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Recreational fishing in Spain: First national estimates of fisher population size, fishing activity and fisher social profile

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ABSTRACT

This study represents the first nationwide assessment of marine recreational fishing in Spain. A new cost-effective approach was used to collect fisher's information: an online application adapted to different platforms was kept operative from February 2016 to February 2017. Commercial and non-commercial dissemination campaigns represented substantial differences in their success rate and cost-effectiveness. In this study, fisher's population size, profile and fishing activity were analysed for shore fishing, boat fishing and spearfishing independently in each of Spain's Autonomous Communities (AC). The official recreational fishing population according to the license registries reported by the AC is of 871,533 fishers, but this study reveals that around 5% of fishers are unlicensed. The most popular modality was shore fishing (83.6% to 67% of recreational fishers) followed by boat-fishing (11% and 31%) and spearfishing (1.2% to 4.9%). The mean age varied significantly between modalities: 36 years for spearfishing, 41 years for shore fishing and 45 years for boat fishing. The education level of spear-fishers and boat-fishers were both higher than that of shore-fishers, which had the highest levels of unemployment. Fisher satisfaction levels of the activity and the catch were high for every modality and AC. Interestingly, a 94% of our respondents declared that their catch was for household consumption. Catch rates differed significantly between fishing modalities: shore fishing had the lowest catch rates (1.17 kg d^{-1}s.e. 0.028), followed by spearfishing (2.02 kg d^{-1} s.e. 0.044) and boat fishing (2.91 kg d^{-1} s.e. 0.78). Estimates of annual fishing days (shore fishing 60.6 d y^{-1} s.e. 0.67; boat fishing 57.1 d y^{-1} s.e. 0.092; spearfishing 51.5 d y^{-1} s.e. 0.71) did not differ from those of previously published studies using onsite surveys in the same regions, despite the fact that our sample could be potentially over-representing avid fishers. The implications of misestimating annual effort and its importance on MRF impact are also discussed.

1. Introduction

The worldwide increasing interest in Recreational Fishing (RF) is evidenced by the rise in scientific publications observed over the last years (Rocklin et al., 2014). In Marine recreational fishing (MRF) this tendency is certainly understandable, given its interaction with the professional fishing sector and its effects on marine resources (Coleman et al., 2004; Cooke and Cowx, 2004; Ihde et al., 2011; McPhee et al., 2002). MRF literature is comprised by a wide variety of studies, some using MRF data for biological or population studies (Bennett, 1993; Hood and Schlieder, 1992; Manooch and Haimovici, 1978; Poot-López et al., 2017; Thurstan et al., 2017), others directly studying the activity and its impact (Coleman et al., 2004; Eero et al., 2014; Lewin et al., 2006; Lindfield et al., 2014), and still others analyzing fisher's profile and motivations (Cooke et al., 2018; Fedler, 1984), or its potential effects on fish consumption and demand (Morales-Nin et al., 2013). The positive or negative impact of this activity, inferred from different studies, depends greatly on the analyzed subject. Studies on RF's economic value or on its effects on social wellbeing tend to portray the activity's positive impacts (Franquesa et al., 2004; Lovell et al., 2013; McConnell, 1979; Pascoe et al., 2014; Peirson et al., 2001; Steinback et al., 2004; Morales-Nin et al., 2015), while those with ecological or biological perspectives mostly observe the negative ones (Coleman et al., 2004; Donaldson et al., 2003; Font and Lloret, 2014; Marengo et al., 2015). Further, the underlying moral debate and the conflicting moral economies are more topical than ever, especially where key concepts like fishing values or public resources contribute to the conflict with the professional fishing sector (Boucquey, 2017). Consequently, the perceptions on MRF vary between advocates and detractors, recreational or professional fishing stakeholders both justifying their positions from different considerations or moral arguments. But, both the recreational and professional sectors have socially

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and economically important roles in coastal communities, furthermore, they can be interdependent (Voyer et al., 2017).

The contribution of MRF to the global catch faces growing attention (Aas, 2008; Cooke and Cowx, 2006; McPhee et al., 2002) and different studies are stressing that management based only on commercial fishing data could be insufficient, highlighting the need to include MRF data in stock assessments (Griffiths and Fay, 2015; Lewin et al., 2006; Cabanellas-Reboredo et al., 2017). To do so, it is first necessary to have good estimates of MRF harvesting data and to develop national monitoring programs. In European countries, the need for national MRF monitoring programs has been repeatedly stated for almost two decades (Roth et al., 2001). Furthermore, since 2008 the EU Council obligates member states to estimate recreational harvests as a part of the Common Fisheries Policy (EC, 2008, 2011). However, the Data Collection Framework introduced by The European Commission only requires estimates of annual recreational catches for a few species, which vary across regions. As a consequence of this command, several European countries initiated national surveys to estimate the recreational catch for listed species such as cod, sea bass and eels (Sparrevohn and Storr-Paulsen, 2012; Strehlow et al., 2012; van der Hammen et al., 2015). Recently, a regional survey provided the first catch estimates of sea bass for the entire MRF in the Spanish AC of the Basque Country (Zarauz et al., 2015). But still, in many European countries the data collection programs on MRF continues to be a pending subject, leading to large differences in MRF data quality between countries as has been recently pointed out (Hyder et al., 2017). The deficiency in MRF national surveys is more pronounced in Southern European countries (Pita et al., 2017) with the exception of France, the only country that has carried out a nationwide pilot study so far (Herfaut et al., 2013). Nevertheless, the scientific interest on MRF in Southern European countries is relevant, as evidenced by the numerous published studies. Most of these studies are limited regarding the spatial coverage and the RF modalities analyzed (Chavoin and Boudouresque, 2004; Diogo and Pereira, 2013; Font and Lloret, 2011; Lloret et al., 2008b; Pranovi et al., 2016; Rangel and Erzini, 2007; Veiga et al., 2010). With the exception of two studies, carried out in the Basque country and Balearic Islands (Morales-Nin et al., 2005; Ruiz et al., 2014), which covered the three main RF modalities: shore angling, boat angling and spearfishing. Recently, the first synthesis of MRF across Europe compiled all the available information providing estimates for European states (Hyder et al., 2017) and revealed the deficient or null information available in many countries.

The poor information on MRF could be attributed to Government´s generalized lack of interest in the sector, but also difficulties associated to the very nature of MRF. Approaching MRFs comes with great challenges due to the diffuse character of both the sector and the activity. The MRF sector is poorly represented, because the numerous local associations lack coordination. Thereby, MRF lacks structure and a representative body that might look out for their common interests. Consequently, the absence of an interlocutor makes it all the more difficult for other bodies or groups of interests to approach the sector. On the other hand, the nature of the activity itself, which is remote and diffuse, complicates the achievement of representative sampling surveys. Survey methods have their own strengths and weaknesses, and their appropriateness varies with the objectives and scale of each particular survey (ICES, 2010; Pollock et al., 1994). In general, they can be categorized as off-site and on-site methods (Zarauz et al., 2015). Off-site methods are the most feasible and cost effective for fisheries that are diverse and operate over large spatial scales (Hartill et al., 2012) but they present several biases (Connelly and Brown, 1995; Lyle et al., 2002; Vaske et al., 2003). Moreover, registries of fishing license holders are the preferred sampling frame when they are available (Teixeira et al., 2016), they are used in many surveys worldwide, and provide representative sampling frames at low cost (ICES, 2013). However, license holders´ contact details are private information, and therefore protected by data protection laws and challenging to obtain unless the surveys are part of a monitoring program where the administration is in charge or directly involved.

In Europe, MRF depends on national and regional administrations, which explains the great differences in national MRF policies among and within European countries (Gaudin and De Young, 2007; Gordoa et al., 2004; Pawson et al., 2008). In Europe, the Spanish MRF policy is one of the most restrictive, alongside the Portuguese. It includes a mandatory fishing license, daily bag limits, gear and tackle limitations as well as banned species and size limits among others measures (Decreto 347/2011). However, the management of MRF in Spain is transferred to the coastal autonomous administrations, which are responsible for issuing the licenses and have the authority to add more limitations in their coastal area of responsibility, creating different management scenarios (Gordoa et al., 2004). This situation makes it more difficult to manage the activity, and also to develop national surveys. In addition to the abovementioned difficulties associated to MRF and the little concern shown so far by the fisheries administration, a national survey would also require coordination and cooperation among regional and national administrations and their different management bodies.

Spain is a country with a deeply rooted fishing culture, both recreational and professional. It is practiced along its 8000 km coastline, which is divided at the administrative level into ten AC; five in the Mediterranean basin and five in the Atlantic. In Spain, MRF has received little attention, and no national survey has been carried out so far. Only in two AC, the Balearic Isl. and the Basque country, has MRF been assessed (Morales-Nin et al., 2005; Ruiz et al., 2014). Here, we present the results of a study on MRF in Spain, with the aim of filling in the current deficiency in information. A cost-effective online-based application was developed and adapted to different terminals (smartphones/computers) and its strengths and shortcomings were examined. It was coupled with broad dissemination campaigns, both commercial and non-commercial, and also prize raffles and an associated informative website intended to approach marine recreational fishers, and encourage their participation. This study is part of a broader project, which includes four major subjects: fisher profile and behavior, fishing activity, fishing associated costs and catch composition. Here we present the results of the first two topics for the three main fishing modalities: fishing from shore, fishing from boat and spearfishing, providing essential information on MRF by modality and also by AC. The reliability of the different results obtained here was examined and contrasted with those previously published at regional scale in Spain.

2. Material and methods

2.1. Recreational fishers population

Spain is divided into 17 Autonomous Communities (AC), 10 of which are coastal regions, which are responsible for issuing MRF licenses (Fig. 1). The official recreational fishers in Spain are those registered in the RF licence system. This information was requested to each of the 10 fishing administrations of the coastal AC. Licence domains are not consistent and vary among AC: Andalusia, Asturias, the Balearic Islands and the Valencian Community have independent licences for boat and shore angling; whilst Cantabria, the Canary Islands, Catalonia, Galicia, the Basque Country and Murcia include both modalities in a single angling licence. In the Balearic Islands, boat licenses are not issued for each individual fisher, but for each RF vessel. Consequently, the number of licenses do not correspond to the number of fishers. In this particular case, we estimated the average crew in the Balearic waters from the information provided in Morales-Nin et al. (2005) as 1.78 fishers per vessel. The product of this value by the number of licenses was considered a proxy of the number of boat fishers in this AC. The Catalan case is more complex because since the year 2000, the so called “surface fishing license” included inland and marine angling together. In a previous study, (Gordoa et al., 2004) the Catalan

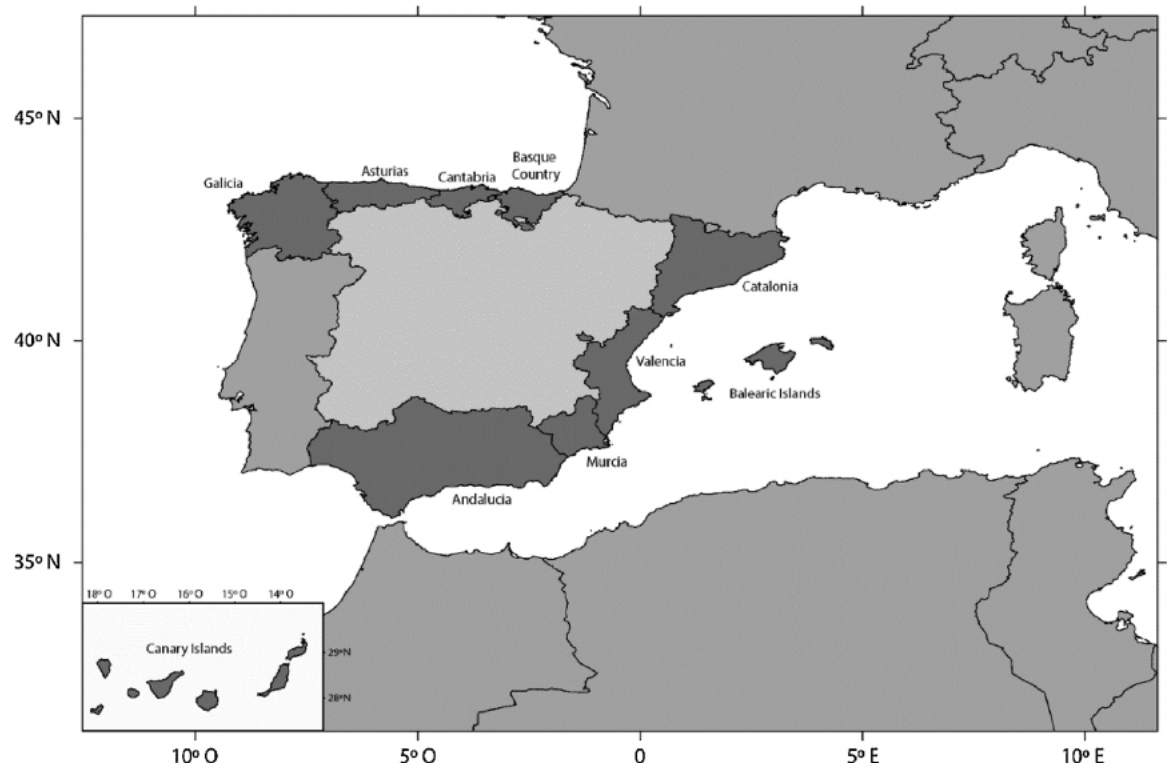

Fig. 1. Map of the study area. The darker regions highlighted correspond to the Spanish Coastal Autonomous Communities.

Fisheries administration provided us with the proportion of inland and marine angling participants (before the year 2000) being 40% and 60% respectively. In this study, we estimated the number of marine anglers as a 60% of the "surface angling" fishing licenses. In addition, in those AC with a single marine angling license, the proportions estimated for each modality were estimated using a geographical proximity criterion, except for the Canary Isl., where we extrapolated Spanish averages. The spearfishing fishing licence is specific in all AC.

2.2. Questionnaires

A preliminary phase of research was devoted in 2015 to identify the questions for each of the four topics of interest: the fishers´ profile, the fishing activity, the associated costs and the catch composition. The comprehensiveness of the questions was tested on small groups of recreational fishers, and, when necessary, questions where re-formulated accordingly. In this study, we analyzed the first two topics: the social profile and fishing activity of the fishers.

The specific questions related to these topics were common for the three modalities and all the AC. The specific included were: AC where they fish, age of the fisher, years of experience, education level, employment status, gender, recreational license ownership, sport license ownership, participation in contests, daily fishing hours, annual fishing days, percentage of days without catch, daily catch on days with catch, catch destination, satisfaction level with the catch and satisfaction level with the activity. After the last question, they were asked to volunteer their contact information. The subset of questions addressed by this study are appended (A.0). It is worth noting that in Spain, recreational fishing licenses are mandatory and the sport license is additionally required for participating in competitions.

2.3. Online application and dissemination campaign

Data collection was done using an online application adapted to different platforms (including smartphones and tablets), which was kept operative from February 2016 to February 2017. The application was developed using the online survey software tools of SurveyGizmo platform. This platform allows developing a complex questionnaire architecture, where a logic flow branches out questions to each particular respondent. The platform provides a continuous data reporting system and also registers the date, the starting and finishing time, the geographical location (Country and municipality) and the IP addresses.

A dissemination campaign was carried out in an initial stage, by contacting directly with all the official Sportive federations of underwater activities and angling fishing. Information of the project´s objectives was sent to a total of 323 entities between yacht clubs, recreational and sport fishing associations, fishing tackle and diving shops. Promotional posters were sent to the whole list of contacts requesting the dissemination of the project among their members, associates, costumers and at their websites and on-site facilities. The campaign also included social networks (Facebook and Twitter). The dissemination campaign was successful during the first month, in which 1300 entries were recorded. After the first month, the number of entries dropped sharply, to around 80 per month. To overcome this problem, we launched two commercial campaigns through Facebook, from 14th May to 17th July and from 12th to 20th October. Finally, during the last four months, a second commercial campaign was launched through Google AdWords, using both the search and display approaches.

2.4. Data analysis

Duplicate IP address entries were revised, some corresponded to complete entries preceded by incomplete ones, in which cases the first the first entry was removed. Other duplicate entries had the same IP addresses providing complete information; these where individually checked through phone calls. Most of them were explained either by family members or friends using the same device, but others were full replicas presenting analogous or identical information. These cases were scrutinized, and only one valid entry was kept.

A number of incomplete entries were removed, either because they provided insufficient or unreliable information (very likely from people engaging casually, but unwilling to provide information). During the

data preparation period we found some questionable answers such as extreme values of daily catches or number of fishing days. In those cases, we phoned the participants to corroborate or revise their answers but in most cases they corroborated their data providing additional explanations.

The total population size of people engaging in MRF included all license registers and an estimate of unlicensed fishers. The proportion of unlicensed fishers (PUF) was given by the percentage of unlicensed fishers declared in the surveys in each AC and for each fishing modality. The total population size of unlicensed fishers was then estimated as the product of recreational fishing licences (RFL) reported officially by each AC and the corresponding percentage of unlicensed fishers declared in the surveys (PUF). The total number of recreational fishers (TRF) was:

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Participation rates were then determined as the proportion of TRF relative to each AC's total population.

The average age of the respondents was estimated for each fishing modality and within each AC. Additionally, the age frequency distribution by modality was compared with the Spanish demographic pyramid using The Kolmogorov-Smirnov test. In this analysis ages < 15 yrs were excluded because in Spain the RF license are only issued for ages older that 14 or 18 yrs., varying among AC. Recreational fishers' gender ratio, educational level and employment status was estimated for each fishing modality separately. The proportion of recreational fishers potentially involved in fishing competitions was given by the percentage of respondents with a sport fishing license, and was later compared with the percentage that declared participating in fishing contests.

Fishers were asked to provide their daily catch in kg (DC) of the days with catch. Thus, Daily catch rates (DCPUE) per fisher were estimated by weighting DC by the declared percentage of days without catch (DWC):

The Average daily catch rate and annual fishing days (AD) per fishing modality and AC were estimated as:

Where N is the number of respondents per AC and fishing modality.

Total annual catches (TAC) for each AC and modality were estimated by multiplying the average daily catch rate (DCPUE) and the average annual fishing days (AD). Adjusted values of effort were used to provide a second value of total catch. To do this, a second value of effort was calculated for each AC using as a reference value the effort presented by Ruiz et al. (2014) for the Basque Country. Specifically, the values of effort obtained in our study for each other AC were divided by the value obtained in the Basque Country, and then multiplied by the reference value of effort.

3. Results

The effect of the commercial dissemination campaigns was diverse: a minor success was obtained with Facebook, and substantial one with Google AdWords (Fig. 2). The cost-benefit analysis of the two Google AdWords commercial campaigns (search and display), showed substantial differences between both approaches. The number of visualizations was higher in the display campaign: over 8 million compared to the 327 000 of the search campaign. The cost per click was 0.11 € and 0.29 € for the display and search campaigns respectively, and the net conversion rate's cost per finalized questionnaire was 1.6 € and 14.6 €. The platforms used by the respondents were mostly smartphones (62%), followed by computers (30%) and tablets (8%).

After the data pre-treatment, the number of entries was reduced from 7848 to 6261. Of all the participants, a 4% declared living inland

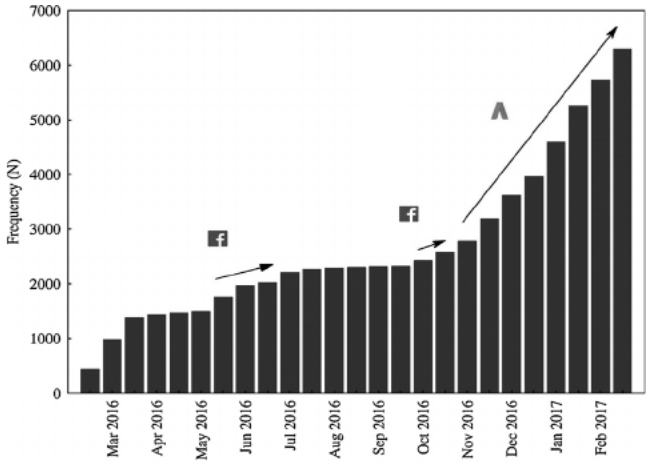

Fig. 2. The distribution of accumulated entries throughout the operative frame of the online application. The arrows show the periods with ongoing commercial campaigns (Facebook and Google AdWords).

(not in the coastal AC), most of which declared living in Madrid (46%). A detailed description of the regions of provenance and the coastal receiving regions is appended (Table A.1)). More than 95% of participants were men in all three modalities (96% of shore anglers, 98% of boat anglers and 98% of spear fishers). The percentage of participants without recreational fishing license varied slightly between modalities: 6.3%, 3.7% and 5.9% of shore, boat and spear fishers respectively. The fraction of participants holding sport fishing licenses varied substantially between the three modalities: 19% (shore angling), 24.4% (boat angling) and 59.7% (spearfishing). Yet, not all of those holding a sport license declared participating in fishing contests: 61.8% (shore), 63.6% (boat) and 36.8% (spearfishing).

The modal age interval of the fishers was 35–39 years for the three fishing modalities, but the mean age varied significantly between modalities; 36 years (s.e. 0.23) in spearfishing, 41 years (s.e. 0.25) in shore fishing and 45 (s.e. 0.33) years in boat fishing. The age distribution of spear fishers showed that they engage in the activity earlier and abandoned younger than recreational anglers (Fig. 3). The results of the Kolmogorov Smirnov test showed that only the age frequency distribution of spearfishing differed significantly ($p < 0.05$) from the Spanish population pyramid. Spear fishers' and boat fishers' education levels were similar, and they were both higher than that of shore fishers, who also showed the highest levels of unemployment (Fig. 4). While boat fishers presented the highest proportion of self-employed and retirees, spear fishers had the highest proportion of students. A detailed account of employment status by AC and modality is appended (Table A.2).

Fishers' average satisfaction levels were always high, both for the catch perception and for the activity as a whole (Fig. 5). Spearfishing showed the highest levels in both variables (Fig. 6), and its satisfaction with the activity was less dependent on the perceived catch satisfaction. The official fisher population according to the registered number of licenses received from the AC fisheries administrations was 871533. This figure was corrected by the fraction of reported unlicensed fishers, giving a final number of 921726 recreational fishers. This information is also detailed by AC and fishing modality (Table 1). Fisher participation rates and the fraction of the population engaging the activity varied from a minimum of 1.31% in Catalonia to a maximum of 7.02% in Asturias. The Spanish participation rate in recreational fishing, considering a population of approximately 46.56 million in 2016, would be 1.98%. The most popular modality was shore fishing which had varying proportions among AC, from 83.7% to 58% of the total population of recreational fishers. Boat fishing activity varied between 11.4% and 38.5% while spear fishers represented the smallest fraction: from 1.3% to 4.9% of the recreational fisher' population. An interesting

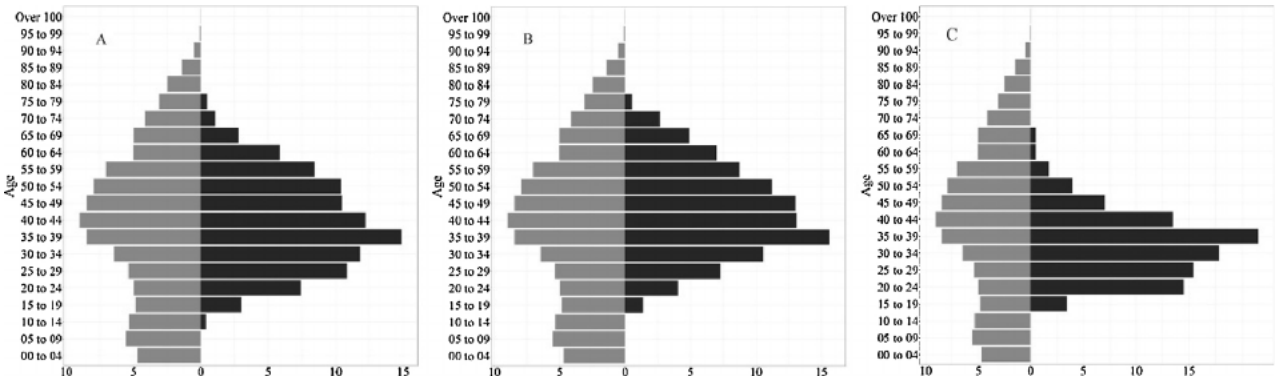

Fig. 3. Age structure of marine recreational fishers (bars in black): A) shore fishers, B) boat fishers and C) spear fishers. The structure of Spanish´ population pyramid (bars in grey) of 2016.

result was the type of boats used by the boat anglers participating in this survey. Motorboats were the most frequent type (88%), as we would expect, followed by rowing boats (10%), including kayaks; while sailboats only represented 2% of the total.

Daily catch rates differed significantly between fishing modalities (Table 2). Shore fishing was the modality with the lowest catch rates (1.17 ± 0.05 kg), followed by spearfishing (2.02 ± 0.08 kg) and boat fishing, which had the highest rates (2.91 ± 0.16 kg). The results of the destination of the catches showed that most respondents declared it was for household consumption, but a small fraction of fishers declared that more than 50% of it had a different destination (Fig. 7).

Daily effort did not differ significantly in the number of fishing hours between shore (5.69 ± 0.11 h) and boat fishers (5.80 ± 0.13 h), however, they did differ significantly for spear fishers, which had a daily effort of 4.02 ± 0.07 h. Annual fishing days did vary significantly between all three modalities. Shore fishing had the highest values (60.6 ± 1.33 d) followed by boat fishing (57.09 ± 1.81 d) and shore-fishing (51.50 ± 1.39 d). The frequency distribution of this variable for the three fishing modalities showed their modal class at the highest values (Fig. 8), indicative that respondents represent the most active fishers. Consequently, the representativeness of the annual effort estimated in this study for the whole recreational fishing population is questioned. The total annual catch, which is a product of the daily catch rates and annual effort is detailed by modality and AC in Table 2.

The total annual catch can be distorted by the estimation of the annual effort, and by the assumption that the size of the fisher population corresponds to the population of active fishers. This generalization is the most commonly used in the literature, with the exception of a study carried out in the Basque Country (Ruiz et al., 2014). These authors used the registries of fishing license holders as the sampling frame and estimated the percentage of inactive fishers per fishing modality (15% for shore fishing, 17% for boat fishing and 7% for spear fishing); they also estimated the annual fishing effort of the active fishers for shore-fishing (32 d), boat-fishing (42 d) and spear-fishing respectively (27 d). Here, we reassess the total catch using Ruiz et al.'s (2014) proportions of annual effort to estimate the population of active fishers and annual fishing days by modality (Table 2). The total catch for the entire country would be 40 015 t, most of it (35.8%) caught in one single AC (Andalusia).

4. Discussion

This study represents the first nationwide assessment of marine recreational fishing in Spain. It provides the official recreational fishing population size, which was unknown until now, despite the mandatory recreational license system that exists in this country.

The cost-effective benefits of online surveys have been mentioned in numerous studies (Papenfuss et al., 2015). They are an approach with a potentially unlimited spatial reach, but their effectiveness depends, to a great extent, on their success in reaching the target group and obtaining representative population samples. In this study in particular, the first challenge was to make fishers aware of the existence of the survey and to attract them to participate voluntarily. The initial dissemination campaign had a limited impact, despite the direct communication plan through a large and diverse list of contacts representing different group of interests, and in spite as well of the raffle prizes. The obvious reality is that in order to successfully connect with the people in today´s connected society, internet tools are required. We used different approaches, which spanned from social networks to search and display commercial campaigns. Each of them presented substantial differences in their success rate and cost effectiveness, as shown in our results. The analysis of these observed differences are out of the scope of this study, but the results might provide some guidance for future studies. In this context, it is important to highlight that the search and display campaigns change the direction of the approach. The advertisements are passive online elements that allowed participants to reach the survey through their continuous internet searches.

The recreational fishing population in Spain, according to the current license registries is of 862903 fishers. This represents nearly 3 times the number of marine recreational fishers recently reported through indirect estimations (Hyder et al., 2017). Nevertheless, illegal fishers (those without license) do exist, to a greater or lesser extent, and consequently the true size of the fisher population is actually higher than the number of licenses. This study estimated that at least a 5% of fishers are currently fishing without license, a value that was similar to that estimated in southern Portugal (Veiga et al., 2010) but which was extremely lower than the 41% of unlicensed fishers reported in Majorca island during the last decade (Morales-Nin et al., 2005).

The current participation rate in MRF in Spain is around 1.8%. This participation value is similar to the values estimated in neighbouring countries, but far lower than those estimated in northern European countries (Hyder et al., 2017). Participation rates vary among the main fishing modalities: shore fishing being the most popular, followed by boat angling and, to a much lesser extent, spearfishing. This participation pattern was previously shown in Balearic waters and the Basque country (Morales-Nin et al., 2005; Ruiz et al., 2014), and has here been ratified for every coastal region in Spain. The popularity of shore fishing is understandable, given its low economic and physical requirements, as well as its lower dependence on the weather conditions. On the other hand, spear fishing in Spain represents a very small proportion of MRF, with similar values to those estimated in France (Herfaut et al., 2013). Boat angling, which presents intermediate levels of participation, is mostly practised from motor-boats, and to a lesser extent, from sailing-boats; it is consequently associated with high economic impacts, as demonstrated by different studies carried out in Spain (Franquesa et al., 2004; Gordoa et al., 2004; TRAGSATEC, 2005; Zarauz et al., 2013). These fleets require port facilities and skippers with boat-master's license and maritime training. This study, however,

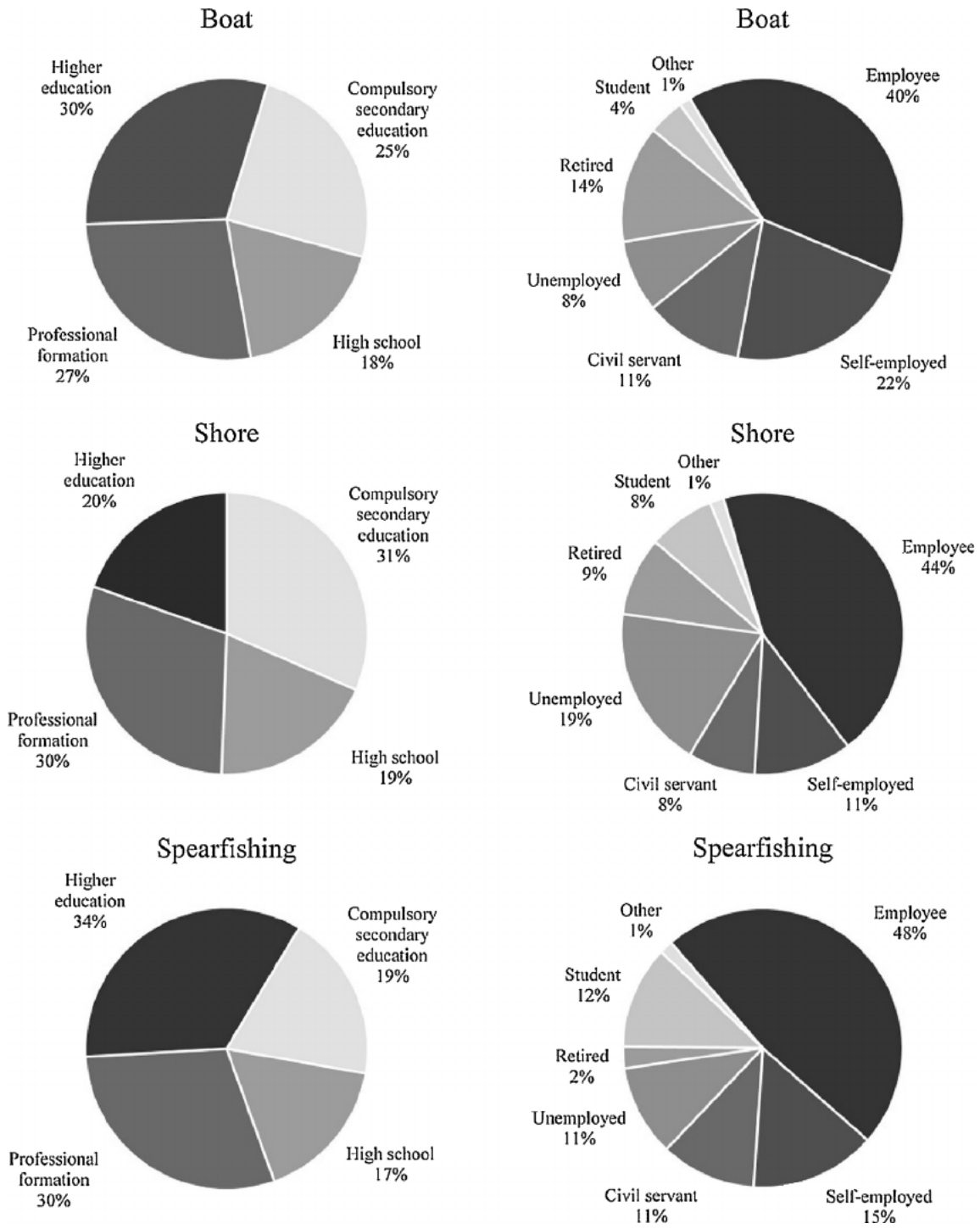

Fig. 4. Educational attainment and Employment status for each fishing modality.

reveals a new type of vessel, which is almost free from these requisites: a 10% of boat anglers fished from kayaks. This previously unreported typology has fewer requirements, and consequently the potential of emerging fast. Rowing boats do not have to be registered, and are hence hard to quantify so we recommend to pay particular attention on them in future studies.

Sport fishing licenses, which are issued by the sport fishing federations, are unnecessary to practice recreational fishing in Spain, but compulsory to participate in official fishing contests. In Spain, Sports fishing federations are organised at state and regional level and represent the major structured entity related to recreational fishing. Nevertheless, according to our results, their representation is limited to under a 25% of recreational anglers, but it is significantly higher for spear fishers, 60% of which are members of sport fishing federations. However, the possession of a sports license doesn´t necessary imply that the fishers participate in competitions, as revealed in this study, thus the affiliation might be due to other reasons. Sport licenses can offer additional advantages such as accident and personal liability insurance, which is mandatory for the spearfishing practice in Spain. Moreover, the legislation associated with this modality has an added requirement that explains the high percentage of federates in spear fishing. In Spain, spear guns are under the current arms regulation (Decreto 137/1993),

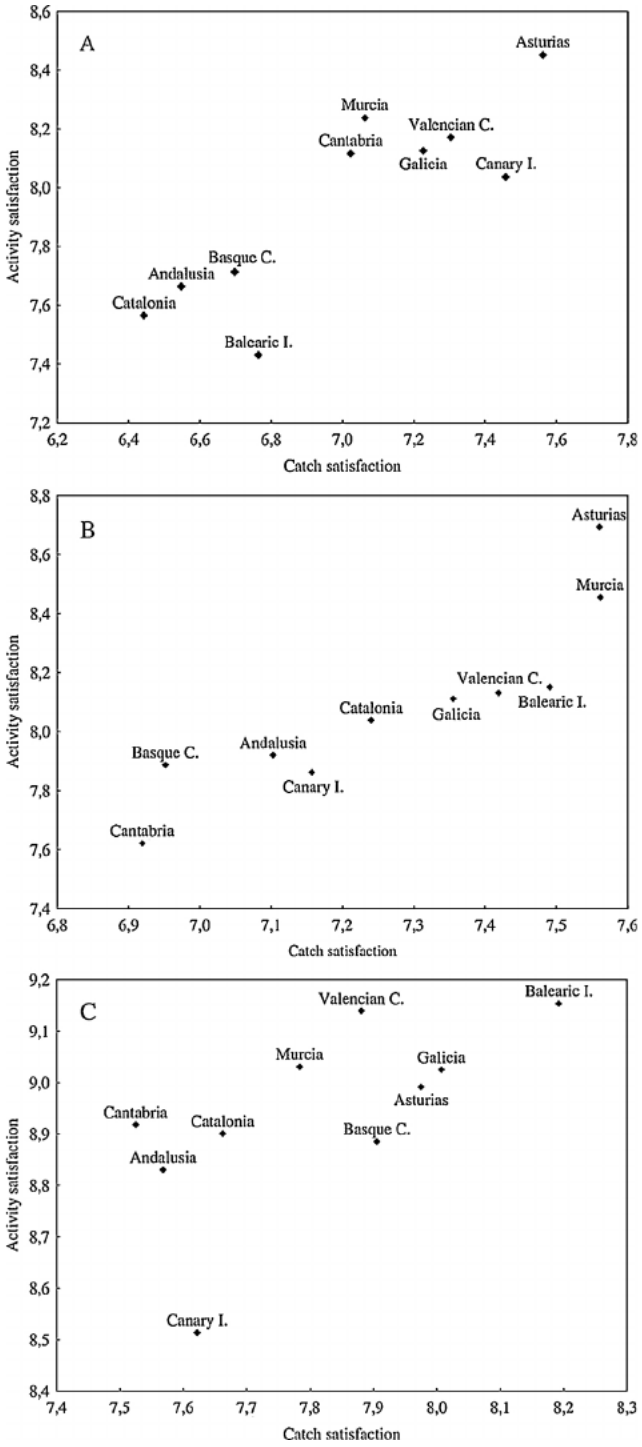

Fig. 5. Average fisher satisfaction level with the catch vs activity satisfaction for each Autonomous Community by fishing modality: A) shore fishers, B) boat fishers and C) spear fishers.

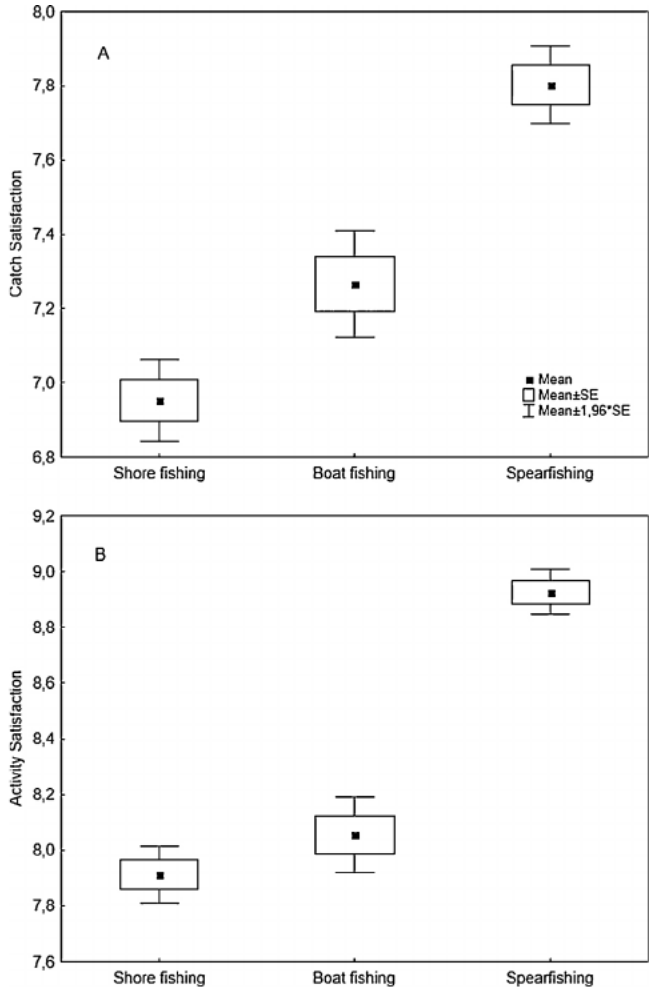

Fig. 6. Differences in satisfaction level between recreational fishing modalities.

which specifies the mandatory requisite of having a sport fishing license to purchase a spear gun. Nevertheless, in this study we demonstrate that this legislative measure is not complied by at least 40% of spear fishers. This non-compliance can possibly be explained by internet or second hand purchases, which allow evading license requirements. Moreover, it is likely that shopkeepers considered, wrongly but understandably, that the recreational fishing license is the required permit needed to buy a spear gun. This illustrates that unintelligible or excess of regulatory measures might hold up management objectives.

An effective management of MRF requires understanding fishers and their behaviour (Hunt et al., 2013), and a proper understanding of marine recreational fishers requires in turn studies focussing on MR fisher's social profile. This issue has received little attention in Europe, and, to a certain extent, the absence of studies addressing the fisher's social profile is understandable, given the increasing evidence of MRF impact on fish populations (Cowx et al., 2010; Lewin et al., 2006; McPhee et al., 2002). Because of this, concerns have mainly focussed on the fishing activity itself. Current priorities respond to EU regulations, including the Data Collection Regulation and Data Collection Framework (EC, 2001, 2008), which incorporate recreational catches for a limited number of species. The scarcity of social information available of Mediterranean countries (Ardahan and Turgut, 2013; Tunca et al., 2016; Veiga et al., 2010; Cardona-Pons and Morales-Nin, 2013) indicates relevant differences between countries. It is expected that education and employment go hand in hand, which might explain the observed differences in the unemployment rates between modalities. The unemployment rate of shore fishing participants (19%) doubled that of the other two modalities and faithfully reflected the Spanish unemployment rate in the year the study was conducted (18.6%). The practice of shore fishing presents few economic and physical limitations, and hence may better reflect the entire society.

Recreational fishers fish for fun (Pitcher and Hollingworth, 2002), they engage in the activity for different reasons (Ardahan and Turgut, 2013) and their overall satisfaction is derived by different factors. The catch itself is one of these factors (Arlinghaus, 2006; Beardmore et al., 2013). This dependence was not observed in our results, but it is plausible that this may be because above a certain level of catch fisher´s

Table 1
Estimates compiled by Autonomous Community and fishing modality on: number of citicens, number of recreational fishing licenses, percentage of fishers without a license, number of recreational fishers, participation rate, Km of coastline and fisher population per Km.

AC	Population (x10^3)	Number of licences	Unlicensed RF	Number of RF	Participation	Km coastline[1]	RF per km coastline
Basque C. (Atl)	**2189**			68,314	**3.12%**	**246**	**278**
shore N = 168		60,636	9.52%	55,780[a]	2.55%		
boat N = 90			1.11%	10,629[a]	0.49%		
spearfishing N = 110		1823	4.54%	1906	0.09%		
Cantabria (Atl)	**582**			31,122	**5.35%**	**284**	**110**
shore N = 108		29,628	3.70%	25,807[a]	4.43%		
boat N = 50			0.00%	4917[a]	0.84%		
spearfishing N = 71		382	4.22%	398	0.07%		
Asturias (Atl)	**1042**			73,171	**7.02%**	**401**	**182**
shore N = 202		58,718	1.48%	59,587	5.72%		
boat N = 75		10,950	0.00%	10,950	1.05%		
spearfishing N = 146		2581	2.05%	2634	0.25%		
Galicia (Atl)	**2718**			65,173	**2.40%**	**1498**	**44**
shore N = 378		59,692	4.76%	52,525[a]	1.93%		
boat N = 148			3.39%	10,009[a]	0.37%		
spearfishing N = 325		2584	2.15%	2640	0.10%		
Canary Isl. (Atl)	**2109**			99,511	**4.72%**	**1583**	**63**
shore N = 324		88,526	4.94%	65,008[b]	3.08%		
boat N = 168			2.98%	27,891[b]	1.32%		
spearfishing N = 237		6293	5.06%	6611	0.31%		
Andalusia (Med & Atl)	**8388**			28,1720	**3.36%**	**945**	**298**
shore N = 691		180,675	5.21%	190,088	2.27%		
boat N = 365		85,383	3.29%	88,192	1.05%		
spearfishing N = 337		3133	9.79%	3440	0.04%		
Murcia (Med)	**1465**			53,072	**3.62%**	**274**	**194**
shore N = 107		32,601	9.34%	35,646[c]	2.43%		
boat = 84		8543	2.38%	8746[c]	0.60%		
spearfishing N = 111		8306	4.50%	8680	0.59%		
Valencian C. (Med)	**4960**			98,910	**1.99%**	**518**	**191**
shore N = 327		65,987	13.19%	74,691	1.51%		
boat N = 189		19,695	6.88%	21,050	0.42%		
spearfishing N = 255		2983	6.27%	3170	0.06%		
Catalonia (Med)	**7522**			98,653	**1.31%**	**699**	**141**
shore N = 342		87,895	6.72%	82,551[d]	1.10%		
boat = 191			6.81%	11,250[d]	0.15%		
spearfishing N = 261		4427	9.58%	4851	0.06%		
Balearic Isl. (Med)	**1107**			52,080	**4.70%**	**1428**	**36**
shore N = 90		29,183	4.44%	30,479	2.75%		
boat N = 164		10,855[e]	3.05%	20,079	1.81%		
spearfishing N = 146		1424	6.85%	1522	0.14%		

[1] Source: Spanish National Cartography Institute. Extrapolation sources: [a]Asturias; [b] National Average; [c] Unified boat and shore licenses up to 23/08/16 extrapolated from Valencian Community; [d] Valencian Community.

pleasure is no longer influenced by the catch. The fisher's satisfaction level with both the catch and the activity were always high, being the activity *per se* consistently higher than the catch. This pattern was common for every fishing modality, but differences were observed between modalities. The lowest level of satisfaction was given for shore fishing, whilst the highest values were given for the spearfishing modality. These results are understandable considering the nature of the spearfishing modality: since one of the main motivations of recreational fishers is experiencing nature (Knopf et al., 1973), and the quality of the catch (Arlinghaus, 2006; Dorow et al., 2010), the underwater nature of spearfishing accentuates the environmental experience and simultaneously allows to select the catch. Selectivity is not necessarily synonymous of sustainability, which is one of the most common arguments against spearfishing (Lloret et al., 2008b), but it does allow foreseeing a wide range of management actions that can guarantee the activity's sustainability (Sbragaglia et al., 2016).

There are some features of MRF that are characteristic of Mediterranean countries, as has been proved by different studies (Font and Lloret, 2011; Gordoa et al., 2004; Herfaut et al., 2013; Lloret et al., 2008a; Morales-Nin et al., 2005; Ruiz et al., 2014; TRAGSATEC, 2005; Unal et al., 2010) and which is also consistent with the results presented here. This findings contradict the view that on-line methods are not very satisfactory for angler-scientist communications and are particularly dependant on angler age (Cardona-Pons et al., 2010) In general, recreational fishing is an overwhelmingly male activity, whose participants mean age is around 40 years, though there are slight differences between modalities according to our results. Another relatively common feature of RF is the length of the fishing day: here it varies slightly between AC but overall the average duration of shore and boat outings (c.a 5.7 h d^{-1}) were in between previous estimations (Font and Lloret, 2011; Lloret et al., 2008b; Morales-Nin et al., 2005; Unal et al., 2010; Veiga et al., 2010). Spear fishing outings, however, were shorter in every region, a difference that has not been observed in previous studies. Another consistent pattern observed in every region was the difference in daily catch rates between modalities; boat fishing presenting the highest rates, followed by spear fishing and shore fishing with the lowest rates (Table 2). Although this pattern was found in the abovementioned studies, their absolute values varied highly among each other. The highest catch rate for boat angling in the Mediterranean was the 16.8 kg d^{-1} estimated in Turkey (Unal et al., 2010), indicative of

Table 2
Estimates compiled by Autonomous Community and fishing modality on: average daily catch per fisher, average annual effort per fisher, days per year estimated using Ruiz et al. (2014), total catch and total catch estimated using Ruiz et al. (2014) values of effort. Standar errors included in brackets.

AC	Daily catch (kg)	Days per year	Days per year *	Total catch (t)	Total catch ** (t)
Basque C. (Atl) N = 368				**5486**	**2559**
shore N = 168	0.95 (0.10)	65.6 (2.76)	32.0	3494	1470
boat N = 90	2.66 (0.36)	64.6 (3.80)	42.0	1827	1003
spearfishing N = 110	1.78 (0.13)	48.6 (2.86)	27.0	165	86
Cantabria (Atl) N = 229				**2886**	**1327**
shore N = 108	1.11 (0.16)	66.0 (3.39)	32.2	1899	792
boat N = 50	2.52 (0.39)	77.1 (4.14)	50.1	955	519
spearfishing N = 71	1.77 (0.24)	45.2 (3.85)	25.1	32	17
Asturias (Atl) N = 423				**6523**	**2963**
shore N = 202	1.15 (0.08)	64.8 (2.51)	31.6	4436	1843
boat N = 75	2.71 (0.03)	59.6 (4.88)	38.7	1770	954
spearfishing N = 146	2.49 (0.16)	48.4 (2.53)	26.9	317	166
Galicia (Atl) N = 851				**7275**	**3323**
shore N = 378	1.41 (0.08)	66.8 (1.86)	32.6	4964	2074
boat N = 148	2.86 (0.22)	66.2 (3.14)	43.0	1896	1032
spearfishing N = 325	2.78 (0.11)	56.6 (1.76)	31.5	415	217
Canary Isl. (Atl) N = 729				11,769	**5583**
shore N = 324	1.51 (0.10)	64.8 (2.12)	31.6	6368	2661
boat N = 168	2.86 (0.24)	56.2 (3.03)	36.5	4487	2443
spearfishing N = 237	2.42 (0.17)	57.2 (2.32)	31.8	914	479
Andalusia (Med & Atl) N = 1393				29,394	14,353
shore N = 691	1.20 (0.06)	56.0 (1.32)	27.3	12,794	5348
boat N = 365	3.44 (0.19)	53.6 (1.84)	34.8	16,236	8814
spearfishing N = 337	2.18 (0.12)	48.4 (1.77)	26.9	364	191
Murcia (Med) N = 302				**3870**	**1858**
shore N = 107	1.00 (0.10)	52.8 (3.37)	25.7	1888	794
boat = 84	2.80 (0.30)	58.7 (3.83)	38.1	1434	777
spearfishing N = 111	1.31 (0.11)	48.1 (2.58)	26.7	548	287
Valencian C. (Med) N = 771				**9026**	**4310**
shore N = 327	1.13 (0.09)	58.9 (1.88)	28.7	4991	2111
boat N = 189	3.11 (0.25)	57.6 (2.62)	37.5	3778	2064
spearfishing N = 255	1.52 (0.09)	53.5 (1.89)	29.7	257	135
Catalonia (Med) N = 794				**6119**	**2770**
shore N = 342	0.93 (0.06)	57.7 (1.82)	28.1	4449	1864
boat = 191	2.27 (0.17)	53.4 (2.29)	34.7	1366	746
spearfishing N = 261	1.28 (0.09)	49.1 (1.93)	27.3	304	160
Balearic Isl. (Med) N = 400				**4423**	**2211**
shore N = 90	0.84 (0.08)	58.7 (3.73)	28.6	1494	624
boat N = 164	2.82 (0.19)	49.1 (2.47)	31.9	2784	1511
spearfishing N = 146	1.92 (0.14)	49.7 (2.53)	27.6	145	76

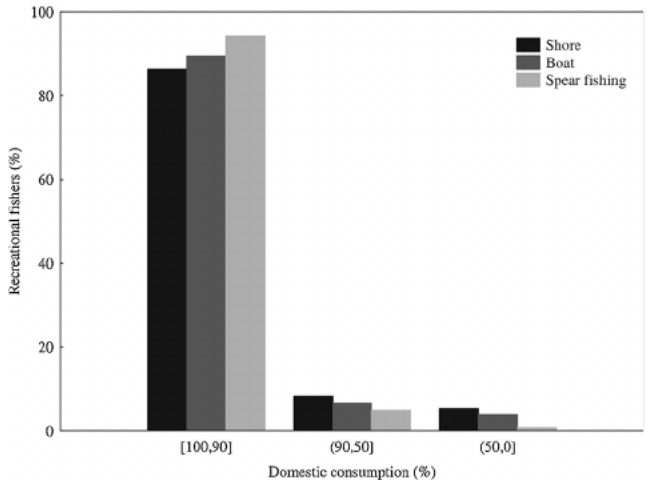

Fig. 7. Percentage of the catch used for domestic consumption.

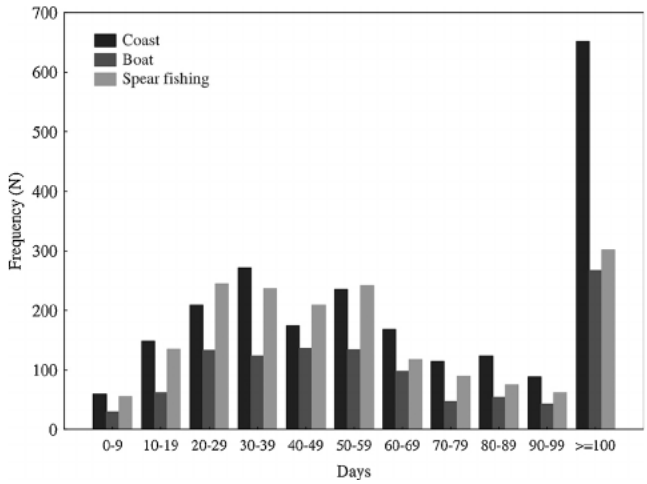

Fig. 8. The frequency distribution of the annual fishing days declared by fishing modality.

the fish resources and the size of species present in that specific region. Nevertheless, the observed differences among other studies cannot always attributed to regional differences in fish resources. The results presented here, correspond to three regions: Mediterranean, Atlantic and Subtropical, but catch rates of recreational angling (from either boat or from shore) did not show any significant differences between regions. In contrast, spearfishing harvest rates showed regional differences; overall they were significantly lower in the Mediterranean regions and showed maximum rates in Galicia. This consistent pattern among regions gives us confidence in our results. Contrasting them with other studies published in Spain (Morales-Nin et al., 2005; Ruiz et al., 2014), we found different outcomes: on the one hand, no major differences were found in boat angling or spear fishing catch rates compared with previous studies developed in the Basque Country, although these were here found to be slightly lower for shore angling than established by previous estimations. Contrarily, in the Balearic Isl., the differences between our results and previous studies were extremely high: previous catch rates ranged from 1.5 times higher for shore fishing to 4 times higher for boat and spearfishing. Catch rates have a direct effect on the estimations of annual recreational yield, and differences of such a magnitude will lead to different results on the impact of RF. The observed differences manifest the risk of extrapolating when it comes to assessing the impact of this activity.

Nevertheless, recreational yield estimations result from the product of catch rates and fishing effort. Annual effort, in turn, is calculated as the product of RF population and the annual effort of the average fisher. While in this study the size of recreational fisher population has been well estimated, the annual effort might be overestimated because our sample does not represent the RF population as a whole. It has been acknowledged that fishers who agree to give their data are the most avid and involved (Strehlow et al., 2012) which causes effort to be slightly overestimated (Rocklin et al., 2014). The online survey represents an extreme case, as fishers voluntarily answer without having been previously approached. Consequently, our estimations of effort are expected to be highly positively biased, but comparing them with other published estimations based on onsite surveys such difference are not observed. We did find significant differences between modalities: the highest values were approximately 60 days per year for shore fishing and the lowest were 51 annual days for spearfishing. Previous onsite surveys in Spain had estimated effort around 66 days (Morales-Nin et al., 2005) or from 47 to 61 days depending the modality (Font and Lloret, 2011; Lloret et al., 2008a; Lloret et al., 2008b). Thus, we would expect on-site surveys to also incur in population misrepresentation, due to the fact that the chances of finding a fisher are proportional to their fishing frequency. The problem of non-representative sampling is partially overcome by the sampling approach used by Ruiz et al. (2014), where the survey was directly addressed to the whole RF population. Unfortunately, this is only feasible if the RF population is officially registered through a license system and if the contact information is provided by the administration. This approach is only viable when sampling programs are launched by the administrations, due to data protection policies. In the particular case of Spain, this would be administratively complex, because it would involve the commitment of the 10 different regional governments which are responsible for issuing the RF licenses.

In this study, the annual RF yield derived from the estimated annual fishing effort doubled the yield estimated with Ruiz et al.'s (2014 effort (Table 2). But Ruiz et al.'s (2014) estimations of fisher annual effort also doubled the effort reported in France (Herfaut et al., 2013). This alone could explain the differences in total RF catch estimated in France 24,000 t by Herfaut et al. (2013) and in this study, (40,015 t) but they are unlikely to represent the true differences in the level of RF harvesting yield between these two neighbour countries.

In summary, this study provides an accurate estimation of RF population size, and also a consistent pattern in catch rates between modalities and in fisher profiles. Conversely, no improvement has been made on the estimation of fishing effort, which has been largely overestimated. While it is true that managing marine resources requires data of all types of fishing activities (Rocklin et al., 2014), including recreational fishing is equally essential to dispose of reliable data. We consider that the license system is a step forward in providing the size of RF population. In addition, it would allow future surveys to address the target population directly in order to obtain a representative sample of the RF population. However, only the commitment of fishery managers and governments could ensure the feasibility of this approach.

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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.2018.10.026.

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