natural capital, ecosystem goods and services and related economies (Doldán García and Villasante, 2015). The effects of these confounding changes can be reduced through the development of measures that can adequately assess the health of complex socio-ecological systems, thereby allowing for their sustainable management and the continued availability of marine resources (Arlinghaus et al., 2016). Thus, achieving the 'Blue Growth' objective in Galicia involves monitoring the performance and sustainability of all marine activities (e.g., recreational, industrial and small-scale fisheries) relating to the use of aquatic resources.

Due to the absence of systematic data collection on MRF in Galicia, there is a need to better understand the contribution of the activity in the region (Pita and Freire, 2016; Pita et al., 2017). This paper provides the first comprehensive attempt to describe and analyze the economic, social, and ecological dimensions of MRF. The purpose of this study was to: 1) obtain baseline information on the economic, social and ecological contribution of MRF in Galicia; 2) estimate total marine recreational fishing MRF annual catch and effort by main MRF modes and for MRF overall; 3) analyze the overlap between MRF and commercial fishing in the area, in terms of commonly captured species and their respective volumes; and 4) provide recommendations for future management and monitoring of the activity in this region. To this end, a survey was conducted to collect and analyze key economic, social, and ecological information about MRF in Galicia. The main findings of this study are discussed in the context of future monitoring of MRF in Galicia, and recommendations for a sustainable and resilient management of MRF in the region are provided.

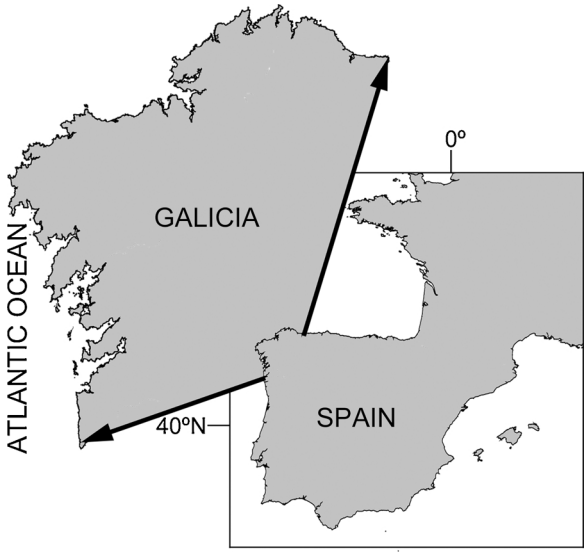

Fig. 1. Map of the study area.

2. Material and methods

2.1. Study area

Galicia in the Northwest of Spain (Fig. 1) is the main commercial fishing region in the country and one of the most important in the EU (Surís-Regueiro and Santiago, 2014; Villasante et al., 2016). The commercial fishing sector strongly contributes to the gross domestic product, with this region accounting for over 40% of the country's commercial fleet and for more than 60% of total employment in the fisheries related sectors. Furthermore, 50% of Spanish catches are landed in Galician ports (Villasante et al., 2016; Xunta de Galicia, 2017; STECF, 2015). Available information suggests that MRF is also relevant in Galicia, with 59,730 licenses to practice this activity issued in 2015 (Xunta de Galicia, *pers. comm.*).

2.2. Data collection

A complementary web-based and onsite survey was conducted between February 2015 and August 2017 to collect key economic, social, and ecological information about MRF in Galicia. In the surveys, fishers were asked to complete a structured questionnaire (the questionnaire is provided in the Supplementary Information, Annex I), which included questions about MRF related expenditures, gears used, seasonal fishing cycle, fishing effort and catches, targeted species, and other aspects that could influence activity including the socio-economic characteristics of fishers. To prevent temporal trends in the responses the fishers were asked to provide averages in their responses for the last 5 years. The

questionnaire was made available online and publicized through social media and the web portals of the scientific institutions involved in this study. In addition, the survey was done in collaboration with fishing clubs and the main associations of recreational fishers in Galicia: FEDPEMAR (Galician Federation of Responsible Maritime and Recreational Fishing), with about 13,000 associates that fish mainly from boats, and FEGAS (Galician Federation of Subaquatic Activities) comprised of around 3 000 spear fishers.

The online survey was assumed to be accessible to most of the MRF population, given that in Galicia 71% of households have internet access and 63% of them have a computer (IGE, 2017). However, in order to maximize coverage, the questionnaire was also administered during onsite interviews performed by researchers and collaborators from the fishers' associations and clubs. Both for the web-based and onsite interviews, a brief introduction was included describing the main goals, expected outcomes, and how to complete the questionnaire. For the onsite interviews, survey respondents were selected following a snowball model (Goodman, 1961), starting with a small group of initial informants (identified by representatives of the fishers' associations involved), and expanding through their contacts and social networks. Moreover, the results of this study have been based in the number of responses obtained for each of the questions (the number of answers is available in the Supplementary Information, Annex I, and in the captions of tables and figures).

2.3. Number of recreational fishers

In Galicia recreational fishers are required by law to own a fishing license, plus a federative license in the case of spear fishers (Xunta de Galicia, 2009). In 2015, a total of 59 730 fishing licenses were issued: 56 767 licenses for surface fishing (which allow hook and line fishing from the shore and boats); and 2 963 licenses for spear fishing (Xunta de Galicia, *pers. comm.*).

The current license system does not distinguish between boat and shore anglers (grouped under surface fishing licenses). Therefore, the ratio between surface licenses and the number of boats engaged in recreational fishing (13:1) that is available for the Basque Country (Ruiz et al., 2014), another northern Spanish region that share the same license system, was used to estimate the number of boats involved in MRF in Galicia. Mean crew on board recreational boats, obtained from the questionnaires, was used to estimate the number of boat anglers operating in Galicia.

2.4. Avidity bias correction

The results of a survey are likely to be biased when the sample is self-selecting and is unlikely to be representative of the whole population of fishers, e.g. differences in the avidity, platforms fished, ages, etc. (Armstrong et al., 2013; Teixeira et al., 2016; Bellanger and Levrel, 2017). The keenest and most active fishers are more likely to complete the survey, so the sample will not be representative of the general population of fishers. In addition, it is expected that in Galicia the results will vary significantly depending on the gear used (angling or spear fishing) and access platform (from boats or from the shore) (Pita et al., 2017). In this study bias was addressed by post-stratification of the survey data by avidity, gear, and platform, and using information from a survey of license holders in the Basque Region (Ruiz et al., 2014) to account for differences when raising to the population of fishers. Following Armstrong et al. (2013), four categories for access frequency were considered for each gear: inactive (0 days per year fishing), occasional (1–10 days per year fishing), regular (11–40 days per year fishing), and frequent (more than 41 days per year fishing). Average economic, social, and ecological results obtained for each of the strata (a combination of gear type, access platform and access frequency) were grossed up to the total population of each group by using the information about access frequency that was available in the Basque Country for the same strata, i.e., boat anglers, shore anglers, and spear fishers (Ruiz et al., 2014). Furthermore, for catch and fishing effort estimates, seasonal data provided by the fishers in the survey were also considered in the calculations. Although spear fishers often access water from the shore, they can also operate from boats; however, since their relative proportions are unknown, only data from rod and line anglers were used to obtain estimates for total population of boat recreational fishers.

Table 1
Fishing gears and access type reported by recreational fishers (N = 363). Rod and line anglers could have selected more than one gear.

Access	Gear		
	Spear fishing (N)	Handline fishing (N)	Rod and line fishing (N)
Shore	26	2	163
Boat	33	59	101

3. Results

3.1. Interviews answered by recreational fishers and total population

In this study, 363 interviews were performed, 236 online and 127 on site. Most of the interviews were answered by shore angling (46% of total), followed by boat angling (44%) and spear fishing (16%) (Table 1).

Based on the information of licenses and boats engaged in recreational fishing in the Basque Country (Ruiz et al., 2014), it was calculated that in 2015 there were 4 315 boats involved in recreational fishing in Galicia. Since the mean number of people on each boat reported in the questionnaires was 2.8 anglers (95% confidence interval, $CI_{95\%}$ = 2.6–3.0 anglers), it was estimated that there were 12 031 anglers operating from boats (20.1% of total licenses) and 44 736 shore anglers (75%). Based on the numbers of licenses, it was estimated that 2% of Galician spear fishers, 1% of boat anglers and 0.4% of shore anglers, respectively, were covered by our study.

3.2. Economic features of marine recreational fisheries

3.2.1. Fishers' expenses on the activity

Mean total individual annual expenses reported by the fishers in the questionnaires were 1 637 € ($CI_{95\%}$ = 1 595-1 871€) (Fig. 2). Fishers declared that they spend most of their annual budget on travels (654 €, $CI_{95\%}$ = 520–777 €) and fishing gears (518 €, $CI_{95\%}$ = 442–587 €), followed by baits (256 €, $CI_{95\%}$ = 215–291 €), and fishing clothes (186 €, $CI_{95\%}$ = 156–212 €) (Fig. 2).

After correcting estimates for avidity bias, in 2015 total annual expenses spent by all marine recreational fishers in Galicia combined was estimated at 85.6 €M ($CI_{95\%}$ = 54.9–112.3 €M). Shore anglers were responsible of 74% of total expenses, boat anglers of 20% and spear fishers of 6%.

3.2.2. Fishers' expenses on recreational boats

For fishers that reported owning a recreational fishing boat, the average length was 5.6 m ($CI_{95\%}$ = 5.4–5.7 m) and they were equipped with an average engine of 60.3 HP ($CI_{95\%}$ = 53.5–64.6 HP). These fishers reported that they spent 15 474 € ($CI_{95\%}$ = 12 644–18 026 €) to buy their boats (Fig. 3), mostly in the second-hand market (61% of total). Moreover, the mean annual boat related expenses were 2 902 € ($CI_{95\%}$ = 2 233–3 502 €) per boat, mostly destined to cover fuel expenses (991 €, $CI_{95\%}$ = 779–1 179 €), maintenance costs (870 €, $CI_{95\%}$ = 699–1 018 €) and mooring (819 €, $CI_{95\%}$ = 700–936 €) (Fig. 3).

After correcting avidity bias, total annual spent (in 2015) in the operation and maintenance of the 4 315 boats involved in MRF in

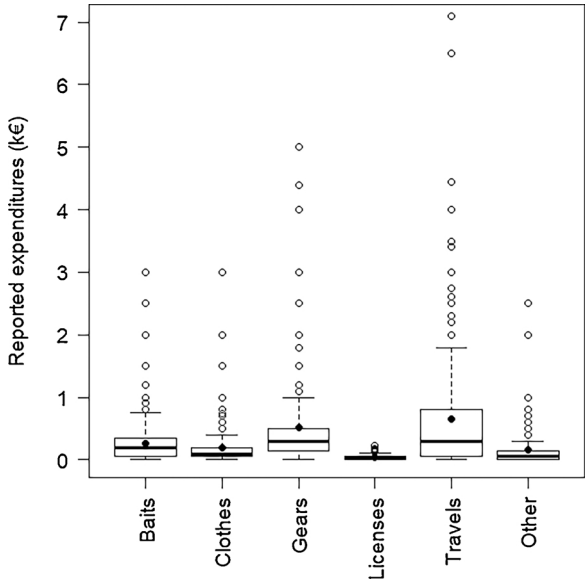

Fig. 2. Annual expenditure reported by recreational fishers (N = 284). Annual spend per fisher on baits, clothes, gears, licenses, travels, and other expenses. The top and bottom of the boxes correspond to the first and third quartiles of the data, the whiskers extend to 1.5 times the interquartile range, the median is indicated with a thick horizontal line, and the mean with a black dot.

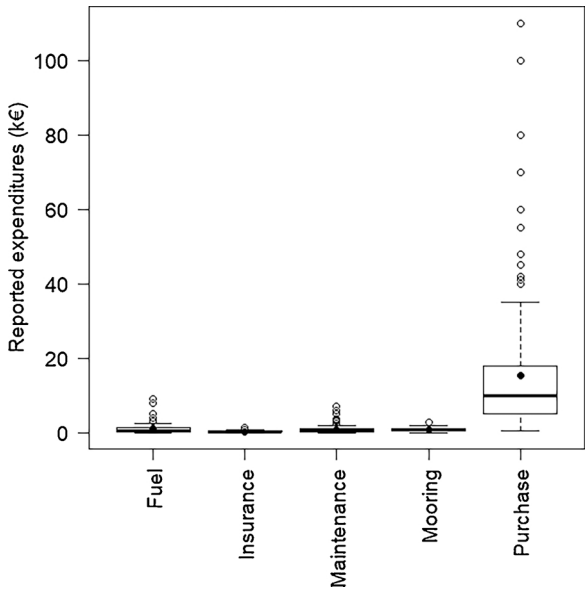

Fig. 3. Annual expenditure on boats reported by recreational fishers (N = 132). Annual spend per fisher on boat fuel, insurance and permits, maintenance, mooring, and purchase are shown. The top and bottom of the boxes correspond to the first and third quartiles of the data, the whiskers extend to 1.5 times the interquartile range, the median is indicated with a thick horizontal line, and the mean with a black dot.

Galicia was estimated at 10.6 €M ($CI_{95\%}$ = 5.8–13.0 €M).

3.3. Social features of marine recreational fisheries

3.3.1. Demography

The mean age of interviewed fishers was 45.5 years ($CI_{95\%}$ = 44.0–46.9 years) (Fig. 4a). The majority of fishers were men (99%), married (68%) and lived in households with 3.2 ± 1.1 family members (Fig. 4b and c). Most of the them (82%) have finished high school or a higher education level, of which 33% obtained a university degree (Fig. 4d).

After avidity bias was corrected, it was estimated that mean age was highest for boat anglers (53.2 years, $CI_{95\%}$ = 51.9–55.7 years), followed by shore anglers (49.7 years, $CI_{95\%}$ = 47.6–50.3 years), and spear fishers (37.2 years, $CI_{95\%}$ = 35.5–38.8 years). In contrast, shore anglers showed the highest fishing experience (31.6 years, $CI_{95\%}$ = 30.3–33.0 years), followed by boat anglers (30.0 years, $CI_{95\%}$ = 28.4–31.6 years) and by spear fishers (21.5 years, $CI_{95\%}$ = 19.8–23.1 years).

3.3.2. Fishing habits

Fishers were asked to report if they fish alone, with family members, or with friends (respondents were allowed to select more than one option). Most (75%) usually fish with friends, while 41% reported that they fish alone and 17% with family members. After avidity bias was corrected, fishing with friends was the main choice for spear fishers, boat anglers, and shore anglers (71%, 69%, and 50%, respectively). Notably, up to 44% of spear fishers reported that they sometimes fish alone, while only 35% of boat anglers and 34% of shore anglers.

In relation to hazards associated to the fishing activity, 12% of fishers reported that they already suffered an accident while fishing, for which 1% needed medical care. After avidity bias was corrected, the most dangerous activity was spear fishing (54% of spear fishers were injured, with 22% of the accidents needing medical care), followed by boat fishers (14% accidents with 4% in need of medical care) and by shore anglers (13% accidents, 4% in need of medical care).

3.3.3. Satisfaction with fishing associations and fishing regulations

Fishers' satisfaction with their fishing associations did not show a clear pattern, with approximately half of the fishers (49%) reporting that they feel satisfied or very satisfied (Table 2). The most satisfied fishers, after avidity was corrected, were spear fishers, as most of them felt satisfied or very satisfied (58%); while only 29% of the shore anglers were satisfied or very satisfied with their fishing associations (Table 2).

Of those who answered this question, the large majority of fishers reported feeling unsatisfied with the current fishing regulations (87%; Table 2). Boat anglers were the most dissatisfied, followed by spear fishers and shore anglers (Table 2). When asked about what changes should be made to the current regulations, fishers were mainly unsatisfied with current temporal and spatial restrictions (36%) (see Supplementary Information, Table SI1). Many fishers reported that some of the current regulations are too harsh for MRF or hard to understand (18%). Some of the fishers also reported that the bag limits on some species should be changed (18%), and that there should be an increase in control and enforcement of illegal activities, both for recreational (18%) and for commercial fishers (14%) (Table SI1).

3.3.4. Other recreational activities

Fishers reported that they also practiced up to 11 other recreational activities, with swimming at the beach reported as the preferred activity (14%) (Fig. 5a). Moreover, their reported mean annual expenses in other recreational activities was 953 € ($CI_{95\%}$ = 696–1 180 €) (Fig. 5b). After correcting avidity bias, total annual spent in other recreational activities was estimated in 38.5 €M ($CI_{95\%}$ = 15.8–56.1 €M).

3.4. Ecological features of marine recreational fisheries

3.4.1. Seasonal fishing cycle

Most fishers indicated that they usually fish during the summer (87% of total), spring (79%) and autumn (77%), while slightly more than half of them reported that they keep fishing throughout winter time (57%). After avidity bias was corrected, boat anglers, shore anglers and spear fishers showed a preference for summer (80%, 66% and 84%, respectively) and spring (71%, 64% and 77%) than for autumn (60%, 47% and 74%) and winter (39%, 56% and 66%) (Fig. 6).

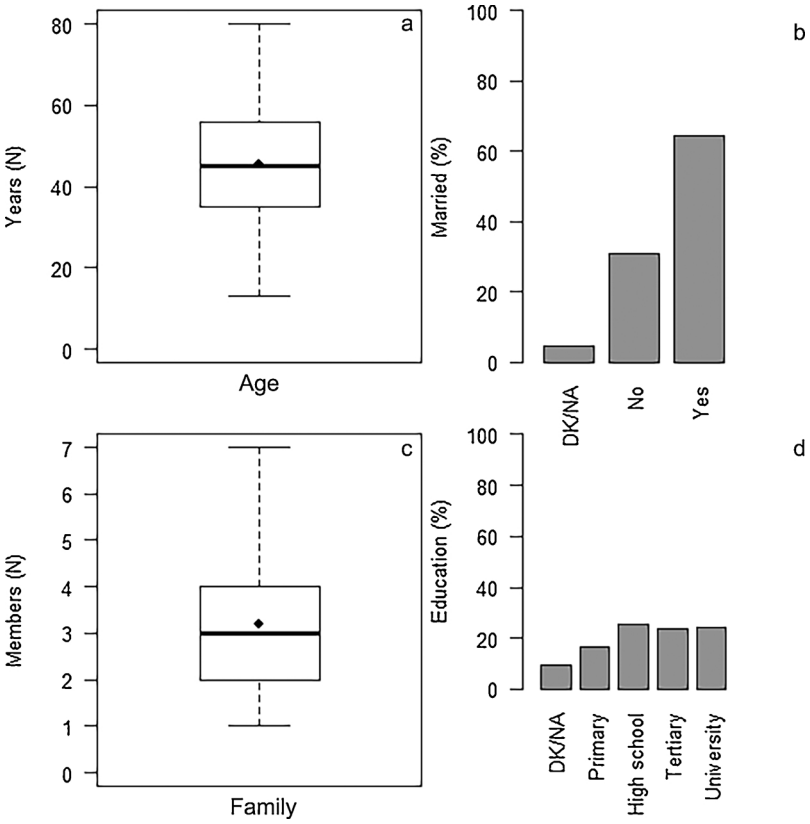

Fig. 4. Social characteristics of recreational fishers (N = 329). Age (a), civil status (b), number of family members (c), and education level (d) are shown. For a and c, the top and bottom of the boxes correspond to the first and third quartiles of the data, the whiskers extend to 1.5 times the interquartile range, the median is indicated with a horizontal line, and the mean with a black dot (DK/NA = don't know/no answer).

Table 2
Degree of satisfaction reported by recreational fishers with respect to their fishing association (fishers selected among four categories, from very dissatisfied to very satisfied) (N = 335), and to current fishing regulations (fishers selected among two categories, dissatisfied or satisfied) (N = 288). Avidity bias was corrected in the results by fishing gear.

Degree of satisfaction	Gear			
	All	Boat anglers (%)	Shore anglers (%)	Spear fishers (%)
With fishing associations				
Very dissatisfied	32.2	19.1	49.3	10.0
Dissatisfied	18.5	37.0	21.3	32.0
Satisfied	29.9	21.0	10.2	6.4
Very satisfied	19.4	22.9	19.2	51.6
With fishing regulations				
Dissatisfied	86.8	83.5	64.5	77.8

3.4.2. Bait used

Anglers reported that they used 1.8 hooks ($CI_{95\%}$ = 1.7–1.9 hooks) per line and fishing day; once avidity was corrected, it was estimated that boat anglers used 2.0 hooks ($CI_{95\%}$ = 1.9–2.1 hooks) per line, while shore anglers used 1.6 hooks ($CI_{95\%}$ = 1.5–1.6 hooks) per line. Moreover, anglers indicated that they use up to 17 different baits, with a clear preference for artificial baits (used by 83% of anglers), and worms (65%) (Table 3).

3.4.3. Species caught

Shore anglers reported that they caught up to 30 of the 38 species of fish and cephalopods harvested by all fishing modes, with boat anglers catching 23 and spear fishers 18 (Fig. 7). The most captured species was European seabass which accounted for 35% ($CI_{95\%}$ = 30–39%) of the fishers' reported catches, followed by white seabream *Diplodus sargus* (Linnaeus, 1758), 19% ($CI_{95\%}$ = 17–22%), and ballan wrasse *Labrus bergylta* (Ascanius, 1767), 14% ($CI_{95\%}$ = 11–17) (Fig. 7).

After avidity bias was corrected, the European seabass was the most caught species for shore anglers (33%, $CI_{95\%}$ = 31–40%, of the reported catches) and boat anglers (24%, $CI_{95\%}$ = 17–28%), while it was relatively important for spear fishers (21%, $CI_{95\%}$ = 17–26%) (Table SI2). The main species for spear fishers was white seabream (34%, $CI_{95\%}$ = 30–38%) and was also important for shore anglers (22%, $CI_{95\%}$ = 18–23%) (Table SI2). Ballan wrasse was also a relevant species for spear fishers (33%, $CI_{95\%}$ = 27–39%) and shore anglers (15%, $CI_{95\%}$ = 11–16%), while Atlantic mackerel *Scomber scombrus* (Linnaeus, 1758) (15%, $CI_{95\%}$ = 9–22%), and pouting *Trisopterus luscus* (Linnaeus, 1758) (13%, $CI_{95\%}$ = 10–17%) were important for boat anglers (Table SI2).

3.4.4. Catch and fishing effort

Fishers were asked to identify the most relevant environmental factors affecting fish abundance and frequency of species in their catches. The type of substrate of the seabed was considered as highly relevant by 61% of the informants who answered the question, followed by the moon phase (59%), the currents (50%) and sea temperature (48%) (Fig. 8).

In terms of seasonality of fishing effort, the reported number of fishing hours and catches per day were, in general, higher in the summer and shorter in the winter (Table 4). Also, since catches reported by fishing day followed a similar pattern, catches by season, estimated by the product between catches by day and days per month, were in general higher in summer and lower in winter (Table 4). Thus, by adding the seasonal catches, mean annual catch was estimated at 183 kg ($CI_{95\%}$ = 160–205 kg) per fisher. Estimated mean annual catch of spear fishers (244 kg, $CI_{95\%}$ = 196–287 kg, per spear fisher) was higher than catches reported by boat anglers (239 kg, $CI_{95\%}$ = 195–279 kg, per angler) and by shore anglers (98 kg, $CI_{95\%}$ = 77–118 kg, per angler).

Using the estimated number of recreational fishers by fishing gear

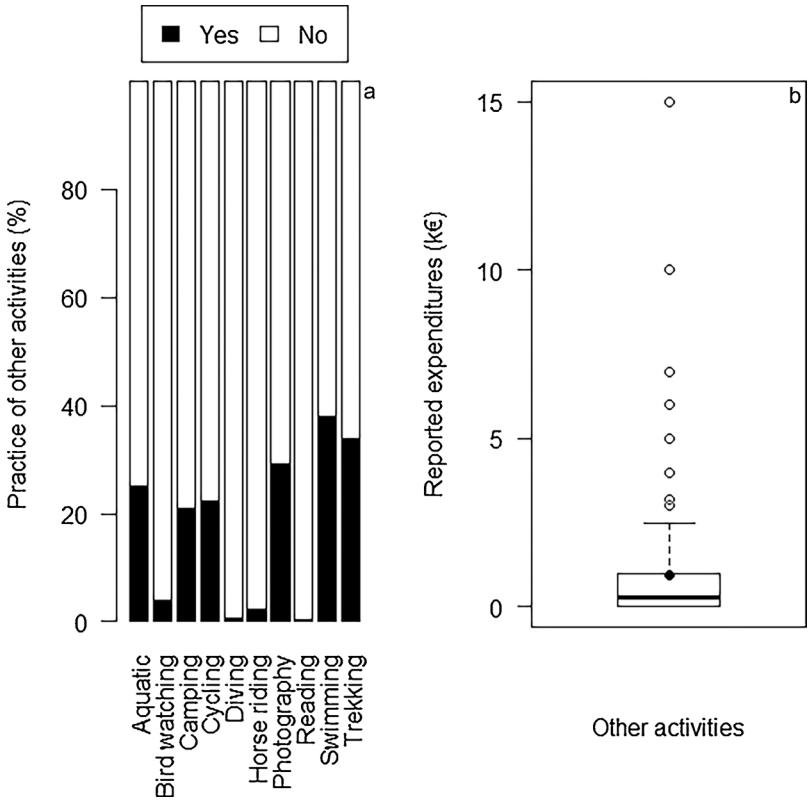

Fig. 5. Other recreational activities practiced by interviewed recreational fishers (N = 268). Percentage of practicing and non-practicing informants (a), and annual expenses per fisher in the activities (b) are shown. For b, the top and bottom of the boxes correspond to the first and third quartiles of the data, the whiskers extend to 1.5 times the interquartile range, the median is indicated with a horizontal line, and the mean with a black dot.

and the total annual catch by fisher (avidity was previously corrected), it was estimated that in 2015 recreational catches in Galicia were 7 683 t ($CI_{95\%}$ = 5 705–9 309 t), boat anglers were responsible by 39% of total catches (2 979 t; $CI_{95\%}$ = 2 415–3525 t), shore anglers by 51% (3 828 t; $CI_{95\%}$ = 2 755–4 847 t), and spear fishers by 10% (758 t; $CI_{95\%}$ = 536–938 t).

4. Discussion

Despite the recent efforts in collecting national estimates of MRF across Europe (ICES, 2011; Hyder et al., 2017b; ICES, 2017c), information at a smaller scale is still needed to better understand local economic contribution, impacts in coastal resources, and to assess

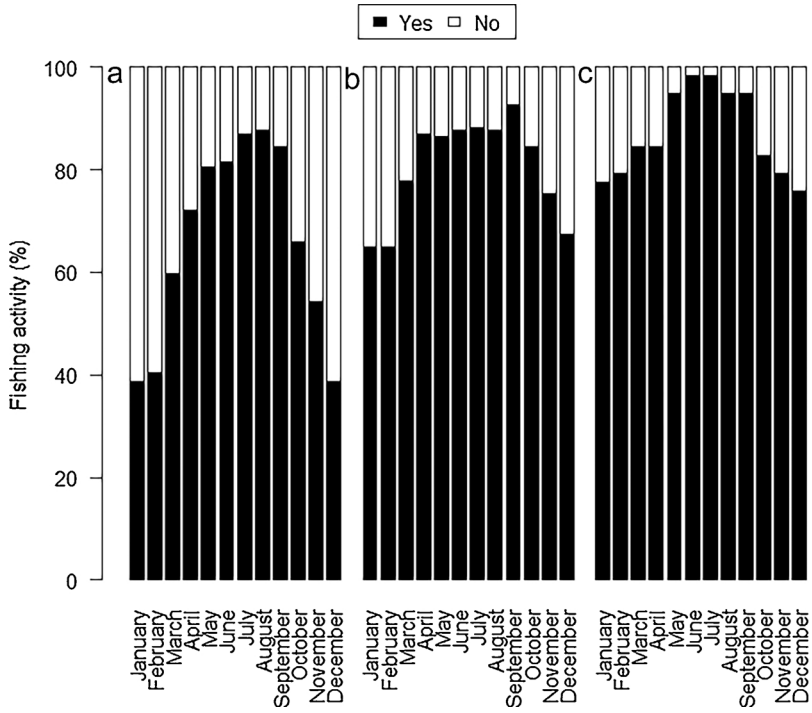

Fig. 6. Annual fishing cycle of recreational fishers after avidity bias was corrected (N = 357). Percent of active boat anglers (a), shore anglers (b), and spear fishers (c) is shown.

Table 3
Used fishing baits reported by recreational anglers (N = 213). Percent of fishers using each bait by fishing gear is shown.

Bait	Gear	
	Boat anglers (%)	Shore anglers (%)
Artificial	26.92	55.97
Atlantic mackerel	0.00	1.49
Chicken	0.00	1.49
Crabs	2.56	3.73
Fish	0.00	1.49
Korean worm	5.13	5.22
Mussel	7.69	2.99
Octopus	1.28	2.24
Peanut worm	0.00	0.75
Pilchard	26.92	2.24
Polychaeta	25.64	16.42
Prawn	7.69	5.22
Razor clam	5.13	8.96
Sand worm	2.56	4.48
Shrimp	12.82	5.22
Squid	15.38	2.24
Tube worm	0.00	4.48

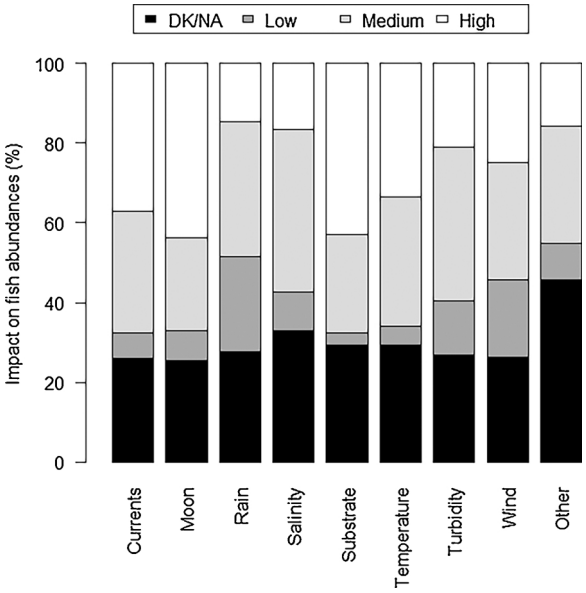

Fig. 8. Relevance of environmental factors affecting fish abundance and frequency of species reported by recreational fishers (N = 363). Percent of answers for each category (low, medium and high) given by the fishers are shown (DK/NA = don't know/no answer).

effectiveness of current management regulations (Pita et al., 2017). Regional information is particularly important for countries like Spain, where most MRF regulations and management measures are issued and enforced at the regional level (Macho et al., 2013). The present study obtained for the first time estimates on the participation, human dimensions, catches and expenditures of marine recreational fishers in Galicia. This study showed that MRF is an important leisure activity in the region, with approximately 60 000 recreational fishers with a fishing license, that annually spend almost 100 €M in the activity and catch more than 7 500 t of fish.

4.1. Economic, social and ecological relevance of MRF in Galicia

Annual expenditure made by recreational fishers in Galicia (96 €M) is logically smaller than the 1.2 € billion spent by 884 000 fishers operating in England (Roberts et al., 2017), but is comparable, e.g., to expenses made by Finnish (105 €M) or even German fishers (118 €M) (Hyder et al., 2017b). Indeed, expenses made by Galician recreational fishers represent 0.2% of Gross Domestic Product (GDP) of Galicia (56 309 €M in 2015) (IGE, 2017). Moreover, although the economic contribution of MRF was found to be higher in other regions of Spain, e.g., in Majorca Island it reaches 1% of GPD (Morales-Nin et al., 2015), this activity is relatively important because Galicia is one of the regions of Europe that is most dependent on fishery resources (Villasante, 2012). Indeed, to highlight the relevance of Galician MRF, sales of landings of the powerful Galician commercial fleet reached 460 €M in 2015 (Xunta de Galicia, 2017), which represents 0.8% of GDP (IGE, 2017). Moreover, recreational fishers fulfill their "need for nature" (Walsh et al., 1989; Inglehart, 1990; Manfredo et al., 1996) by practicing other outdoor leisure activities. The demand of intermediate inputs by recreational fishers from other branches of the Galician economy to develop these other leisure activities contribute with other 39 €M (Fig. 5). Due

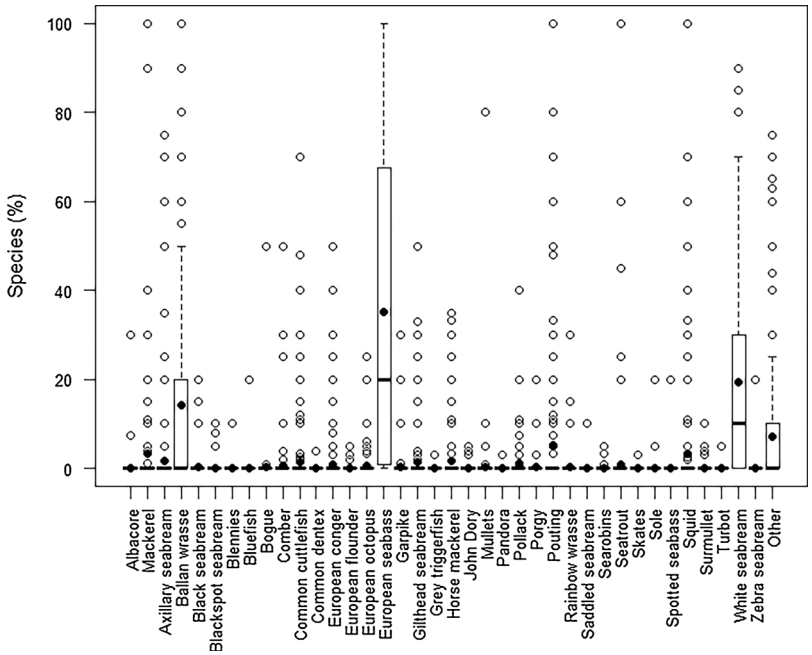

Fig. 7. Reported catch composition of recreational fishers (N = 251). Percent of total catches by species is shown. The top and bottom of the boxes correspond to the first and third quartiles of the data, the whiskers extend to 1.5 times the interquartile range, the median is indicated with a thick horizontal line, and the mean with a black dot.

Table 4
Mean number of hours and catch per day, fishing days per month and total catch per season (and 95% confidence interval), estimated from data reported by the fishers (N = 294). Avidity bias was corrected in the results by gear.

Season	Gear	Hours per day (N)	Days per month (N)	Catch per day (kg)	Catch per season (kg)
Spring	All	4.43 (4.23–4.62)	7.06 (6.42–7.67)	2.15 (1.98–2.31)	49.79 (42.68–56.36)
	Boat anglers	4.35 (4.06–4.65)	6.98 (5.88–7.99)	2.45 (2.19–2.70)	59.57 (45.82–71.99)
	Shore anglers	4.64 (4.27–4.98)	7.48 (6.45–8.43)	1.23 (1.07–1.39)	30.92 (23.25–37.85)
	Spear fishers	4.05 (3.73–4.36)	6.55 (5.17–7.77)	3.47 (3.10–3.84)	71.95 (54.82–87.44)
Summer	All	5.62 (5.30–5.93)	6.82 (6.24–7.38)	2.45 (2.24–2.65)	59.78 (51.12–67.70)
	Boat anglers	5.24 (4.83–5.64)	9.06 (7.90–10.16)	2.85 (2.50–3.17)	88.16 (71.42–103.61)
	Shore anglers	5.70 (5.17–6.22)	5.08 (4.40–5.67)	1.36 (1.15–1.56)	23.62 (17.06–29.15)
	Spear fishers	6.54 (5.53–7.48)	5.86 (4.97–6.62)	4.0 (3.61–4.38)	75.53 (56.94–90.59)
Autumn	All	4.81 (4.52–5.08)	5.14 (4.67–5.59)	2.24 (2.06–2.41)	38.70 (32.80–43.84)
	Boat anglers	4.41 (4.04–4.77)	6.07 (5.16–6.91)	2.48 (2.21–2.75)	52.08 (39.85–62.44)
	Shore anglers	5.30 (4.82–5.77)	4.55 (3.85–5.17)	1.35 (1.17–1.52)	19.24 (14.80–23.29)
	Spear fishers	4.61 (3.95–5.23)	4.52 (3.84–5.11)	3.69 (3.34–4.05)	52.72 (40.92–62.55)
Winter	All	3.02 (2.75–3.30)	4.62 (4.02–5.19)	1.64 (1.45–1.82)	29.96 (23.41–35.71)
	Boat anglers	2.60 (2.15–3.03)	4.14 (3.01–5.20)	1.60 (1.27–1.92)	34.89 (20.13–46.84)
	Shore anglers	3.53 (3.08–3.98)	5.81 (4.87–6.69)	1.08 (0.87–1.29)	23.74 (16.40–30.16)
	Spear fishers	3.27 (2.78–3.73)	3.53 (2.81–4.16)	3.14 (2.73–3.53)	36.85 (27.25–45.14)

to the economic contribution of MRF, careful management decisions are needed to ensure growth and sustainable development of the activity in Galicia, and in other European regions. In this sense, the inclusion of MRF in the EU 'Blue Growth' initiative could be beneficial to achieving these objectives.

Participation rate (percent of recreational fishers to total population) in Galicia (2.2% in 2015) is higher than the average participation in the Atlantic coast of Spain (0.7%) and in Portugal (1.7%) (Hyder et al., 2017b). In fact, it is higher than the average participation across European Atlantic countries (1.7%), and similar to participation rates of relatively close countries like France, or Ireland (2.1%) (Hyder et al., 2017b). This relatively high participation rate in Galicia could be related to the key role of fishing in Galician coastal culture and traditions (Cornide, 1788; Franquesa, 2005; Taboada, 2007), and to the high number of retired commercial fishers participating in MRF (Pita et al., 2017). Moreover, since industrialization-induced social changes were found to be negatively related with participation in MRF (Arlinghaus et al., 2014), the high participation in Galicia could also be explained because Galicia is among the least industrialized regions in Europe (Rodriguez-Pose, 2000; Doldán García and Villasante, 2015).

In additional to the economic and social importance of MRF in Galicia, results from this study also suggest that the activity can contribute significantly to the total catches of particular coastal species. In 2015, the commercial landings of 94 species of fish and cephalopods potentially shared with recreational fishers (coastal species) were 138 926 t, while landings of species actually caught by recreational fishes (identified in this study, see Table SI2) were 52 952 t (Xunta de Galicia, 2017). Thus, estimated total catches of recreational fishers in 2015 (7 683 t) potentially represented between 5%–13% of the total catches of coastal species. The share of total recreational catches with respect to total catch is lower than recreational fisheries in the Mediterranean Sea (that ranges from 10% up to 50%) (Font and Lloret, 2014; Morales-Nin et al., 2015), but is consistent with studies in other regions of the North East Atlantic (from 1% to 12%) (Rangel and Erzini, 2007; Veiga et al., 2010; Diogo and Pereira, 2014). The greater specific weight of the artisanal fleet in the Spanish Atlantic compared to that in the Spanish Mediterranean could explain these differences (Lloret et al., 2016; Pita et al., 2017).

4.2. Validity and confidence on the study results

4.2.1. Representativeness and bias

Collecting data and obtaining accurate information on recreational fishing is difficult because of the large number of fishers involved, which leads to sampling a small part of the population (National Research Council, 2006). Onsite sampling methods are often expensive, especially in the case of MRF, because fishers are usually dispersed over large areas (e.g., Mitchell et al., 2008; Smallwood et al., 2011). Conversely, online surveys are faster and cheaper, but there is a greater risk that these are affected by bias (Zarauz et al., 2015). In this study, the questionnaire was answered by a moderate proportion of Galician recreational fishers, ranging from 0.4% of the estimated shore anglers to 2.0% of the spear fishers. It was assumed that most of the recreational fishers of Galicia have had the opportunity to access the online questionnaire, since in most households there is internet access (71%) and computers (63%) (IGE, 2017). However, onsite interviews were also performed to increase the response rate of those fishers with lower computer literacy, or lacking internet access. Several efforts were made to publicize this study throughout the Galician RMF community, but it is likely that some fishers were not aware of it. In particular, the lack of strong associations of shore anglers in Galicia (Pita et al., 2017) could be related to the lower response rate of fishers using this gear. Thus, the results obtained for shore anglers might present a higher degree of uncertainty. Furthermore, it could be argued that the survey is biased towards fishers belonging to clubs or associations, thus lacking representativeness with respect to the total population. However, all Galician spearfishers and most of boat anglers belong to the fisher's associations that helped in the dissemination of the survey (FEGAS and FEDPEMAR, respectively, see Material and Methods section). Conversely, the lack of strong shore angler associations and clubs meant that they did not collaborate in the dissemination of the survey, so that the shore anglers were only made aware of the study through social media and web portals, or by information provided by other fishers. In any case, although it would be appropriate in the future to analyze the differences between club fishers and the general population of recreational fishers, e.g., by using creel surveys, either because of the strong membership of associations and clubs in the case of spear fishers and boat anglers, or because of its lack in the case of shore anglers, we assume that the survey is representative of marine recreational fishers of Galicia.

Moreover, the real number of recreational fishers in the region is likely higher because Galicia is a relatively important tourist destination in Spain (Cortés-Jiménez, 2008), and MRF licenses issued in other regions of Spain are also valid in Galicia (Pita et al., 2017). Consequently, catches and economic contribution could be higher than found in this study. In addition, the number of boats, and subsequently the number of boat and shore anglers have been estimated in this study by using the proportion between the number of boats and recreational licenses in the Basque Country (1:13). Although it is not possible to confirm that the number of boats (4315) and the distribution of the relative proportions calculated for the two types of anglers are correct (12031 boat anglers and 44,736 shore anglers) due to deficient regional

license systems (Pita et al., 2017), the number of boats is similar to figures reported in other studies in Galicia (Palas et al., 2017). Furthermore, the same pattern is observed in neighboring countries like Portugal where shore anglers represent more than two thirds of the total MRF licenses (DGRM, 2017).

Avidity is a particularly important bias that has been corrected in this study by post-stratifying by activity levels and correcting for differences between the sample and population when raising estimates. Combinations of gear type and frequency of recreational fishers in the Basque Country were used as a reference (Ruiz et al., 2014). In comparison with reference strata, regular fishers were overrepresented (between 0.59 and 0.66-fold), while occasional and frequent fishers were underrepresented (1.82–3.30-fold). The method used here aimed to correct avidity bias through reweighting the results obtained, it is likely that the results from this study are representative of MRF in Galicia.

4.2.2. Recall bias

Fishers tend to overestimate their effort and catch with longer recall periods than some months (Hiett and Worrall, 1977; Pollock et al., 1994). Moreover, recall bias has also been found to be influenced by factors such as the frequency of participation (Thompson and Hubert, 1990). It is likely that due to the off-site nature of this study, the results and estimates about catches have been affected to some extent by the fishers' recall bias.

4.2.3. Non-response bias

Non-response bias can affect survey results when a group of individuals refuses to participate in the survey, or do not answer certain questions, so the results are not representative (Fisher, 1996). Although regular fishers tended to be overrepresented in the survey performed in this study (as opposed to occasional and frequent fishers), no trends were detected in their answers. Therefore, once avidity bias was corrected, it is not expected that non-response bias has affected the results of this study.

4.2.4. Declaration bias

Because fishers' organizations promoted participation on the survey, it cannot be dismissed that some of the respondents integrated in these organizations have answered some of the questions idiosyncratically according to their convenience, inducing declaration bias (Pollock et al., 1994). In particular, some fishers could have tended to minimize their negative impacts, i.e., their catch and effort, and/or maximize their contribution to the economy. In this sense, it must be taken into account that mean annual expenses estimated in this study (1 434 € per fisher), were higher than mean expenses estimated by Hyder et al. (2017b) for Northern Spain (729 € per fisher). However, Hyder et al. (2017b) indicated that their result was probably underestimated. In any case, without additional specific sampling it is difficult to determine accurately whether declaration bias affected the results of this study and its relative importance.

4.3. Implications for management

Fishers' habits, perceptions, attitudes and values differ between and within regions and time(Hauck et al., 2002; Ward et al., 2016). Therefore, regular collection of this type of data regarding MRF is important at different management scales (from international to regional), because it enables fisheries scientists and managers to reduce uncertainty in the assessment, control and monitoring of MRF, as well as to develop sustainable co-management initiatives for commercial and recreational fisheries (e.g., Sutinen and Johnston, 2003; Veiga et al., 2013; Pita et al., 2016). Thus, policy makers must be aware in the first place that most recreational fishers showed in this study that they are unsatisfied with current fishing regulations (87%, see Table 2). This attitude may be related to factors such as a mismatch between fishers' perceptions and managers' expectations, a sense of unfairness regarding other sectors (e.g., commercial fishing), a considerable impact in their activity, or a perception of lack of involvement in the decision-making process (Sutinen and Johnston, 2003; Veiga et al., 2013). In fact, the most important aspect of disagreement with regulations in this study was related with the feeling that several restrictions currently in place for MRF are too harsh (e.g., spatial and temporal restrictions), inadequate (e.g., bag limits, minimum landing sizes) and lacking scientific support, and that the MRF sector is unfairly treated when compared with the commercial sector (Table SI1). Similar attitudes and perceptions towards specific restrictions for MRF were observed in Portugal, just after new restrictions were put in place (Veiga et al., 2013). Conversely, some positive attitudes and perceptions were also observed in this study (Table SI1), namely by suggesting additional protection measures (e.g., smaller bag limits, closed seasons for breeding purposes, increase in minimum landing sizes), which suggest support for conservation and acceptance that all users of the stock need to be included in management if conservation goals are to be achieved (Nielsen and Mathiesen, 2003; Veiga et al., 2013). The goal of such measures is likely easier to understand from a conservation perspective; hence it is easier for fishers to find legitimate and agree with (Page and Radomski, 2006). In this sense, the low satisfaction with fishing regulations and positive attitudes shown in this study should be taken into consideration when promoting actions to increase awareness and understanding of the regulations, and actively engage fishers' in the decision-making process (Pita et al., 2017). Such actions have been found to foster fishers' sense of complicity and agreement with regulations, which ultimately could result in better compliance and state of MRF (Hatcher et al., 2000; Sutinen and Johnston, 2003; Veiga et al., 2013).

A good way to reduce the gap between fishers, managers and scientists (Dedual et al., 2013), and foster sustainable management of marine resources, while promoting healthy and economically positive attitudes, can be achieved by empowering fishers through strengthening fishermen's associations (Pita et al., 2017). Like in other Southern European regions (Pita et al., 2017), in this study shore anglers were the less satisfied with their fishing associations (Table 2). Since shore anglers are the most numerous, the implementation of an association that represents them would greatly benefit the socio-ecological sustainability of marine recreational fisheries (Pita et al., 2017). Powerful and cohesive fishers' associations could also promote the involvement of fishers in scientific studies with diverse objectives (e.g., Venturelli et al., 2016; Palas et al., 2017), taking advantage of the Traditional Ecological Knowledge (TEK) accumulated during a lifetime of fishing, on average more than 30 years of fishing experience by recreational anglers reported in this study. Conversely, policy makers and managers must be aware that certain fishing habits can be dangerous for people's' health, especially considering the relatively high mean age of recreational fishers (Fig. 4). In this regard, a significant percentage of fishers recognized that they fish alone. Fishing alone is especially dangerous for spear fishers due to the hazardous nature of their activity, and many were fishing without a partner (44%). More than half of the spear fishers (54%) reported that they had been injured when fishing, and that many of the accidents (22%) needed medical care. Therefore, the implementation of measures that encourage less dangerous fishing habits, e.g., through training activities organized by clubs, associations or sports federations, would be beneficial both for fishers and society in general.

To carry out fisheries management aimed at the sustainability of coastal ecosystems and their fishing resources, fisheries managers must take into account recreational catches (ICES, 2016), especially in the case of species for which recreational fishing catches are significant, overexploited species, or those vulnerable to fishing (Cheung et al., 2005). By means of the distribution of the total catches according to the targeted species reported by the fishers in this study (Table S2), recreational fishers caught mainly European seabass (2 111 t), white seabream (1 393 t), and ballan wrasse (1 144 t). A direct comparison to

the commercial landings of the same species suggests that, for the same area, recreational catches on these species are higher than catches from the commercial fleet (306 t, 568 t, and 300 t in 2015, respectively) (Xunta de Galicia, 2017). These results are aligned with previous studies, where recreational catches of particular species were found to be comparable to the commercial landings for the same species (e.g., Cooke and Cowx, 2004; Rangel and Erzini, 2007; Veiga et al., 2010; Pita and Freire, 2016). Recreational catches for most of the remaining species relevant to MRF were relatively unimportant; e.g., Atlantic mackerel (453 t), a pelagic species mainly targeted by boat anglers, barely accounted for 3.8% of total catch (Xunta de Galicia, 2017). Thus, among the most commonly captured species by recreational fishers in Galicia, only European seabass is moderately vulnerable to fishing (Cheung et al., 2007). European seabass is a highly mobile species (Fritsch et al., 2007; Pita and Freire, 2011) with a relevant ecological role as one of the main predators in coastal ecosystems across Europe (Pinnegar et al., 2002; Spitz et al., 2013; Pita and Freire, 2017). Due to the limited knowledge on its winter sexual aggregations and warnings about health of some stocks (Fritsch et al., 2007), the EU has recently introduced access restrictions and limitations of the fishing opportunities for this species in some areas (Council of the European Union, 2015). In this study, the European seabass was the preferred species for boat anglers (Table SI2), but since winter spawning areas are located offshore (Fritsch et al., 2007), and the activity of recreational boats is very low in the winter (Fig. 6), recreational catch of spawning fish might be relatively low. However, the identification of winter spawning areas of European seabass is essential to establish, e.g., temporary restriction access, or permanent Marine Protected Areas (MPAs) in these zones. European seabass is probably mainly caught in summer, when recreational fishers are more active (Fig. 6) and fish move closer to seashore to feed (Fritsch et al., 2007), and even enter estuaries and rivers (Frimodt, 1995). Thus, inshore nursery areas for juvenile fish (Vasconcelos et al., 2010; Reis-Santos et al., 2013) should be identified and protected, since shore anglers are known to catch a significant proportion of immature European seabass (e.g., Rangel and Erzini, 2007; Veiga et al., 2010). As mentioned before, ballan wrasse is not particularly vulnerable to fishing pressure (Cheung et al., 2007). However, since it plays a key ecological role in rocky reef and kelp forest ecosystems (Pita and Freire, 2017), and is under relevant recreational fishing pressure (Table SI2), some protection measures aimed to ensure conservation of this fish would be desirable (Pita et al., 2017). In this sense, since this is a sedentary species (Pita and Freire, 2011), MPAs would be effective for the conservation of this fish, but also of the entire coastal ecosystems (Pita et al., 2017).

As in the scientific literature (e.g., Jennings et al., 1996; Guidetti et al., 2004; Pita et al., 2018), in this study recreational fishers recognized the high influence of habitat features, like the type of substrate, on the fish abundances (Fig. 8). The Galician seascape is characterized by kelp forests growing on rocky formations (Pita et al., 2018). The EU has protected these ecosystems (Council of the European Union, 1992), but since they have been severely impacted across Europe (Airoldi et al., 2008), it is necessary to successfully monitor the evolution of these important ecosystems over time. Furthermore, the use of non-native worm species reported by Galician anglers (Table 3) should be evaluated and included in regulations, because they have been related to increases in undesired fish mortalities by deep hooking (Alós et al., 2009; Lewin et al., 2018), and to risks for environment (Font and Lloret, 2011; Hyder et al., 2017a).

Sustainable management of complex socio-ecological systems like recreational fisheries is not a simple task (Ostrom, 2009; Arlinghaus et al., 2017). Although part of the results and subsequent estimates of this study may be subject to some bias, and new studies would be desirable using randomized sampling and larger sample sizes, this is the first comprehensive study on the economic, social and ecological relevance of MRF in the Atlantic coast of Spain (Pita et al., 2017). Since this is the most important fishing region in the EU (Villasante et al., 2015, 2016), the results of this study represent the first comprehensive contribution to support current and future management of MRF in Galicia and nearby regions. Furthermore, the measures identified for conserving species and ecosystems should also support the sustainable management of European fisheries through accounting for recreational catches, as stated in the Common Fisheries Policy (European Parliament and Council of the European Union, 2013). Nevertheless, a greater degree of involvement is required from managers, scientists, recreational fishers and other stakeholders. In fact, it is still necessary to collect standardized information on MRF in Galicia, and also in other European regions (Pita et al., 2017).

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.fishres.2018.07.014.

References

Airoldi, L., Balata, D., Beck, M.W., 2008. The Gray Zone: relationships between habitat loss and marine diversity and their applications in conservation. J. Exp. Mar. Biol. Ecol. 366, 8–15.

Alós, J., Arlinghaus, R., Palmer, M., March, D., Álvarez, I., 2009. The influence of type of natural bait on fish catches and hooking location in a mixed-species marine recreational fishery, with implications for management. Fish. Res. 97 (3), 270–277.

Arlinghaus, R., Tillner, R., Bork, M., 2014. Explaining participation rates in recreational fishing across industrialised countries. Fish. Manag. Ecol. 22, 45–55.

Arlinghaus, R., Cooke, S., Sutton, S., Danylchuk, A., Potts, W., Freire, K., Alós, J., Silva, E., Cowx, I., Anrooy, R., 2016. Recommendations for the future of recreational fisheries to prepare the social-ecological system to cope with change. Fish. Manag. Ecol. 23, 177–186.

Arlinghaus, R., Alós, J., Beardmore, B., Daedlow, K., Dorow, M., Fujitani, M., Hühn, D., Haider, W., Hunt, L., Johnson, B., 2017. Understanding and managing freshwater recreational fisheries as complex adaptive social-ecological systems. Rev. Fish. Sci. Aquacult. 25, 1–41.

Armstrong, M., Brown, A., Hargreaves, J., Hyder, K., Munday, M., Proctor, S., Roberts, A., Roche, N., Williamson, K., 2013. Sea Angling 2012 – A Survey of Recreational Sea Angling Activity and Economic Value in England. Department for Environment Food and Rural Affairs, Government of the United Kingdom, London, UK.

Beiras, R., Bellas, J., Fernández, N., Lorenzo, J.I., Cobelo-García, A., 2003. Assessment of coastal marine pollution in Galicia (NW Iberian Peninsula); metal concentrations in seawater, sediments and mussels (*Mytilus galloprovincialis*) versus embryo-larval bioassays using *Paracentrotus lividus* and *Ciona intestinalis*. Mar. Environ. Res. 56, 531–553.

Bellanger, M., Levrel, H., 2017. A cost-effectiveness analysis of alternative survey methods used for the monitoring of marine recreational fishing in France. Ocean Coast. Manag. 138, 19–28.

Bellas, J., Fernández, N., Lorenzo, I., Beiras, R., 2008. Integrative assessment of coastal pollution in a Ría coastal system (Galicia, NW Spain): correspondence between sediment chemistry and toxicity. Chemosphere 72, 826–835.

Bode, A., Cabanas, J.M., Porteiro, C., Santos, M.B., 2009. Variabilidade interanual da sardiña en Galicia e na rexión ibérica. In: Muñuzuri, V.P., Fernández Cañamero, M., Gómez Gesteira, J.L. (Eds.), Evidencias do cambio climático en Galicia. Xunta de Galicia, Consellería de Medio e Desenvolvemento Sostible, pp. 341–354.

Cheung, W.W.L., Pitcher, T.J., Pauly, D., 2005. A fuzzy logic expert system to estimate intrinsic extinction vulnerabilities of marine fishes to fishing. Biol. Conserv. 124, 97–111.
Cheung, W.W.L., Watson, R., Morato, T., Pitcher, T.J., Pauly, D., 2007. Intrinsic vulnerability in the global fish catch. Mar. Ecol. Prog. Ser. 333, 1–12.
Cooke, S.J., Cowx, I.G., 2004. The role of recreational fishing in global fish crises. BioScience 54, 857–859.
Cooke, S.J., Cowx, I.G., 2006. Contrasting recreational and commercial fishing: searching for common issues to promote unified conservation of fisheries resources and aquatic environments. Biol. Conserv. 128, 93–108.
Cornide, J., 1788. Ensayo de una historia de los peces y otras producciones marinas de la costa de Galicia: arreglado al sistema del caballero Carlos Linneo. Con un tratado de las diversas pescas, y de las redes y aparejos con que se practican. Oficina de Benito Cano, Madrid.
Cortés-Jiménez, I., 2008. Which type of tourism matters to the regional economic growth? The cases of Spain and Italy. Int. J. Tour. Res. 10, 127–139.
Council of the European Union, 1992. Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Off. J. Eur. Union 1–66 Brussels, Belgium.
Council of the European Union, 2015. Council Regulation (EU) 2015/960 of 19 June 2015 amending Regulation (EU) 2015/104 as regards certain fishing opportunities. Off. J. Eur. Union 1–19 Brussels, Belgium.
Dedual, M., Sague Pla, O., Arlinghaus, R., Clarke, A., Ferter, K., Geertz Hansen, P., Gerdeaux, D., Hames, F., Kennelly, S., Kleiven, A., 2013. Communication between scientists, fishery managers and recreational fishers: lessons learned from a comparative analysis of international case studies. Fish. Manag. Ecol. 20, 234–246.
DGRM, 2017. Recreational Fishing Licenses Statistics: Years 2007-2015. General Directorate on Natural Resources, Safety and Maritime Affairs (DGRM), Portuguese Webpage.
Diogo, H., Pereira, J.G., 2014. Assessing the potential biological implications of recreational inshore fisheries on sub-tidal fish communities of Azores (north-east Atlantic Ocean) using catch and effort data. J. Fish Biol. 84, 952–970.
Doldán García, X., Villasante, S., 2015. El metabolismo socioeconómico de Galicia, 1996-2010. In: Carpintero, O. (Ed.), El metabolismo económico regional español. FUHEM Ecosocial, pp. 621–690.
Doldán-Garcia, X., Chas-Amil, M., Touza, J., 2011. Estimating the economic impacts of maritime port development: the case of A Coruña, Spain. Ocean Coast. Manag. 54, 668–677.
European Commission, 2001. Commission Regulation (EC) No 1639/2001 of 25 July 2001 establishing the minimum and extended community programmes for the collection of data in the fisheries sector and laying down detailed rules for the application of Council Regulation (EC) Nº 1543/2000. Off. J. Eur. Union 53–115 Brussels, Belgium.
European Commission, 2012. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Blue Growth Opportunities for Marine and Maritime Sustainable Growth, COM/2012/0494 Final. Brussels.
European Commission, 2016. Commission implementing decision (EU) 2016/1251 of 12 July 2016 adopting a multiannual union programme for the collection, management and use of data in the fisheries and aquaculture sectors for the period 2017-2019 (notified under document C(2016) 4329). Off. J. Eur. Union 113–177 Brussels, Belgium.
European Parliament and Council of the European Union, 2013. The common fisheries policy, 1380/2013. Off. J. Eur. Union 22–61 Brussels, Belgium.
Food and Agriculture Organization for the United Nations (FAO), 2012. FAO technical guidelines for responsible fisheries. N1 13. Recreational Fisheries. FAO, Rome 176 p.
Fisher, M.R., 1996. Estimating the effect of nonresponse bias on angler surveys. Trans. Am. Fish. Soc. 125, 118–126.
Font, T., Lloret, J., 2011. Biological implications of recreational shore angling and harvest in a marine reserve: the case of Cape Creus. Aquat. Conserv. Mar. Freshw. Ecosyst. 21, 210–217.
Font, T., Lloret, J., 2014. Biological and ecological impacts derived from recreational fishing in Mediterranean coastal areas. Rev. Fish. Sci. Aquacult. 22, 73–85.
Franco, M.A., Viñas, L., Soriano, J.A., de Armas, D., González, J.J., Beiras, R., Salas, N., Bayona, J.M., Albaigés, J., 2006. Spatial distribution and ecotoxicity of petroleum hydrocarbons in sediments from the Galicia continental shelf (NW Spain) after the Prestige oil spill. Mar. Pollut. Bull. 53, 260–271.
Franquesa, R., 2005. Las cofradías en España: papel económico y cambios estructurales. In: 12th Conference of the International Institute of Fisheries Economics and Trade (IIFET). Tokyo.
Freire, J., García-Allut, A., 2000. Socioeconomic and biological causes of management failures in European artisanal fisheries: the case of Galicia (NW Spain). Mar. Policy 24, 375–384.
Frimodt, C., 1995. Illustrated Multilingual Guide to the World's Commercial Warmwater Fish. Fishing News Books, Oxford. GB.
Fritsch, M., Morizur, Y., Lambert, E., Bonhomme, F., Guinand, B., 2007. Assessment of sea bass (*Dicentrarchus labrax*, L.) stock delimitation in the Bay of Biscay and the English Channel based on mark-recapture and genetic data. Fish. Res. 83, 123–132.
Goodman, L.A., 1961. Snowball sampling. Ann. Math. Stat. 32, 148–170.
Griffiths, S.P., Fay, G., 2015. Integrating recreational fisheries data into stock assessment: implications for model performance and subsequent harvest strategies. Fish. Manag. Ecol. 22, 197–212.
Guidetti, P., Bianchi, C.N., Chiantore, M., Schiaparelli, S., Morri, C., Cattaneo-Vietti, R., 2004. Living on the rocks: substrate mineralogy and the structure of subtidal rocky substrate communities in the Mediterranean. Sea. Mar. Ecol. Prog. Ser. 274, 57–68.
Hatcher, A., Jaffry, S., Thébaud, O., Bennett, E., 2000. Normative and social influences affecting compliance with fishery regulations. Land Econ. 76, 448–461.
Hauck, M., Sowman, M., Russell, E., Clark, C.M., Harris, J.M., Venter, A., Beaumont, J., Maseko, Z., 2002. Perceptions of subsistence and informal fishers in South Africa regarding the management of living marine resources. South Afr. J. Mar. Sci. 24, 463–474.
Hiett, R.L., Worrall, J.W., 1977. Marine Recreational Fishermen's Ability to Estimate Catch and to Recall Catch and Effort Over Time. Human Sciences Research Inc. Report HSR-RR7711l3-Cd McLean, Va.
Hyder K., Armstrong M., Ferter K., Strehlow, H.V., 2014, September. Recreational sea fishing – the high value forgotten catch, ICES INSIGHT (51): 8–15, Copenhagen, Denmark.
Hyder, K., Radford, Z., Prellezo, R., Weltersbach, M., Lewin, W., Zarauz, L., Ferter, K., Ruiz, J., Townhill, B., Mugerza, E., Strehlow, H., 2017a. Research for PECH Committee – Marine Recreational and Semi-subsistence Fishing – Its Value and its Impact on Fish Stocks. European Parliament, Policy Department for Structural and Cohesion Policies, Brussels.
Hyder, K., Weltersbach, M.S., Armstrong, M., Ferter, K., Townhill, B., Ahvonen, A., Arlinghaus, R., Baikov, A., Bellanger, M., Birzaks, J., Borch, T., Cambie, G., Dziemian, L., de Graaf, M., Gordoa, A., Grzebielec, R., Hartill, B.W., Kagervall, A., Kapiris, K., Karlsson, M., Kleiven, A.R., Lejk, A.M., Levrel, H., Lovell, S., Lyle, J., Moilanen, P., Monkman, G., Morales-Nin, B., Mugerza, E., Martinez, R., O'Reilly, P., Olesen, H.J., Papadopoulos, A., Pita, P., Radtke, K., Roche, W., Rocklin, D., Ruiz, J., Scougal, C., Silvestri, R., Skov, C., Steinback, S., Sundelöf, A., Svagzdys, A., Turnbull, D., van Voorhees, D., van Winsen, F., Verleye, T., Veiga, P., Vølstad, J.-H., van der Hammen, T., Zarauz, L., Zolubas, T., Strehlow, H.V., 2017b. Recreational sea fishing in Europe in a global context – participation rates, fishing effort, expenditure, and implications for monitoring and assessment. Fish Fish. 19, 225–243.
International Council for the Exploration of the Sea (ICES), 2011. Report of the Planning Group on Recreational Fisheries Surveys (PGRFS) ICES CM 2011/ACOM:23. Esporles, Spain. .
International Council for the Exploration of the Sea (ICES), 2013. Report of the ICES Working Group on Recreational Fisheries Surveys (WGRFS), ICES CM 2013/ACOM:23. Esporles, Spain. .
International Council for the Exploration of the Sea (ICES), 2017a. Report of the Baltic Fisheries Assessment Working Group (WGBFAS). ICES CM 2017/ACOM:11. Copenhagen, Denmark. .
International Council for the Exploration of the Sea (ICES), 2017b. Report of the Benchmark Workshop on Widely Distributed Stocks (WKWIDE). ICES CM 2017/ACOM:36. Copenhagen, Denmark. .
International Council for the Exploration of the Sea (ICES), 2017c. Report of the Working Group on Recreational Fisheries Surveys (WGRFS). ICES CM 2016/SSGIEOM:1. Nea Peramos, Greece. .
Inglehart, R., 1990. Culture Shift in Advanced Industrial Society. Princeton University Press, Princeton 488 pp.
Instituto Galego de Estadística, IGE, 2017. Sociedade da información. Available online at. https://www.ige.eu/web/mostrar_seccion.jsp?idioma=gl&codigo=0401.
Jennings, S., Marshall, S.S., Polunin, N.V.C., 1996. Seychelles' marine protected areas: comparative structure and status of reef fish communities. Biol. Conserv. 75, 201–209.
Kleiven, A.R., Fernandez-Chacon, A., Nordahl, J.-H., Moland, E., Espeland, S.H., Knutsen, H., Olsen, E.M., 2016. Harvest pressure on Coastal Atlantic Cod (Gadus morhua) from recreational fishing relative to commercial fishing assessed from tag-recovery data. PLoS One 11, e0149595.
Lewin, W.-C., Strehlow, H.V., Ferter, K., Hyder, K., Niemax, J., Herrmann, J.-P., Weltersbach, M.S., 2018. Estimating post-release mortality of European sea bass based on experimental angling. ICES J. Mar. Sci., fsx240.
Lloret, J., Cowx, I.G., Cabral, H., Castro, M., Font, T., Gonçalves, J.M.S., Gordoa, A., Hoefnagel, E., Matić-Skoko, S., Mikkelsen, E., Morales-Nin, B., Moutopoulos, D.K., Muñoz, M., Santos, M.N., Pintassilgo, P., Pita, C., Stergiou, K.I., Ünal, V., Veiga, P., Erzini, K., 2016. Small-scale coastal fisheries in European Seas are not what they were: ecological, social and economic changes. Mar. Policy in press.
Lovell, S., Steinback, S., Hilger, J., 2013. The Economic Contribution of Marine Angler Expenditures in the United States, 2011. U.S. Dep. Commerce, NOAA Tech. Memo NMFS-F/SPO-134, 188 p.
Macho, G., Naya, I., Freire, J., Villasante, S., Molares, J., 2013. The key role of the Barefoot Fisheries Advisors in the co-managed TURF system of Galicia (NW Spain). Ambio 42 (8), 1057–1069.
Ministerio de Agricultura, Pesca, Alimentación y Medio Ambiente (MAGRAMA), 2016. Panel De Consumo Alimentario. Base De Datos De Consumo En Hogares. Available online at. http://www.mapama.gob.es/es/alimentacion/temas/consumo-y-comercializacion-y-distribucion-alimentaria/panel-de-consumo-alimentario/base-de-datos-de-consumo-en-hogares/consulta.asp.
Manfredo, M.J., Driver, B.L., Tarrant, M.A., 1996. Measuring leisure motivation: a meta-analysis of the recreation experience preference scales. J. Leis. Res. 28, 188.
Mitchell, R.W.D., Baba, O., Jackson, G., Isshiki, T., 2008. Comparing management of recreational Pagrus fisheries in Shark Bay (Australia) and Sagami Bay (Japan): conventional catch controls versus stock enhancement. Mar. Policy 32, 27–37.
Monaco, D., Chianese, E., Riccio, A., Delgado-Sánchez, A., Lacorte, S., 2017. Spatial distribution of heavy hydrocarbons, PAHs and metals in polluted areas. The case of "Galicia", Spain. Mar. Pollut. Bull. 121 (1-2), 230–237.
Morales-Nin, B., Cardona-Pons, F., Maynou, F., Grau, A.M., 2015. How relevant are recreational fisheries? Motivation and activity of resident and tourist anglers in Majorca. Fish. Res. 164, 45–49.
National Research Council, 2006. Review of Recreational Fisheries Survey Methods. National Academies Press, Washington 202 pp.
Nielsen, J.R., Mathiesen, C., 2003. Important factors influencing rule compliance in

fisheries lessons from Denmark. Mar. Policy 27, 409–416.
Ostrom, E., 2009. A general framework for analyzing sustainability of social-ecological systems. Science 325, 419–422.
Otero, J., González, A.F., Guerra, A., Álvarez-Salgado, X.M., 2009. Efectos do clima sobre o polbo común. In: Muñuzuri, V.P., Fernández Cañamero, M., Gómez Gesteira, J.L. (Eds.), Evidencias do cambio climático en Galicia. Xunta de Galicia, Consellería de Medio e Desenvolvemento Sostible, pp. 403–421.
Page, K.S., Radomski, P., 2006. Compliance with sport fishery regulation in Minnesota as related to regulation awareness. Fisheries 31, 166–178.
Palas, S., Villasante, S., Pita, P., 2017. Combining fishers' knowledge and cost-effective monitoring tools in the management of marine recreational fisheries: a case study of the squid and cuttlefish fishery of the Ría of Vigo (NW Spain). Fish. Manag. Ecol. 24, 469–477.
Pinnegar, J.K., Jennings, S., O'brien, C.M., Polunin, N.V.C., 2002. Long-term changes in the trophic level of the Celtic Sea fish community and fish market price distribution. Ecology 39, 377–390.
Pita, P., Freire, J., 2011. Movements of three large coastal predatory fishes in the northeast Atlantic: a preliminary telemetry study. Sci. Mar. 75, 759–770.
Pita, P., Freire, J., 2014. The use of spearfishing competition data in fisheries management: evidence for a hidden near collapse of a coastal fish community of Galicia (NE Atlantic Ocean). Fish. Manag. Ecol. 21, 454–469.
Pita, P., Freire, J., 2016. Assessing the impact of spear fishing by using competitions records and underwater visual censuses. Sci. Mar. 80, 27–38.
Pita, P., Freire, J., 2017. Trophic ecology of an Atlantic kelp forest fish assemblage targeted by recreational fishers: implications for coastal management. J. Mar. Biol. Assoc. U. K. 1–11.
Pita, P., Freire, J., García-Allut, A., 2008. How to assign a catch value to fishing grounds when fisheries statistics are not spatially explicit. Sci. Mar. 72, 693–699.
Pita, P., Fernández-Vidal, D., García-Galdo, J., Muíño, R., 2016. The use of the traditional ecological knowledge of fishermen, cost-effective tools and participatory models in artisanal fisheries: towards the co-management of common octopus in Galicia (NW Spain). Fish. Res. 178, 4–12.
Pita, P., Artetxe, I., Diogo, H., Gomes, P., Gordoa, A., Hyder, K., Pereira, J., Pita, C., Mafalda, R., Garcia-Rodrigues, J., Sagué, O., Veiga, P., Vingada, J., Villasante, S., 2017. Research and management priorities for Atlantic marine recreational fisheries in Southern Europe. Mar. Policy 86, 1–8.
Pita, P., Fernández-Márquez, D., Freire, J., 2018. Spatiotemporal variation in the structure of reef fish and macroalgal assemblages in a north-east Atlantic kelp forest ecosystem: implications for the management of temperate rocky reefs. Mar. Freshw. Res. 69, 525–541.
Pollock, K.H., Jones, C.M., Brown, T.L., 1994. Angler survey methods and their application in Fisheries management. American Fisheries Society Special Publication Series No 25, 371 p.
Rangel, M.O., Erzini, K., 2007. An assessment of catches and harvest of recreational shore angling in the north of Portugal. Fish. Manag. Ecol. 14, 343–352.
Reis-Santos, P., Tanner, S.E., Vasconcelos, R.P., Elsdon, T.S., Cabral, H.N., Gillanders, B.M., 2013. Connectivity between estuarine and coastal fish populations: contributions of estuaries are not consistent over time. Mar. Ecol. Prog. Ser. 491, 177–186.
Roberts, A., Munday, M., Roche, N., Brown, A., Armstrong, M., Hargreaves, J., Pilgrim-Morrison, S., Williamson, K., Hyder, K., 2017. Assessing the contribution of recreational sea angling to the English economy. Mar. Policy 83, 146–152.
Rocklin, D., Levrel, H., Drogou, M., Herfaut, J., Veron, G., 2014. Combining telephone surveys and fishing catches self-report: the French sea bass recreational fishery assessment. PLoS One 9, e87271.
Rodriguez-Pose, A., 2000. Economic convergence and regional development strategies in Spain: the case of Galicia and Navarre. EIB Pap. 5, 88–115.
Ruiz, J., Zarauz, L., Urtizberea, A., Andonegi, E., Mugerza, E., Artetxe, I., 2014. In: Gondra, J.R. (Ed.), Establecimiento de un sistema de recogida sistemática de datos sobre PESCA RECREATIVA. AZTI-Tecnalia, Sukarrieta.
Schroeder, D.M., Love, M.S., 2002. Recreational Fishing and Marine Fish Populations in California. California Cooperative Oceanic Fisheries Investigations, Santa Barbara (USA).
Smallwood, C.B., Beckley, L.E., Moore, S.A., Kobryn, H.T., 2011. Assessing patterns of recreational use in large marine parks: a case study from Ningaloo Marine Park, Australia. Ocean Coast. Manag. 54, 330–340.
Spitz, J., Chouvelon, T., Cardinaud, M., Kostecki, C., Lorance, P., 2013. Prey preferences of adult sea bass Dicentrarchus labrax in the northeastern Atlantic: implications for bycatch of common dolphin Delphinus delphis. ICES J. Mar. Sci. 70, 452–461.
Scientific, Technical and Economic Committee for Fisheries (STECF), 2013. The Economic Performance of the EU Fish Processing Industry (STECF - 13-31). Publications Office of the European Union, Luxembourg EUR 26444 EN, JRC 87692, 223 pp.
Scientific, Technical and Economic Committee for Fisheries (STECF), 2015. The 2015 Annual Economic Report on the EU Fishing Fleet (STECF 15-07). Publications Office of the European Union, Luxembourg, pp. 433.
Scientific, Technical and Economic Committee for Fisheries (STECF), 2017. The 2017 Annual Economic Report on the EU Fishing Fleet (STECF-17-12). Publications Office of the European Union, Luxembourg, pp. 492 2017.
Surís-Regueiro, J., Santiago, J., 2014. Characterization of fisheries dependence in Galicia. Mar. Policy 47, 109–119.
Sutinen, J.G., Johnston, R.J., 2003. Angling management organizations: integrating the recreational sector into fishery management. Mar. Policy 27, 471–487.
Taboada, M.S., 2007. Las prácticas contables de las cofradías de pescadores gallegas. La coerción como vehículo de institucionalización cultural normativa. Revista Galega de Economía 16, 1–26.
Teixeira, D., Zischke, M.T., Webley, J.A., 2016. Investigating bias in recreational fishing surveys: fishers listed in public telephone directories fish similarly to their unlisted counterparts. Fish. Res. 181, 127–136.
Thompson, T., Hubert, W.A., 1990. Influence of survey method on estimates of statewide fishing activity. North Am. J. Fish. Manag. 10, 111–113.
Vasconcelos, R.P., Reis-Santos, P., Maia, A., Fonseca, V., França, S., Wouters, N., Costa, M.J., Cabral, H.N., 2010. Nursery use patterns of commercially important marine fish species in estuarine systems along the Portuguese coast. Estuar. Coast. Shelf Sci. 86, 613–624.
Veiga, P., 2013. Recreational shore fishing in southern Portugal: biological and socio-economic aspects and perspectives for management. Thesis for the Degree in Doctor of Philosophy in Fisheries Sciences and Technology, Specialty in Resources Management and Assessment. University of the Algarve, pp. 147 Doctoral thesis.
Veiga, P., Ribeiro, J., Gonçalves, J.M.S., Erzini, K., 2010. Quantifying recreational shore angling catch and harvest in southern Portugal (north-east Atlantic Ocean): implications for conservation and integrated fisheries management. J. Fish Biol. 76, 2216–2237.
Veiga, P., Pita, C., Leite, L., Ribeiro, J., Ditton, R.B., Gonçalves, J.M.S., Erzini, K., 2013. From a traditionally open access fishery to modern restrictions: portuguese anglers' perceptions about newly implemented recreational fishing regulations. Mar. Policy 40, 53–63.
Venturelli, P.A., Hyder, K., Skov, C., 2016. Angler apps as a source of recreational fisheries data: opportunities, challenges and proposed standards. Fish Fish. 18, 578–595.
Villasante, S., 2009. Magnitud e implicaciones de la Política Pesquera Comunitaria: aplicación de indicadores de sostenibilidad sobre el metabolismo de los ecosistemas marinos. Tesis Doctoral. Universidad de Santiago de Compostela 613 pp.
Villasante, S., 2012. The management of the blue whiting fishery as complex social-ecological system: the Galician case. Mar. Policy 36 (6), 1301–1308.
Villasante, S., Rodríguez-González, D., Antelo, M., Rivero-Rodríguez, S., Lebrancón-Nieto, J., 2013. Why are prices in wild catch and aquaculture industries so different? Ambio 42 (8), 937–950.
Villasante, S., Macho, G., Giráldez, J., Rivero, S., Isusu, J., Divovich, E., Harper, S., Zeller, D., Pauly, D., 2015. Estimates of total fisheries removals from the Northwest of Spain (1950-2010). Working Paper Series. Fisheries Centre, University of British Columbia, Vancouver.
Villasante, S., Pazos Guimerans, C., Rodrigues, J., Antelo, M., Rivero Rodríguez, S., Pita, C., Pierce, G., Lee, H., Garcia, D., Da Rocha, J.M., Sumaila, R., Coll, M., 2016. Fishers' perceptions about the EU discards policy and its economic impact on small-scale fisheries in Galicia (NorthWest Spain). Ecol. Econ. 130, 130–138.
Walsh, R.G., John, K.H., McKean, J.R., Hof, J.G., 1989. Comparing long-run forecasts of demand for fish and wildlife recreation. Leis. Sci. 11, 337–351.
Ward, H.G., Allen, M.S., Camp, E.V., Cole, N., Hunt, L.M., Matthias, B., Post, J.R., Wilson, K., Arlinghaus, R., 2016. Understanding and managing social–ecological feedbacks in spatially structured recreational fisheries: the overlooked behavioral dimension. Fisheries 41, 524–535.
Xunta de Galicia, 2009. Orde do 17 de setembro de 2009 pola que se desenvolve o Decreto 211/1999, do 17 de xuño, polo que se regula a pesca marítima de recreo. Santiago de Compostela. .
Xunta de Galicia, 2017. Pesca de Galicia. Estadísticas oficiais de pesca da Xunta de Galicia. [Online]. Available online at:. [Accessed February 15, 2017]. http://www.pescadegalicia.com/.
Zarauz, L., Ruiz, J., Urtizberea, A., Andonegi, E., Mugerza, E., Artetxe, I., 2015. Comparing different survey methods to estimate European sea bass recreational catches in the Basque Country. ICES J. Mar. Sci. 72, 1181–1191.