Ocean and Coastal Management 169 (2019) 191–200

Contents lists available at ScienceDirect

Ocean and Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

The building of a management system for marine recreational fisheries in Galicia (NW Spain)

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ARTICLE INFO

Keywords:
Marine recreational fisheries
Fisheries management
Legal review
Economic and social relevance
European Union

ABSTRACT

Over the past decades, the nature of the management of marine fisheries in Galicia (NW Spain) has changed substantially. In addition to a powerful commercial fleet and high fisheries dependence of coastal communities, Galicia has a long and strong tradition in marine recreational fisheries, with 60 000 fishers and 4000 boats engaged in this activity in coastal waters. This paper analyses, for the first time, key changes in the management framework of marine recreational fisheries in Galicia by investigating past and current regulations and research initiatives developed so far. Three periods in the management of marine recreational fisheries (1963–1982; 1983–2000; and 2001-present) have been identified. The results show that the management of marine recreational fishing (MRF) moved from a poorly regulated and *de facto* open access system under the rule of the Spanish administration in the 1980's to a current highly regulated fishery under regional, national and European Union (EU) governments. EU regulations are being fundamental to promote the ecological and socioeconomic sustainability of MRF. However, the lack of scientific data, with only eight papers about MRF in Galicia published in international referred journals, the absence of experts in the field working in the fisheries administration and in research centers, and the lack of strong fishers' organizations are jeopardizing the sustainability of this complex socioecological system in the long term. The development of a strategic plan for MRF in Galicia is needed, including a diagnosis of its current status in relation to other sectors sharing coastal ecosystems, like commercial fisheries, and tourism. Co-management initiatives and adaptive policies favoring both the development of commercial fisheries and the promotion of MRF-based economies to offer new opportunities to local communities are encouraged.

1. Introduction

Confidence in the fallacious notion that marine resources are inexhaustible due to human action has been weakened throughout the twentieth century (Watson et al., 2015). Traditional and new commercial fisheries (Morato et al., 2006; Swartz et al., 2010) are operating across a wide range of habitats, depths and trophic levels (Essington et al., 2006; Sethi et al., 2010). However, worldwide catches continued to decline (FAO, 2016; Kelleher, 2005; Watson and Pauly, 2001) and many of the world's fishing grounds have been severely overexploited (Costello et al., 2016; Worm et al., 2009). In the European Union (EU), discretionary and opaque decision making in fisheries management has tended to keep exploitation rates above the scientific recommendations (Borges, 2018; Carpenter et al., 2016a), contributing to the fact that many European fisheries have been exploited above ecology sustainable target levels (Froese and Proelß, 2010). Thus, long-term sustainability of many European fish stocks has been threatened by commercial overfishing (Coll et al., 2008; Guénette and Gascuel, 2012; Thurstan et al., 2010). However, although some criticisms (Khalilian et al., 2010), the EU Common Fisheries Policy (CFF) (European Parliament and Council of the European Union, 2013, 2008) is in general improving the status of common commercial fisheries during the last years (Carpenter et al., 2016b; Marchal et al., 2016; Villasante et al., 2012).

Recreational fisheries add additional pressure on marine ecosystems (Cooke and Cowx, 2006; Lewin et al., 2006), especially on coastal seas, key ecosystems particularly impacted by humans (Lotze et al., 2006). As a consequence, attention to the specific impacts of marine recreational fisheries has been growing with time (Coleman et al., 2004; Cooke and Cowx, 2004; Griffiths and Fay, 2015). In Europe, marine recreational fisheries share some relevant fish stocks with commercial

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https://doi.org/10.1016/j.ocecoaman.2018.12.027
Received 15 November 2018; Received in revised form 21 December 2018; Accepted 24 December 2018

fisheries (Hyder et al., 2018; Kleiven et al., 2016; Pita et al., 2018c; Strehlow et al., 2012). Therefore, there is a need to take into account the fish mortality derived from recreational fisheries in the scientific assessments (Eero et al., 2014; Pita et al., 2017; Rocklin et al., 2014). However, marine recreational fishing (MRF) has been little studied in Europe (Pawson et al., 2008; Pita et al., 2017) compared to industrial and even artisanal fisheries (Cycon, 1986; Platteau, 1989; Weeratunge et al., 2014). Thus, reliable data on catches of MRF to be used in the evaluations is still lacking in many European countries (Hyder et al., 2017), and particularly in the South (Pita et al., 2017). With the aim of solving this lack of attention, the CFP states that "recreational fisheries can have a significant impact on fish resources and Member States should, therefore, ensure that they are conducted in a manner that is compatible with the objectives of the CFP" (European Parliament and Council of the European Union, 2013). Nevertheless, Member States are currently only obliged to provide data on recreational catch and releases of those species under the regulation of total allowable catches, or under recovery plans, i.e., Atlantic cod *Gadus morhua* (Linnaeus, 1758), Atlantic salmon *Salmo salar* (Linnaeus, 1758), European eel *Anguilla anguilla* (Linnaeus, 1758), European seabass *Dicentrarchus labrax* (Linnaeus, 1758), pollack *Pollachius pollachius* (Linnaeus, 1758), elasmobranchs and highly migratory species under ICCAT management (European Commission, 2016; European Parliament and Council of the European Union, 2017). Therefore, to date in practice there is no specific requirements to assess the impacts of MRF on most of the species captured by this sector (Hyder et al., 2018; Pita et al., 2017).

On the other hand, the nine million of European marine recreational fishers generate annually around six billion euros in new capital and millions of related jobs (Hyder et al., 2018). It is for these reasons that a recent resolution of the European Parliament recognizes that "recreational fishing has been practiced for centuries across the EU and is an integral part of the culture, traditions and heritage of a great many coastal and island communities", and urges to "provide support, including financial support, for the development of recreational fishing in the tourism sector, as an important contributor to the development of the blue economy in small communities, coastal communities and islands, particularly in the outermost regions" (European Parliament, 2018). This growing social and economic relevance of the recreational sector has resulted in some developed countries in promotion measures for MRF and limitations for commercial fisheries, with unclear results (Brown, 2016; Voyer et al., 2017). With the aim of reducing conflicts between both sectors in Europe (Hyder et al., 2017; Lloret et al., 2016; Pita et al., 2017), the European Parliament also "highlights the need to protect the artisanal fleet and ensure its survival and generational replacement in the face of the expansion of recreational activity linked to recreational ports and seasonal tourism" (European Parliament, 2018).

Because of all the above, it seems that MRF in the EU is to be considered as an integral part of the CFP, which hopefully will end the traditional neglected management of this sector. However, MRF is managed in the EU at different geographical scales, from European to regional (and even local) and under very different regulatory regimes, resulting in a very complex legal framework (Pita et al., 2018d). For this reason, the steps that must be taken to incorporate MRF progressively into the political, management and scientific agendas involve actions at each of these scales in a coordinated and coherent manner. It seems necessary in the first place to analyze the different MRF management and research initiatives developed so far in key European regions.

In this paper it has been investigated the state of play of MRF in Galicia (NW Spain). It was also reviewed the evolution of the management framework of MRF in Galicia and it is discussed its eventual future development to ensure ecological, social and economic sustainability (European Parliament, 2018).

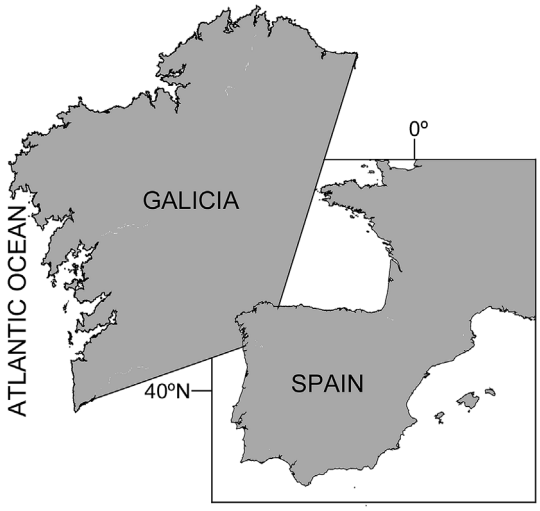

Fig. 1. Map of the study area.

2. Material and methods

2.1. The coastal socioecological system of Galicia

Galician "*rías*" (Fig. 1) are deep water inlets that support wind-driven upwelling pulses that fertilize the coastal and shelf areas with deep-water nutrients (Fraga, 1981), which favors biological production processes and dramatically increase primary production (Bode et al., 2009). This rich marine environment supports a strong commercial fleet based in the numerous towns and villages located along the coastline (Freire and García-Allut, 2000; Pita et al., 2018a), and explains the key role of fishing in the Galician culture (Cornide, 1788; Taboada, 2007). The Galician commercial fleet represent around 40% of Spain's fleet, 50% of catches of the Spanish fleet in EU waters and 60% of Spanish jobs in fishery-related sectors (STECF, 2017). Galicia is the EU region with the higher dependence on commercial fishing, and this sector is a major contributor to the Galician Gross Domestic Product (GDP) (Freire and García-Allut, 2000; Pita et al., 2018a; Surís-Regueiro and Santiago, 2014; Villasante, 2012; Villasante et al., 2016b).

Other demanding marine activities are also operating in Galicia, e.g., heavy maritime traffic (Suárez de Vivero and Rodríguez Mateos, 2012), intensive aquaculture of Mediterranean mussel *Mytilus galloprovincialis* (Lamarck, 1819) (Pérez-Camacho et al., 1991; Villasante et al., 2013), growing tourism (Cortés-Jiménez, 2008) and MRF (Pita et al., 2018c; Pita and Freire, 2016), all of which shape a highly complex socioecological system.

As a consequence of the aforementioned activities, relevant human impacts on coastal ecosystems of Galicia include historical overfishing (Freire and García-Allut, 2000; Pita et al., 2018a; Villasante, 2009) and Illegal, Unreported and Unregulated (IUU) catches (Villasante et al., 2016a), extensive habitat degradation and destruction (Doldán-Garcia et al., 2011; Pita et al., 2008), recurrent oil-spills (Franco et al., 2006; Monaco et al., 2017; Vieites et al., 2004; Viñas et al., 2009) and industrial pollution (Beiras et al., 2003; Bellas et al., 2008). For all this, it is not surprising that, in a local context of poor governance of marine resources (Arnáiz, 2001; Freire and García-Allut, 2000; Pita et al., 2018a) and under the negative influence of global ocean warming (Bode et al., 2009), the future sustainability of this complex socioecological system has been jeopardized (Pita and Freire, 2014).

2.2. Data collection and analysis of the information

In order to analyze the state of play about research on MRF in Galicia, the database ISI Web of Knowledge (available at http://apps.

webofknowledge.com) was searched for scientific publications by using in the title or in the theme of the publication the search string "((“*NW Spain*” OR Galicia) AND (*marine* AND *recreat** AND *fish**))". The search included all scientific articles published until the cut-off date of the end of October 2018. In addition, experts were identified through a “snowball sampling” procedure (Goodman, 1961) to identify additional sources of information to be included in the analysis. Thus, scientific papers undetected by the ISI Web of Knowledge search engine, research projects, contributions to scientific meetings, master's and doctoral academic thesis, books and book chapters, and gray literature (technical and dissemination reports) were also identified and analyzed.

A database was created with the information gathered from the publications and projects on MRF, including details of the publication (title, name and discipline of authors, year of publication and type of publication) and of the project (title, executing and financing institution and funded amount). In addition, the context of the studies was identified (years in which they were developed, geographical location and methodology), their main orientation (governance, social, ecological, economic, or legal), the main results obtained, and the species studied.

Moreover, different legal engines were used to analyze the legal framework about MRF in Galicia until the cut-off date of the end of October 2018. Thus, the Spanish Official Bulletin (available at https://www.boe.es/legislacion/legislacion_ava.php) and the Galician Official Journal (available at https://www.xunta.gal/diario-oficial-galicia/portalPublicoBusqueda.do?lang=es) were used to collect Spanish and Galician legal regulations on MRF, respectively, by using the search string “*pesca recreativa*” (recreational fishing) OR “*pesca deportiva*” (sport fishing) OR “*pesca de recreo*” (recreational fishing). European regulations on MRF were obtained from the Official Journal of the EU (available at https://eur-lex.europa.eu/advanced-search-form.html) by using the search string “*recreational fishing*” OR “*sport fishing*”. A second database was created by including the main norms constituting each of the regulations.

3. Results

3.1. State of play about marine recreational fishing in Galicia

Between 2002 and the end of October 2018, a total of 24 research documents have been published about MRF in Galicia (Fig. 2). Research articles (33% of total) and communications in scientific conferences and meetings (29%) were the most published scientific results, and tended to increase over time. Gray literature, such as technical reports, which are not usually part of scientific reviews, accounted for 21% of the published documents. Since 2005, 472 568 € were spent to develop five research projects to study different aspects of MRF in Galicia (Fig. 2).

Almost half of the main authors (48% of total) of the analyzed publications were experts in ecological-oriented disciplines, while 39% were economists (Fig. 3). Thus, it is not surprising that many of the published papers investigated ecological (32%) and economic (22%) aspects of MRF in Galicia. Moreover, social aspects (22%), including governance (12%), and legal issues (12%) were also relevant (Fig. 3).

Most of the published studies used different types of surveys to achieve their results (63% of total), while the remaining were based in reviews (21%), expert opinion (8%) or experiments and experiences investigating fish abundances (4%) (Fig. 3). Many of the studies (44%) provided results about the socioeconomic and ecological relevance of MRF. Slightly less than a third of the publications obtained estimates of catch and/or effort (26%), while other published estimates of costs or expenditures of recreational fishers (9%). Legal frameworks (13%) and information on the trophic habits of fish caught by recreational fishers were also analyzed in these studies (Fig. 3).

The Sparidae family was the most investigated taxon in the analyzed studies (32% of total), followed by Labridae (11%) and Gadidae (4%),

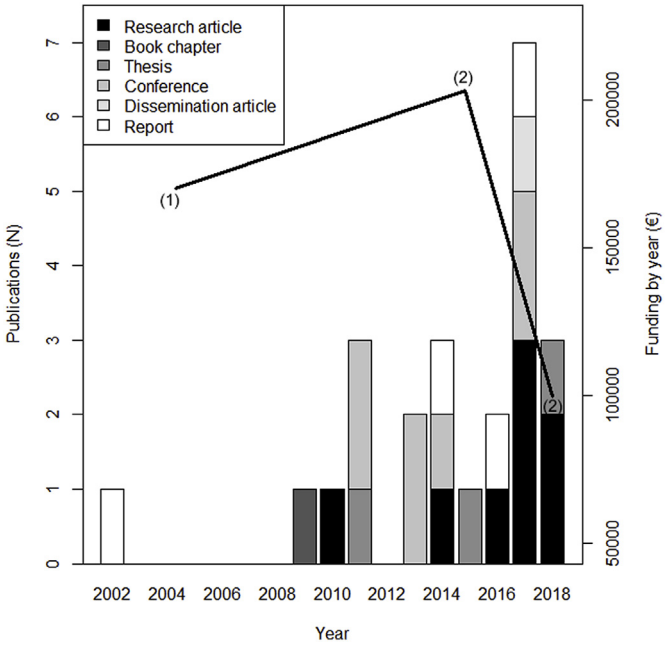

Fig. 2. Number of research texts, groped by category, about marine recreational fisheries in Galicia published by year until the end of October 2018. Line shows annual funding invested in research projects in the same period (in brackets, the number of projects by year).

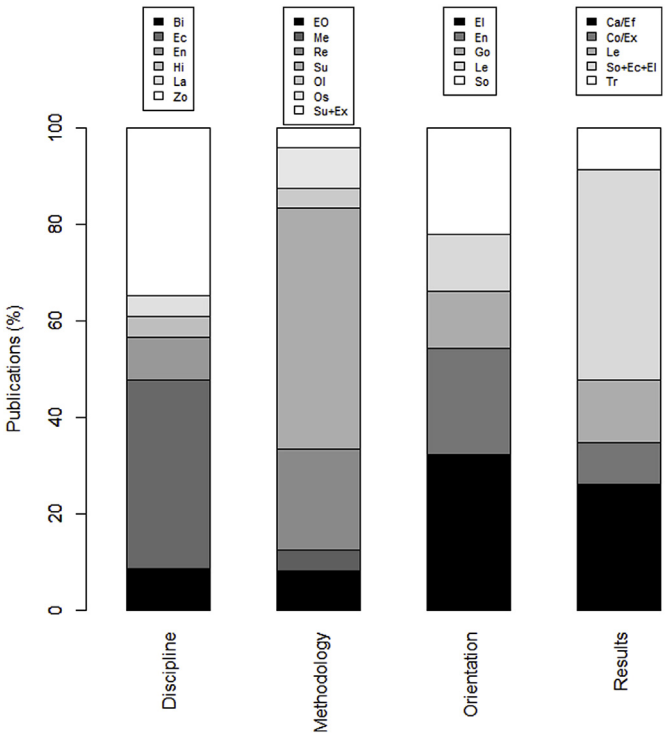

Fig. 3. Description of research studies about marine recreational fisheries in Galicia obtained from scientific texts published until the end of October 2018. It is shown the discipline of the first author (Bi = biology; Ec = economy; En = engineering; Hi = hidrobiology; La = law; Zo = zoology), main methodology (EO = expert opinion; Me = meeting report; Re = review; Su = surveys (in general); OI = online surveys; Os = onsite surveys; Ex = experiments), major orientation (El = ecological; Ec = economic; Go = governance; Le = legal; So = social) and key results (Ca/Ef = catch and/or effort; Co/Ex = costs and/or expenditures; Le = legal review; So + Ec + En = socioeconomic and ecologic relevance; Tr = trophic habits).

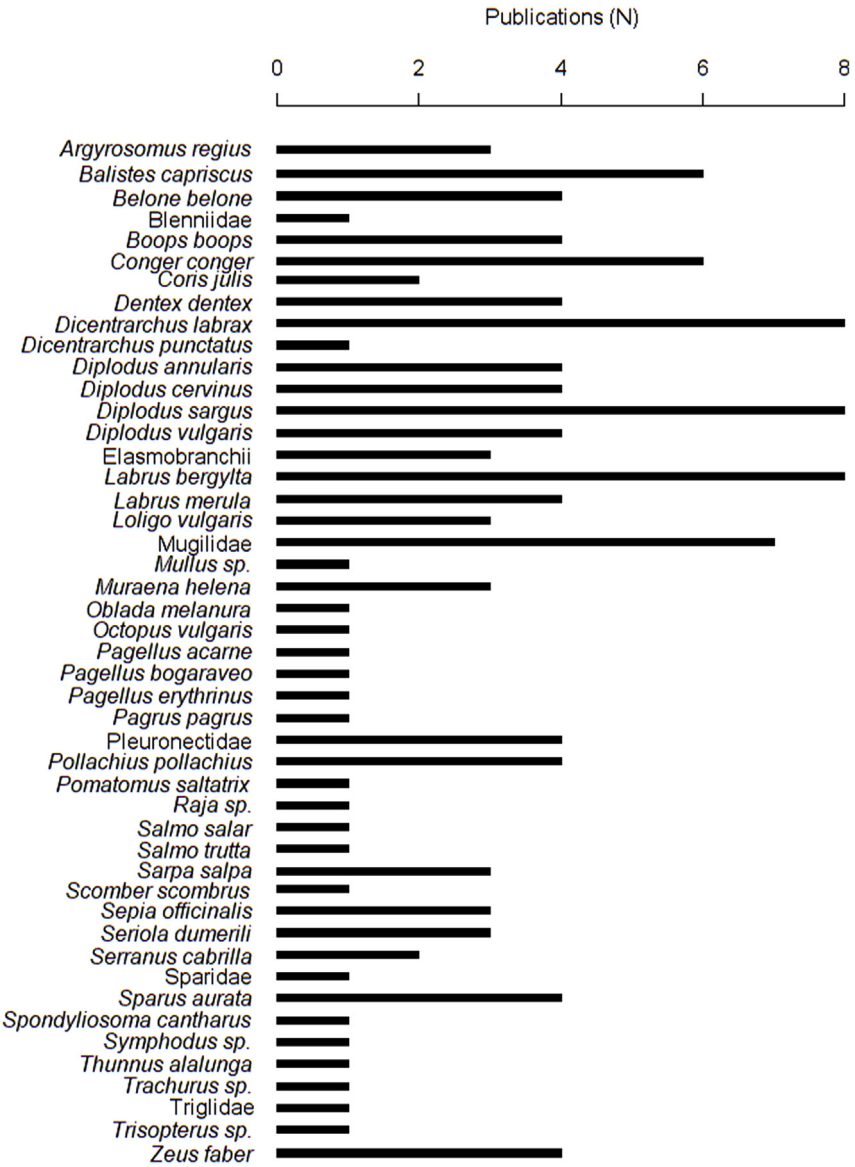

Fig. 4. Studied taxa in scientific texts about marine recreational fisheries in Galicia published until the end of October 2018.

while the most relevant fish species were ballan wrasse *Labrus bergylta* (Ascanius, 1767), European seabass and white seabream *Diplodus sargus* (Linnaeus, 1758) (6% each). Molluscs of the Cephalopoda class were also relatively well studied (5%) (Fig. 4).

3.1.1. Social relevance

In Galicia according to the available estimates there are currently operating about 60 000 marine recreational fishers, who mainly fish during summer and spring (Gordoa et al., 2019; Martínez-Carbajal, 2018; Pita et al., 2018c). The main modality is shore angling (75% of total), followed by boat angling and spear fishing (20% and 5%, respectively) (Pita et al., 2018c, 2017) (Table 1).

The Galician recreational fishers are between 37 and 53 years old, and they mainly practice recreational fishing as a form of socialization, since most of them fish with friends or relatives (Pita et al., 2018c). Noticeably, most fishers believe that the current regulation is inappropriate and excessively complex (Pita et al., 2018c, 2017) (Table 1).

3.1.2. Economic relevance

Pita et al. (2018c) stated in the only publication on the economic relevance of MRF in the region that Galician recreational fishers spend almost €100 million per year in their activity, mainly in fishing trips, fishing gear, baits and clothes (Table 1). Mean annual expenditure exceeds 1500 € per fisher, but almost reaches 3000 € in the case of boat owners to cover fuel, maintenance costs and mooring (Pita et al., 2018c). Thus, boat angling is a very relevant economic activity, with more than 4000 boats of 6 m of average length and equipped with 60 HP engines operating in Galicia (Pita et al., 2018c).

3.1.3. Ecological impacts

Based in the available scientific documents, annual recreational catch in Galicia is about 7000 t, which represents up to 13% of commercial and recreational landings on the same species (Gordoa et al., 2019; Palas et al., 2017; Pita et al., 2018c). In the case of spear fishing, they catch up to 16% of total removals on common species to both fisheries (Pita and Freire, 2016) (Table 1).

Recreational fishers target 38 marine species in Galicia, but the main species are ballan wrasse, European seabass and white seabream (Pita et al., 2018c; Pita and Freire, 2016). Since recreational catches on these species can be even higher than commercial catches (Pita and Freire, 2016), and there have been important reductions in the

Table 1
Available key data on social, economic and ecological relevance of MRF in Galicia.

Type of information	Reference					
	Gordoa et al. (2019)	Martínez-Carbajal (2018)	Palas et al. (2017)	Pita and Freire (2016)	Pita et al. (2017)	Pita et al. (2018c)
Social relevance						
Recreational fishers (N)						
Total	65173	59438	–	–	–	59730
Boat anglers	10009	–	–	–	–	12031
Shore anglers	52525	–	–	–	–	44736
Spear fishers	2640	–	–	–	3500	2963
Mean age						
Boat anglers	–	–	–	–	–	53
Shore anglers	–	–	–	–	–	50
Spear fishers	–	–	–	–	–	37
Fishing habits (%)						
Fishing alone	–	–	–	–	–	41
Fishing with family	–	–	–	–	–	17
Fishing with friends	–	–	–	–	–	75
Dissatisfied with regulations (%)						
Total	–	–	–	–	Very poor[a]	–
Boat anglers	–	–	–	–	–	84
Shore anglers	–	–	–	–	–	65
Spear fishers	–	–	–	–	–	78
Economic relevance						
Annual fishers' expenses (M€)						
Total	–	–	–	–	–	97
Boat anglers	–	–	–	–	–	75
Shore anglers	–	–	–	–	–	17
Spear fishers	–	–	–	–	–	5
Ecological impacts						
Annual fishers' catches (t)						
Total	7275	–	–	–	–	7565
Boat anglers	1896	–	19[b]	–	–	2979
Shore anglers	4964	–	–	–	–	3828
Spear fishers	415	–	–	2069	–	758

[a] 35 experts valuated from (1 = very poor to 5 = excellent) if regulations are balanced at national, regional and local levels, and if legal adaptation to sudden events is easy.
[b] Cephalopode species only in the "ría" of Vigo, the most meridional "ría" in Galicia (Fig. 1).

abundances of these species in last decades, it has been pointed out that the evolution of their populations must be specifically controlled (Pita and Freire, 2014).

3.2. The evolution of the management of marine recreational fisheries in Galicia

Until the end of October 2018, a total of 69 regulations on MRF in Galicia have come into force. Many of the regulations have been created by Galician (38% of total) and EU administrations (36%), and 26% by Spanish regulators (Fig. 5). Based on the number of regulations produced respectively by regional, national and European institutions, three main management periods were identified: a) the national management period, between 1963 and 1982; b) the regional management period, between 1983 and 2000; and c) the European management period, from 2001 to the present (Fig. 5).

3.2.1. National management period (1963–1982)

Open access by recreational fishers ended up in 1963, when the first Spanish regulation on MRF was enacted, creating the first license regime for MRF, and imposing to recreational fishers the same minimum landing sizes already in force for commercial fishing (Gobierno de España, 1963). In that time, fisheries management in Spain was carried out by the pre-democratic Ministry of Commerce, that was also responsible for the fishing ban for crustaceans, molluscs and corals for recreational fishers (Gobierno de España, 1965) (Fig. 5).

The first democratic general regulation on MRF was enacted in 1980 (Gobierno de España, 1980), and although the management of coastal fisheries, including recreational, was transferred to the Autonomous Government of Galicia the following year (Gobierno de España, 1981), it was not until 1983 that the first regional regulation on MRF came into force (Xunta de Galicia, 1983) (Fig. 5).

3.2.2. Regional management period (1983–2000)

Between 1983 and 2000, the management of MRF in Galicia was mainly regulated by the Autonomous Government. The first Galician law of marine fishing was approved in 1993 (Xunta de Galicia, 1993a). However, MRF was previously regulated: in 1983 the first daily bag limit was established in 8 kg per fisher (of finfish and cephalopods exclusively), and spear fishing with scuba was forbidden (Xunta de Galicia, 1983). In 1991 the first regional regulation on enforcement and control of marine fisheries, including MRF, came into force (Xunta de Galicia, 1991); and since 1992 spear fishers were only allowed to target finfish, and to operate exclusively during the day (Xunta de Galicia, 1992). Moreover, spear fishers were soon again allowed to catch cephalopods (Xunta de Galicia, 1993b) (Fig. 5).

Recreational bag limit was reduced in 1999 to the current 5 kg, both for coastal waters under regional jurisdiction (Xunta de Galicia, 1999a) and for outer waters under state jurisdiction (Gobierno de España, 1999). Fishing effort was also limited in this year by restricting the number of allowed hooks (Gobierno de España, 1999; Xunta de Galicia, 1999b), by reducing the fishing days for spear fishers (Xunta de Galicia, 1999b), and by banning night fishing for boat fishers (Xunta de Galicia, 1999b). On the other hand, the need to provide information on the recreational catches of Atlantic sailfish *Istiophorus albicans* (Latreille, 1804), marlins *Makaira* spp. and *Tetrapturus* spp., European hake *Merluccius merluccius* (Linnaeus, 1758), albacore *Tunnus alalunga* (Bonnaterre, 1788), bigeye tuna *T. obesus* (Lowe, 1839), Atlantic bluefin tuna *T. thynnus* (Linnaeus, 1758) and swordfish *Xiphias gladius* (Linnaeus, 1758) was also introduced in state waters (Gobierno de España, 1999)

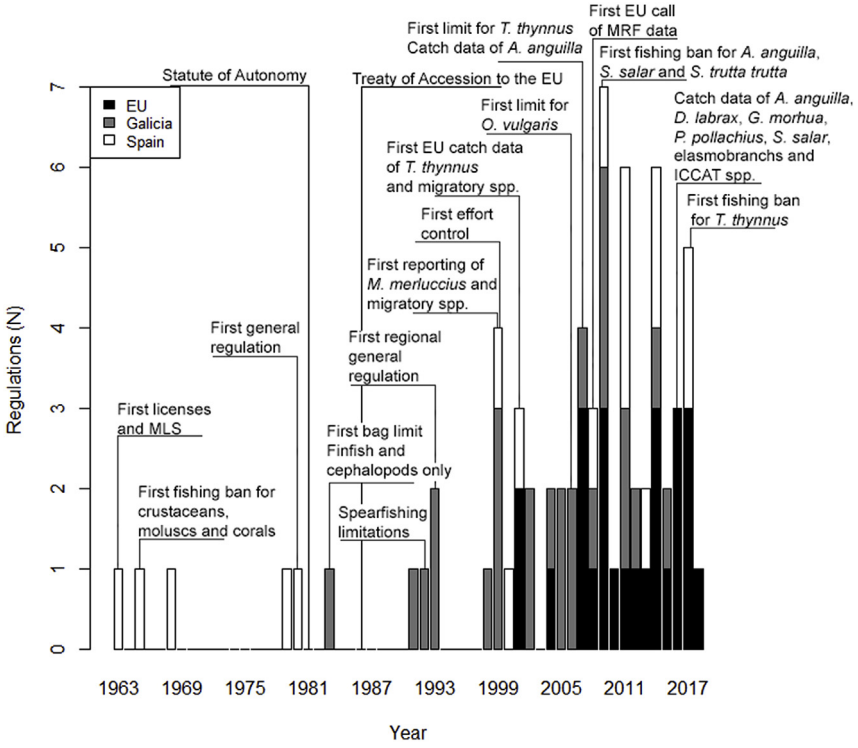

Fig. 5. Number of legal regulations about marine recreational fisheries in Galicia published in the Galician, Spanish and European Union Official Bulletins and Journals until the end of October 2018. Key management milestones are also shown (MLS = minimum landing sizes).

(Fig. 5).

Concerns about the health of the populations of common octopus *Octopus vulgaris* (Cuvier, 1797) due to the high variability of the recruitment of the species (Otero et al., 2007) and the unsustainable fishing practices -including high volumes of IUU catches-in Galicia (Villasante, 2009; Villasante et al., 2015) led the regional government to ban recreational fishing for this species in 1999 (Xunta de Galicia, 1999a), and later to develop a recovery plan that included limitations to recreational catches (Xunta de Galicia, 2006) (Fig. 5).

3.2.3. European management period (2001-present)

Spain entered the EU in 1986, but the first European regulation on MRF was enacted in 2001, when the European Commission obligated Member States to provide information on recreational catches of Atlantic bluefin tuna (European Commission, 2001) and other highly migratory species (Council of the European Union, 2001). Furthermore, the EU regulated in 2007 the recreational catch of Atlantic bluefin tuna, including quotas and a bag limit (Council of the European Union, 2007), and in 2014 restricted the fishing effort on this species by reducing the number of fishing days (European Parliament and Council of the European Union, 2014). Since 2009 Spain allowed catch and release only for Atlantic bluefin tuna to recreational fishers operating in national waters (Gobierno de España, 2009), and in 2017 banned recreational fishing on this species (Gobierno de España, 2017) (Fig. 5).

Regarding other highly migratory species, the EU introduced in 2015 the possibility for Member States to allocate part of the quota of these species to MRF (Council of the European Union, 2015) and the next year obliged to report recreational catch data on elasmobranchs and highly migratory species in Galician waters, as well as on Atlantic cod, Atlantic salmon, European eel, European seabass and pollack (European Commission, 2016). In fact, the need to provide data on the impact of recreational fishing on the EU fish stocks was already implemented in 2008 (Council of the European Union, 2008) (Fig. 5).

Moreover, the EU included the obligation to reduce mortality and report recreational catches on European eel (Council of the European Union, 2017), and in general about all those species under recovery plans (Council of the European Union, 2009). In Galicia, the regional government already introduced in 2009 the prohibition to capture this species to recreational fishers (Xunta de Galicia, 2009) (Fig. 5).

4. Discussion

4.1. The marine recreational fisheries of Galicia in a global context

Recent estimates on participation rate placed the percent of recreational fishers to total population in Galicia between 2.2% (Pita et al., 2018c) and 2.4% (Gordoa et al., 2019). This is a higher participation rate than the Spanish (1.8%; Gordoa et al., 2019) and Portuguese estimates (1.7%; Hyder et al., 2018), and in general than the average participation across European Atlantic countries (1.7%; Hyder et al., 2018). Pita et al. (2018b) suggested that the relevance of fishing traditions in the Galician culture, and its relatively low industrialization could explain this high participation. However, Gordoa et al. (2019) showed that the participation in Galicia is among the lowest of the Spanish coastal regions, and that Galicia presented the second lowest recreational fishing effort in relation to the length of the coast. The presence of a more powerful small-scale commercial fleet in Galicia sharing with MRF coastal fishing grounds and fish stocks (Palas et al., 2017; Pita et al., 2017) could provide clues to this lower access by recreational fishers compared to other Spanish regions in the Atlantic.

The greater relative relevance of commercial fleets in the European Atlantic, and Galician in particular, with respect to the Mediterranean, could be also behind differences in catch shares between recreational and commercial sectors. Thus, recreational catch share with respect to total catches (commercial and recreational) reaches up to 13% in Galicia, and was found by Pita et al. (2018b) similar to that on nearby Atlantic regions, while lower than in the Mediterranean. However, removals of ballan wrasse, European seabass and white seabream can be even higher than those by the commercial sector (Pita et al., 2018c; Pita and Freire, 2016). European seabass populations in particular are

currently being protected by EU legislation from overfishing, also limiting recreational catches in several Atlantic regions, although not in Galician waters (Council of the European Union, 2018). Taking into account that abundance of European seabass have been reduced in Galicia in the last decades (Pita and Freire, 2014), a stock assessment including recreational catches on this species should be urgently carried out, so that decisions based on sound scientific evidence can be made to ensure the sustainability of this stock.

On the other hand, the economic contribution of MRF accounts for 0.17% of Galician GDP (Pita et al., 2018c). This is a relatively higher economic contribution than that of the Spanish average (0.02% of GDP), that of neighboring countries such as France (0.04%) and Portugal (0.08%), and that of the European Atlantic average (0.04%) (Hyder et al., 2018). However, the contribution to scientific knowledge made so far in Galicia, with only five research projects and eight papers published in scientific journals is still limited (Fig. 2). Furthermore, the annual public investment in research projects barely exceeds 30 000 € (Fig. 2), a figure that represents 0.3% of the annual direct economic contribution of MRF (Pita et al., 2018c). It must be considered that annual incomes for the regional administration obtained from the licenses paid by recreational fishers exceed 180 000 €.

The regional fisheries management service of Galicia has not yet performed any regional scale study on MRF fishing. Since the first comprehensive scientific research on catches of MRF in Galicia was published in 2018 (Pita et al., 2018c), all the regulation of this activity, which introduced, e.g., the first bag limit already in the early 80s (Xunta de Galicia, 1983), has been based on regulations from other Spanish administrations, or on scientific studies carried out in other geographic areas. There are currently 23 fisheries biologists working for the regional government (*Consellería do Mar* of the Autonomous Government of Galicia, pers. comm.), and approximately 50 technicians working with them or in some of the 63 commercial fishers' associations (Macho et al., 2013). Given that this is the main task force in charge of the direct management of 4000 commercial vessels and 4000 on-foot shellfishers (Pita et al., 2018a), it seems necessary to increase their number and improve their training to address the management of MRF.

4.2. Rivals or allies: commercial versus recreational fisheries

Long-term sustainability of global (Anticamara et al., 2011; Froese et al., 2011; Pauly, 2009), European (Froese et al., 2011; Lloret et al., 2016; Tsikliras et al., 2015) and Galician fish stocks (Freire and García-Allut, 2000; Pita et al., 2018a; Pita and Freire, 2014; Villasante, 2009) has been threaten by overfishing and other human-induced impacts. In addition to the decrease in the available fishing resources, the incorporation of Spain to the EU caused a dramatic loss of industrial fishing capacity as a result of the European policies of incentives to vessel decommissioning and the shortage of available quotas derived from the principle of relative stability (Surís-Regueiro et al., 2003). Furthermore, Galician small-scale fisheries are also immersed in a deep crisis which has resulted in a decline in the number of boats and employment opportunities in the last decades (Freire and García-Allut, 2000; Pita et al., 2018a; Villasante, 2010). In this context of severe loss of economic capacity and labor force, traditional dependence on fishing of Galician coastal communities (Surís-Regueiro and Santiago, 2014) poses serious social threats.

The first Spanish (e.g., Gobierno de España, 1965, 1963) Galician (e.g., Xunta de Galicia, 1992), and European (e.g., Council of the European Union, 2017) regulations on MRF were initially created to protect marine resources from excessive fishing pressure and to favor commercial fishing from competition by recreational fishers. As the conservation status of European fishing resources has been deteriorating, conflicts between commercial and recreational fishers have increased (Lloret et al., 2016). A similar pattern of competition for limited resources between commercial and recreational fishers led to the virtual demise of commercial fishers and a progressive strengthening of recreational fisheries in European inland waters (Boisneau et al., 2016). Analogous trends in the marine environment are taking place, e.g., in eastern U.S.A., where commercial fishers feel discriminated regarding recreational (Boucquey, 2017); or in southwest Australia, where policy makers have been recently encouraging recreational versus commercial fisheries, leading to undesired loss of valuable ecosystem services to local populations (Brown, 2016; Voyer et al., 2017). However, the idea that both fisheries share the same objectives in a context of socio-ecological sustainability has been gaining acceptance in recent years (Pita et al., 2017). Indeed, representatives of both sectors often reach agreements in the Advisory Councils, stakeholder-led organizations that provide recommendations on fisheries management in the EU (Council of the European Union, 2009).

Policy makers must therefore perform a detailed diagnosis of the current state and of the temporal evolution of commercial and recreational fisheries, but also of other relevant activities sharing the same coastal areas, such as tourism or recreational navigation, to evaluate potential plausible future scenarios derived from the implementation of new policies in Galicia. These new policies should favor the maintenance of commercial fisheries to sustain the economies that depend on their activity and supply markets with a product that is commercially appreciated, with a positive influence on human health (Verbeke et al., 2005). On the other hand, the economies related to MRF should be further developed, e.g., in relation to tourism. Charter fishing has been little exploited in Galicia with respect other relatively close regions (Holland et al., 1998), and it could take advantage of the growing influx of visitors to Galicia (Cortés-Jiménez, 2008). A thriving recreational sector could offer new opportunities to temper social and economic effects of the current commercial fishing crisis. In fact, economic enhancement measures for MRF have already been incorporated into the fishing regulations of other Spanish and European regions (Pita et al., 2018d); while the European Parliament is currently promoting this type of economic initiatives regarding MRF (European Parliament, 2018).

4.3. Hooking in sustainable marine recreational fisheries

In this study it was shown that until recently MRF has been away from the first line of the Galician, Spanish and European policies, which were far more concerned about managing industrial and even small-scale commercial fisheries (Pita et al., 2018d). Thus, there is a need to increase the presence of MRF in the agendas of policy makers, and some EU institutions have been acting as the main engines of this effort. The Common Fisheries Policy (CFP) recognizes the impacts of MRF and asks Member States to take necessary actions to ensure that common fish stocks are exploited in a sustainable manner (European Parliament and Council of the European Union, 2013). Actually, the EU started requesting Member States for information about the impact of MRF on the EU fish stocks already at the end of 2000s (Council of the European Union, 2008). This constituted a paradigm shift in MRF policies, that until then had been mainly devoted to regulations aimed at the conservation of single species (e.g., Council of the European Union, 2015, 2007), to begin progressively developing an ecosystem approach to manage common fisheries (Pita et al., 2018d). Moreover, the European Parliament has recently pushed to improve and increase the current data collection framework on MRF to obtain a more comprehensive range of mandatory data, including catches on more stocks and species, but also socioeconomic information (European Parliament, 2018).

Although the Spanish legal framework is reasonably well prepared to carry out an ecosystem management of fisheries, including recreational activity (Pita et al., 2018d), as noted above, the regulation of MRF in Galicia lacks support from scientific or technical studies, and the influence of new regulations remains unknown. For example, first bag limit was established in 1983 to 8 kg per day and fisher (Xunta de Galicia, 1983), and 16 years later it was reduced to 5 kg (Gobierno de España, 1999; Xunta de Galicia, 1999a), but the influence of these

changes on fish stocks and on fishers access has not been evaluated yet. Furthermore, since EU regulations are focused on common fish stocks managed under quota system and on species under conservation threats, and Galician fishers are mainly targeting species that are not under these regulations (Pita et al., 2018d), there is an institutional decoupling in the data needed to develop sustainable policies for MRF. Accordingly, as stated by Pita et al. (2018c, 2017), the different public administrations need to increase their coordination to develop more simple and coherent fisheries management at different spatial and institutional scales.

Furthermore, the Autonomous Government of Galicia needs to improve the regional fisheries service with technical expertise and studies to fulfill not only current EU needs in relation to MRF data, but also to anticipate future requirements to ensure that MRF is both ecologically and socioeconomically sustainable (European Commission, 2018). The incorporation of fishers into co-management initiatives has been proposed as a good solution to help managers to develop policies that could be better followed by recreational fishers, and therefore potentially increase compliance (Pita et al., 2018c, 2017).

In addition to the suggested improvements in fisheries management, more involvement of scientific institutions is also needed to provide sound information to guide management decisions. It is evident that the research actions developed to date in Galicia (Fig. 2) are not enough to cover current relevant gaps in knowledge. In this sense, it is urgent to obtain information on fishers' habits, attitudes and values (Hauck et al., 2002; Ward et al., 2016), which, in addition to a standardized and periodic monitoring program to assess the recreational fishing effort and catches, will provide information about the ecological impact of this activity. New technological tools like smartphone apps (Venturelli et al., 2016), in combination with the incorporation of the traditional ecological knowledge of recreational fishers into the traditional scientific knowledge (see e.g., Palas et al., 2017) could also help to develop cost-effective monitoring frameworks.

Other research gaps that need to be covered in the near future are related with the biology and ecology of relevant target species like ballan wrasse, a key species of rocky reef and kelp forest ecosystems (Pita et al., 2018b; Pita and Freire, 2017). Also, an evaluation of catch and release practices, voluntary or mandatory (related to undersize fish), including an analysis of the extent of their use among fishers and triggering factors, and their effect on fish mortality, would be desired (Pita et al., 2017).

Policy makers, managers and scientists need powerful and cohesive fishers' associations to help them to develop and support new regulations and to collaborate in research initiatives (for a comprehensive list of proposals on this regard see Pita et al., 2017). However, although shore angling is the main MRF modality in Galicia (Pita et al., 2018c), as in the rest of Spain (Gordoa et al., 2019) and in neighboring regions (Pita et al., 2017), an association of shore anglers is still missing. The European Fisheries Fund (Council of the European Union, 2006) could help to create associations of shore anglers, as well as encouraging the strengthening of associations and fishing clubs that already exist in Galicia, to promote the sustainability of this complex socioecological system.

Acknowledgements

This work received funds from the Xunta de Galicia (RECREGES I and II projects under Grants ED481B2014/034-0 and ED481B2018/017), and SICORE project, funded by Fundación Biodiversidad, Ministerio para la Transición Ecológica, Gobierno de España, Pleamar program, which is cofounded by the European Maritime and Fisheries Fund. SV acknowledges the financial the European COST Action “Ocean Governance for Sustainability - challenges, options and the role of science”, the ICES Science Fund Project “Social Transformations of Marine Social-Ecological Systems”, and the CYTED program for the ECOMAR Network.

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