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# It is recreational but profitability also matters: A cost-effective economic approach to marine recreational fishing in Spain

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## Abstract

This study analyses the costs of marine recreational activity in Spain for the main fishing modalities and provides a cost-effective economic indicator (CEI) for each of them. The activity costs of 4,999 fishers were collected through an online survey, along with other fishing information. The published results of this survey, catch rates and catch composition, have been used in this study. Daily expenses per fisher were estimated by dividing reported annual expenses by annual fishing days. The CEI was estimated as the ratio of the market value of one kilo of recreational catch to the cost of catching it. The CEI showed differences between modalities in all regions, but of varying magnitudes. It is concluded that the CEI could diagnose the risk level of evolving from recreational towards subsistence fishing. The higher the CEI, the more compensatory the activity and the greater the possibility of moving away from a purely recreational activity in adverse economic conditions.

**Keywords:** expenses; catch value; economic indicator; spearfishing; angling; recreational fishing.

## Introduction

The conflict between professional and recreational fishing sectors has been addressed by numerous studies (e.g., Arlinghaus *et al*., 2005; Bower *et al*., 2014; Boucquey, 2017). The growing scarcity of fish resources may intensify this conflict, forcing fishery administrations to take management measures regarding the distribution of access rights for resources either by means of catch allocation or spatial segregation (García-de-la-Fuente *et al*., 2020). However, little discussion is found in the literature of the public's right to resources in the decision-making process (Kearney, 2001; Pawson *et al*., 2008) or people's right to obtain their own food. On the contrary, the most frequent line of argument is based on answering the question addressed by Voyer *et al*. (2017): Who is most deserving of greater access to resource? However, as the format of the specific questions deriving from the general one determines either the answer or the approach to providing the answer, it is possible to find answers of opposite signs. Therefore, it is comprehensible that different sectors use different arguments to defend their own positions. The recreational fishing sector is generally supported by its economic returns (Brown, 2016; Scheufele & Pascoe, 2021) and additional non-market related social benefits (e.g., Buchanan, 1985; Driver *et al*., 1991; Toth & Brown, 1997; Pitcher 1999) which are less tangible and more difficult to quantify (Griffiths *et al*., 2017).

Analysis of the economic magnitude of marine recreational fishing (MRF) focuses on the economic activity associated with the tangible expenditures of recreational fishers on a gross basis (Gislason, 2013). Economic studies of MRF are commonly estimated for the entire recreational fishing population in very wide ranges of spatial scales, from global to local studies (e.g., Herfaut *et al*., 2013; Brownscombe *et al*., 2014; Arlinghaus *et al*., 2015; Roberts *et al*., 2017; Hyder *et al*., 2018). Therefore, some information regarding the MRF population size is necessary to scale up the results obtained from the data collected in the surveys. However, various studies have pointed out the variability and uncertainty in recreational fisher population estimates (Pawson *et al*., 2008; Arlinghaus *et al*., 2015; Cooke *et al*., 2018), particularly in countries where regulations do not include a license system or registry. Yet, even when there is an established licensing system, it is difficult to know what proportion of fishers are active and to what extent they are active, i.e., the fishing intensity of the active population (Gordoa *et al*., 2019). Therefore, selecting a representative sample is an integral part of designing recreational fishing surveys in order to ensure that survey data can be accurately scaled (Pollock *et al*., 1994). Survey methods all have their own strengths and weaknesses and their appropriateness varies depending on the objectives and scale of each particular survey (Pollock *et al*., 1994; ICES, 2010). Surveys based on voluntarily provided answers are generally biased towards more avid fishers. However, the bias is greater in on-site surveys (Thomson, 1991) since the probability of encountering avid fishers would be higher than the probability of encountering occasional or less active fishers. Thus, the results on the final impact of MRF, either on fish resources or the economic impact, would be proportional to recreational fisher population estimates and biased to a greater or lesser degree by how representative the sample is of the population. Similarly, the impact of the different recreational fishing modalities is also proportional to the population size of each fishing modality (García-de-la-Fuente *et al*., 2020). However, in order to assess the effects of potential growth or reduction of the activity and differentiate between MRF modalities, estimates per fishing unit are necessary.

In Spain, as in so many other countries, professional fishing has traditionally played a significant role in coastal communities. However, professional fishing has decreased in many regions while tourist activity has increased (Cooke & Cowx, 2006; Voyer *et al*., 2017), favouring the development of recreational maritime activities, including recreational fishing (Hall, 2021). However, reduced interest in recreational fishing is to be expected with post-industrialisation (Arlinghaus *et al*., 2015). Is there a basis to claim that the interest in or demand for recreational fishing will increase in the future? On which factors could this demand depend? Although the fundamentals may be of an economic nature, two opposing scenarios could increase the growth of this activity. In a scenario of economic growth, recreational activity might be favoured up to a certain limit, but in an opposite scenario, the need for food, and therefore a transition or shift towards subsistence fishing, would increase this activity.

There is an overlap in the transition between recreational fishing as a purely leisure activity, fishing for fun (Pitcher & Hollingworth, 2002), and fishing-induced nutritional needs, running along a continuous axis of two extremes - the catch-and-release modality and subsistence fishing - where the fine line between fishing for food as an additional value or for the real need to obtain it is crossed. However, it is not clear at which point along the axis this qualitative difference may occur. There is no doubt that the catch-and-release modality would represent the other side of the coin to subsistence fishing, while there is a cost-effective economic gradient when the catch is retained. It is reasonable to consider that the conditions for the development of subsistence fishing exist when there is no economic profitability. In other words, the CEI economic gradient would be the proportion of fishing costs to catch value. The costs associated with recreational fishing would vary according to the type of fishing, i.e., fishing from the boat would be more costly than from the shore. Similarly, nor will the value of the catch be equal, as it will depend on differences between modalities as regards the quantity caught and the composition of the catch, which in turn will vary between regions depending on the existing resources (Dedeu *et al.*, 2019). Therefore, estimations of cost effectiveness must take into account the regional particularities of the different fishing modalities in terms of costs, catches and catch values.

Within the above perspective, the objective of this study is to analyse the costs of MRF activity in Spain per fishing unit, fishing day, for the main fishing modalities and in different maritime regions. The choice of these work units aims to provide scalable information when the magnitude of the activity is adequately estimated. Two previous studies, included in the same research project estimated, inter alia, the daily catch rates of the main recreational fishing modalities for each of the Spanish littoral autonomous regions (Gordoa *et al*., 2019) and the species composition of their catches (Dedeu *et al*., 2019). The published information, together with the cost analysis conducted in this study, also allows for the formulation of the main goal: to provide a cost-effective indicator (CEI) as a potential comparative tool for recreational fisheries and explore it for the main modalities of MRF in the different regions of Spain.

## Material and Methods

The associated costs of MRF were collected from a nationwide project of marine recreational fishing in Spain. A web-enabled software application, which was active from February 2016 to February 2017, was used to collect data from Spanish recreational fishers on four areas of interest: fishers' profiles, fishing activity, catch composition and associated costs. Specific details regarding the questionnaire's design and content and on the dissemination campaign can be found in previously published studies (Dedeu *et al*., 2019; Gordoa *et al*., 2019). In Gordoa *et al*. (2019), results regarding fisher typology and fishing activity (catch rates, fishing effort, etc.) were estimated in each of the Spanish Autonomous Communities (hereinafter SACs) for each fishing modality: boat fishing (only angling is permitted in Spain), shore fishing (only angling) and spearfishing (only free diving is permitted). In Dedeu *et al*. (2019), the species composition in each modality and SAC was estimated and the catch composition was grouped into three geographical regions: Atlantic, Mediterranean and Canary Islands (Fig. 1). However, one exception was observed: the boat modality in the Balearic Islands, with a catch composition that is more similar to the boat modality in the Canary Islands geographical region than Mediterranean SACs.

The specific questions in the surveys were grouped into four topics. The first three –social profile, fishing activity and species composition– were already analysed in the above-mentioned studies. The fourth set of questions dealing with annual expenses is studied here, together with the results of previous studies, to provide a CEI. The online platform allowed data to be obtained from 7,848 individuals participating in MRF across Spain, 4,999 of whom provided annual expenses associated with fishing activity.

This study does not seek to analyse the economic value of recreational fishing, but rather the economic prof-

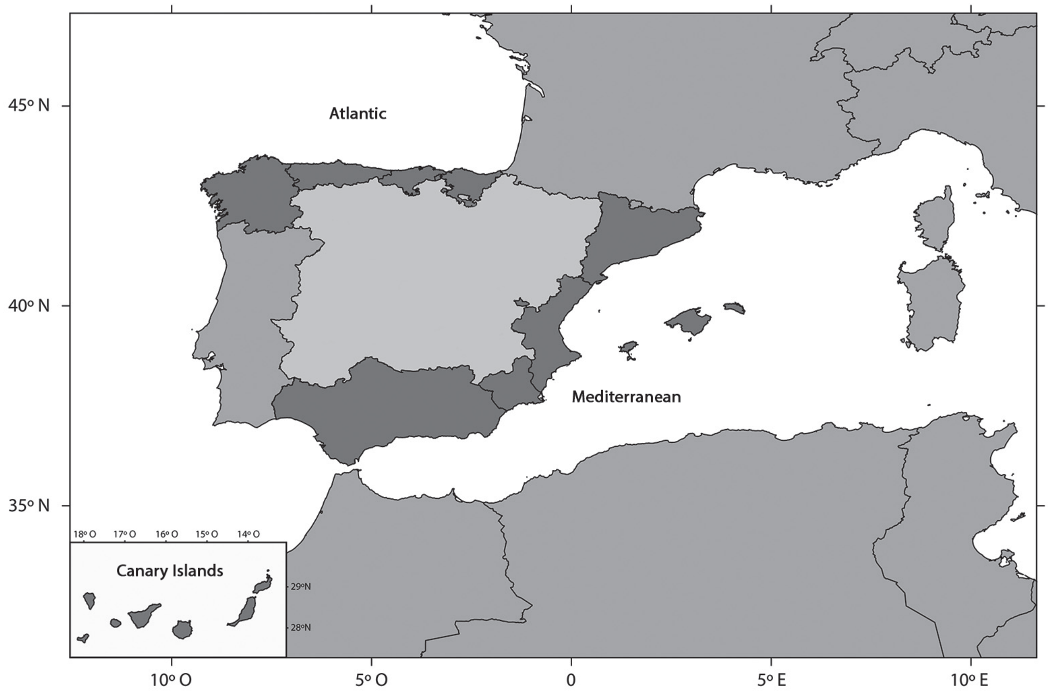


***Fig. 1**:* Map of the study area. The darker regions highlighted correspond to Spanish coastal Autonomous Communities.

itability of its catches as an indicator of its proximity to subsistence fishing. In this study an indicator of economic compensation (CEI) is estimated for each MRF modality and geographical region. The indicator was estimated as the ratio of the market value of a kilo of recreational catch relative to the cost of fishing it. The general outline of the steps followed in the estimation process is illustrated in Figure 2. All calculations were made in daily units per fisher to minimise any possible bias produced by the sampling approach, which was based on the voluntary participation of fishers. Fishers who voluntarily agree to provide data are the most avid with more fishing days and, consequently, higher annual expenses, but working on daily units will minimise bias.

### *Daily expenses and harvesting cost*

To minimize potential problems of recall bias, the fishers were asked to report their recreational expenses in the last year, both durable and non-durable and excluding any expenditure related to the purchase of vessels. The specific items related to annual costs included in the questionnaires were equipment, bait, transport, travel and insurance. Mooring, fuel, maintenance and rental expenses were also added for modalities in which a vessel is used.

The annual expenses ($AE_i$) for each fisher were calculated as the sum of the expenses incurred for the different items:

$$AE_i = \sum_j^n AE_{ij}$$

where $j$ is the type of costs for each fisher ($i$). The daily expenses ($DE_i$) per fisher were estimated by dividing annual expenses by reported annual fishing days:

$$DE_i = \frac{AE_i}{AF_i}$$

Two measures of central tendency of daily expenses were estimated for each fishing modality (m) and geographical region (r). Both statistics (the mean and the me-

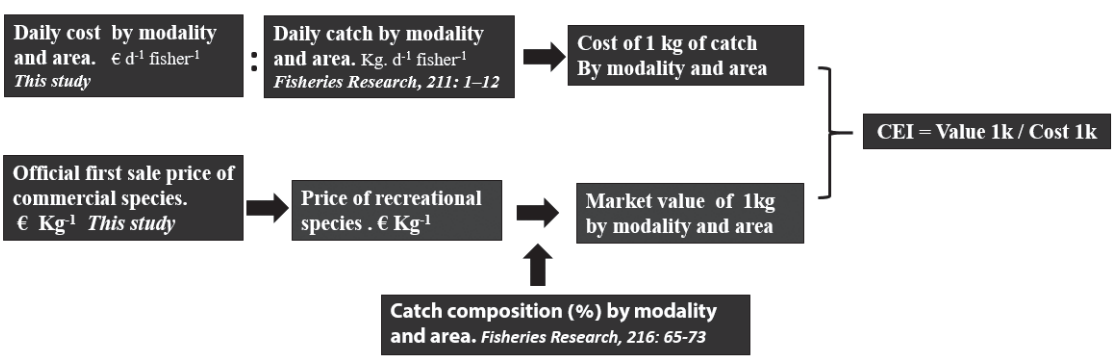


***Fig. 2:*** Summary diagram of the cost-effectiveness indicator calculation process.

dian) were estimated together with the skewness of the distributions to determine which measure better represents daily expenses for each modality and region ($DE_{mr}$), so it may be used in successive calculations.

The cost of harvesting a kilo of fish for each fishing modality and region ($HC_{mr}$) was estimated by dividing daily expenses ($DE_{mr}$) by the corresponding daily catch ($DC_{mr}$). Daily catch for each modality and SAC ($DC_{mc}$) were as reported by Gordoa *et al.* (2019) and here averaged by region:

$$DC_{mr} = \frac{\sum_{c}^{n} DC_{mc}}{n}$$

Where *c* is the set of SACs belonging to each region (*r*) and *n* the total number of SACs (*c*) in each region (r).

### *The market value of the species*

The official first sale price of commercial species in 2016 was searched on the internet for each SAC. Official first sale data were found for 8 of the 10 SACs comprising the Spanish coastline, with the exception of the Balearic Islands and Cantabria; in these particular cases the missing information was replaced with the average prices of the corresponding geographical region: the peninsular Atlantic region and the Mediterranean, respectively.

The first step was to reduce the long lists of commercial species to the list of species caught by MRF. They were then grouped at the taxonomic level reported for marine recreational fishing in Spain (Dedeu et al. 2019). In general, the grouping was for species belonging to the same genus (e.g., *Pagrus* sp*.*, *Epinephelus* sp*.*, *Scorpaena* sp*.*, *Diplodus* sp., etc.), with the exception of two bigger groups: cephalopods (squids, octopus, etc.) and big pelagics (tuna, swordfish, etc.).

The commercial value of each species group in each SAC ($V_{gc}$) was calculated using the average price of the species that formed each group.

Where *i* is the set of species gathered in each group (*g*) and *c* refers to each SAC. Similarly, the commercial value of each group of species in each geographical region ($V_{gr}$) was calculated using the average price for the SACs that formed each region.

$$V_{gc} = \frac{\sum_{i}^{n} V_{igc}}{n}$$

Where *c* is the set of SACs belonging to each region (*r*) and *n* the total number of SACs (*c*) in each region (r).

### *Market value of recreational catch*

The composition of recreational daily catch varies in terms of species and their proportions in different fishing modalities and regions, and this consequently affects the value of their catches. In this study, the market value of 1 kilo of MRF catch for each region and fishing modality was calculated by multiplying the proportion of the species, $P_{gmr}$, estimated in Dedeu *et al.* (2019) by the commercial value of 1 kilo calculated in accordance with the previous section, as described below:

$$CV_{mr} = \sum_{g} P_{gmr} \times V_{gr}$$

Where *P* is the proportion of each species group (*g*) in the catch of each fishing modality (*m*) and region (*r*).

### *Cost-effective economic indicator*

The CEI indicator was considered as the relative proportion of catch value (CV) to catch harvesting costs (HC), and these indicators were calculated for each fishing modality and region. It was estimated as the ratio of the market value of 1 kilo of catch, estimated from first sale, to the cost of harvesting 1 kilo of fish:

$$CEI_{mr} = \frac{CV_{mr}}{HC_{mr}}$$

A CEI > 1 would indicate positive economic compensation of the activity and a CEI < 1 would indicate negative economic compensation or that the activity is costly considering the value of the food extracted.

## Results

### *Daily expenses and harvesting cost*

The results revealed that spearfishing and boat fishing have a greater level of internal complexity that affects the associated costs. The results of 1,794 spearfishing respondents showed large differences in mean daily expenses between different diving approaches: around €20 diving from the shore, €72 diving from the boat and €35 when both diving approaches are practised in unknown proportions (Fig. 3a). Consequently, the expenses of spearfishing have been estimated separately for each diving approach and collectively for all of them.

Similarly, recreational fishing from a boat showed a typology (i.e., kayak fishing) that also affects the associated activity costs. The daily expenses of kayak fishing, €20 $d^{-1}$, turned out to be four times less expensive than fishing from a motorised vessel, €80 $d^{-1}$ (Fig. 3b). However, the number of kayak respondents, 114 fishers, was not sufficient to perform a regional analysis and the subsequent calculations.

In terms daily expenses, the results were highly skewed with mean values above the medians (Table 1). Therefore, the medians were considered in subsequent calculations as they better represented the sampled population. Daily expenses showed wide variation among fishing modalities with a consistent pattern between regions. Shore-based fishing proved to be the least expensive modality followed by spearfishing, and boat fishing was the most costly. However, within spearfishing the results varied greatly depending on the type of dive ac-

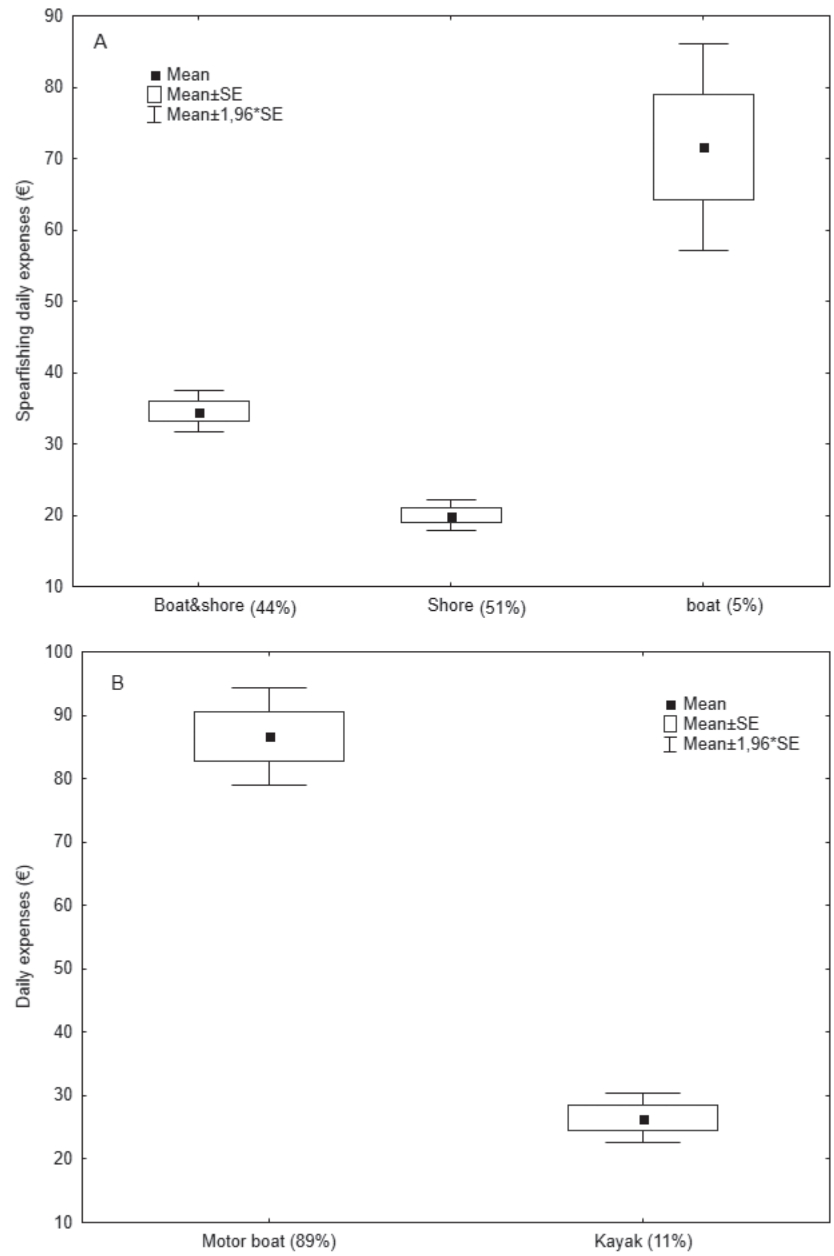


***Fig. 3****:* Daily expenses. A) Spearfishing by diving approach and B) Boat fishing (angling) by type of vessel. The percentage of responses by modality in brackets.

cess. Consistently across all three regions, the costs of boat-based spearfishing were at least double those of shore-based spearfishing (Table 1), which were close to the daily costs of shore-based fishing.

The daily catch rates for each fishing modality and region (Table 1) derived from Gordoa *et al*. (2019) showed a consistent pattern where shore fishing showed the lowest catch rates, followed by spearfishing and boat fishing. The results showed different catch rates between spearfishing diving approaches in the Atlantic and Mediterranean regions. Unfortunately, the limited number of boat-spearfisher respondents in the Canary Islands prevented any comparison. The results regarding harvesting costs (the cost of catching 1 kilo of fish) also varied between different modalities (Table 1). The harvesting costs of boat fishing were the highest as the high catch rates did not compensate for extraction costs. The Mediterranean region showed the highest harvesting costs for the spearfishing and shore fishing modalities as a consequence of low catch rates and high daily costs.

### *The value of the species caught and the value of the catch*

The average price of the species caught by each recreational fishing modality in each geographical region, along with the contribution of each species to the total catch of each region and modality as per the data published in Dedeu *et al.* (2019) and the corresponding value of each species in the catch are detailed in Tables 2-4. Commercial prices vary widely between regions and in particular within the group of sparids. The average prices of species present in recreational fishing catches for all fishing modalities are lower in the Canary Islands (Table 5). At the other extreme is the Atlantic region with

**Table 1.** Daily expenses and harvesting cost for each fishing modality and region. Daily catch rates by region were estimated from previously published daily catch rates estimated for each Spanish Autonomous Community (Gordoa *et al.*, 2019).

| | **Daily Expenses (€)** | **Daily Catch (k)** | **Harvesting cost (€ / k)** | | | |
|---|---|---|---|---|---|---|
| Modality | Region | Valid N | Mean | Median | Regional Average | |
| Spearfishing Shore&Boat | Canary Isl. | 96 | 33.7 | 14.7 | 3.22 | 4.57 |
| | Atlantic | 259 | 22.7 | 13.3 | 2.62 | 5.08 |
| | Mediterranean | 444 | 32.0 | 17.5 | 1.76 | 9.94 |
| Spearfishing Shore | Canary Isl. | 98 | 17.57 | 7.38 | 1.68 | 4.39 |
| | Atlantic | 318 | 14.91 | 10 | 1.93 | 5.18 |
| | Mediterranean | 490 | 23.75 | 11.66 | 1.52 | 7.67 |
| Spearfishing Boat | Canary Isl. | 4 | 46.81 | 22.5 | 2.30 | 9.78 |
| | Atlantic | 17 | 29.82 | 20 | 2.13 | 9.39 |
| | Mediterranean | 71 | 34.7 | 21.6 | 2.50 | 8.64 |
| Spearfishing All modalities | Canary Isl. | 198 | 33.73 | 14.66 | 2.42 | 4.57 |
| | Atlantic | 594 | 22.71 | 13.26 | 2.20 | 5.08 |
| | Mediterranean | 1002 | 31.97 | 17.5 | 1.64 | 9.94 |
| Shore fishing | Canary Isl. | 236 | 15.0 | 7.0 | 1.51 | 4.64 |
| | Atlantic | 688 | 16.2 | 8.5 | 1.16 | 7.30 |
| | Mediterranean | 1269 | 20.3 | 12.0 | 1.02 | 11.76 |
| Boat fishing | Canary Isl. | 114 | 74.9 | 45.7 | 2.41 | 18.95 |
| | Atlantic | 256 | 50.1 | 31.7 | 2.68 | 11.84 |
| | Mediterranean | 616 | 75.0 | 44.0 | 2.90 | 15.17 |
| | Balearic Isl. | 118 | 114.5 | 64.5 | 2.82 | 22.87 |

**Table 2.** Recreational shore fishing; Catch composition. First sale price. Catch values in three Spanish coastal regions (**M**editerranean. **A**tlantic and **Can**ary Isl.).

| **Species** | **% Catch M** | **€ $k^{-1}$ M** | **€ Catch M** | **% Catch A** | **€ $k^{-1}$ A** | **€ Catch A** | **% Catch Can** | **€ $k^{-1}$ Can** | **€ Catch Can** |
|---|---|---|---|---|---|---|---|---|---|
| *Anguilla anguilla* | | | | 0.001 | 66.76 | 0.04 | | | |
| *Argyrosomus regius* | 0.023 | 5.50 | 0.13 | | | | | | |
| *Atherina* sp. | | | | 0.001 | | 0.00 | | | |
| *Balistes* sp. | | | | | | | 0.012 | 3.52 | 0.04 |
| *Belone belone* | | | | 0.009 | 2.61 | 0.02 | 0.040 | 2.61 | 0.10 |
| *Bodianus scrofa* | | | | | | | 0.001 | 4.98 | 0.01 |
| *Boops boops* | 0.015 | 0.43 | 0.01 | 0.020 | 0.39 | 0.01 | 0.080 | 0.39 | 0.03 |
| *Bothus podas* | 0.003 | 3.07 | 0.01 | | | | | | |
| *Cephalopods* | 0.037 | 7.24 | 0.26 | 0.084 | 5.14 | 0.43 | 0.034 | 4.06 | 0.14 |
| *Chromis chromis* | 0.017 | | | | | | | | |
| *Conger conger* | 0.016 | 1.65 | 0.03 | 0.024 | 1.71 | 0.04 | | | |
| *Coris julis* | 0.008 | 2.07 | 0.02 | 0.010 | 4.31 | 0.04 | | | |
| *Coryphaena hippurus* | 0.015 | 5.28 | 0.08 | | | | | | |
| *Ctenolabrus rupestris* | | | | 0.001 | | 0.00 | | | |
| *Dacylopterus volitans* | 0.004 | 0.62 | 0.00 | | | | | | |
| *Dentex dentex* | 0.029 | 17.38 | 0.50 | 0.015 | 4.87 | 0.07 | | | |
| *Dicentrarchus* sp. | 0.116 | 10.25 | 1.19 | 0.198 | 14.18 | 2.81 | | | |
| *Diplodus* sp. | 0.120 | 4.83 | 0.58 | 0.229 | 6.06 | 1.39 | 0.133 | 3.45 | 0.46 |
| *Epinephelus* sp. | 0.005 | 22.15 | 0.12 | | | | 0.013 | 5.83 | 0.08 |
| Gobiidae and Blennidae | 0.004 | 2.90 | 0.01 | | | | | | |

***Continued***

*Table 2 continued*

| Species | % Catch M | € $k^{-1}$ M | € Catch M | % Catch A | € $k^{-1}$ A | € Catch A | % Catch Can | € $k^{-1}$ Can | € Catch Can |
|---|---|---|---|---|---|---|---|---|---|
| Big Pelagics | | | | 0.001 | 2.70 | 0.00 | | | |
| *Labrus* sp. | 0.006 | 2.75 | 0.02 | 0.065 | 1.93 | 0.12 | | | |
| *Lichia amia* | 0.011 | 4.84 | 0.05 | | | | | | |
| *Lithognathus mormyrus* | 0.092 | 5.69 | 0.53 | 0.016 | 4.94 | 0.08 | 0.011 | 3.68 | 0.04 |
| Mugilidae | 0.039 | 1.65 | 0.06 | 0.025 | 0.55 | 0.01 | 0.021 | 2.24 | 0.05 |
| *Mullus* sp. | | | | 0.019 | 10.27 | 0.20 | | | |
| *Muraena* sp. | 0.009 | 2.59 | 0.02 | | | | 0.037 | 3.62 | 0.13 |
| *Mycteroperca rubra* | | | | | | | 0.012 | 5.83 | 0.07 |
| *Oblada melanura* | 0.027 | 1.71 | 0.05 | 0.005 | 2.42 | 0.01 | 0.054 | 3.06 | 0.17 |
| *Pagellus* sp. | 0.035 | 5.10 | 0.18 | 0.020 | 6.94 | 0.14 | 0.021 | 4.12 | 0.09 |
| *Pagrus* sp. | 0.012 | 9.52 | 0.12 | 0.006 | 14.06 | 0.09 | 0.021 | 5.74 | 0.12 |
| *Platichthys flesus* | | | | 0.003 | 9.63 | 0.03 | | | |
| *Pleuronectes platessa* | | | | 0.005 | 9.63 | 0.05 | | | |
| *Pollachius pollachius* | | | | 0.017 | 5.32 | 0.09 | | | |
| *Pomadasys incisus* | 0.019 | 1.25 | 0.02 | | | | 0.017 | 3.13 | 0.05 |
| *Pomatomus saltatrix* | 0.037 | 3.51 | 0.13 | | | | | | |
| Rajiformes | 0.008 | 2.35 | 0.02 | | | | | | |
| *Salmo trutta* | | | | 0.008 | 7.13 | 0.06 | | | |
| *Sarda sarda* | | | | 0.008 | 2.59 | 0.02 | | | |
| *Sarpa salpa* | 0.010 | 0.78 | 0.01 | 0.001 | 0.59 | 0.00 | 0.069 | 2.05 | 0.14 |
| *Sciaena umbra* | 0.016 | 5.57 | 0.09 | | | | | | |
| *Scomber* sp. | 0.022 | 1.56 | 0.03 | 0.008 | 1.00 | 0.01 | | | |
| *Scophthalmus maximus* | | | | 0.003 | 10.90 | 0.03 | | | |
| *Scorpaena sp.* | | | | 0.007 | 7.84 | 0.06 | | | |
| *Scyliorhinus canicula* | | | | 0.002 | 0.50 | 0.00 | | | |
| *Seriola* sp. | 0.002 | 10.55 | 0.02 | | | | 0.013 | 3.86 | 0.05 |
| *Serranus* sp. | 0.009 | 2.79 | 0.03 | 0.010 | 4.17 | 0.04 | 0.014 | 4.97 | 0.07 |
| *Solea solea* | 0.004 | 6.74 | 0.03 | 0.006 | 13.65 | 0.09 | | | |
| *Sparisoma cretense* | | | | | | | 0.265 | 5.48 | 1.45 |
| *Sparus aurata* | 0.174 | 6.93 | 1.21 | 0.044 | 13.95 | 0.61 | | | |
| *Sphyraena* sp. | | | | | | | 0.078 | 2.80 | 0.22 |
| *Spicara* sp. | 0.001 | 0.79 | 0.00 | | | | | | |
| *Spondyliosoma cantharus* | 0.010 | 3.53 | 0.04 | 0.030 | 3.64 | 0.11 | | | |
| *Symphodus* sp. | 0.003 | | | 0.009 | 1.21 | 0.01 | 0.000 | 1.21 | 0.00 |
| *Synodus saurus* | 0.003 | | | | | | | | |
| *Thalassoma pavo* | 0.008 | | | | | | | | |
| *Trachinotus ovatus* | 0.022 | 3.73 | 0.08 | | | | 0.044 | 2.06 | 0.09 |
| *Trachinus* sp. | 0.011 | 3.18 | 0.03 | 0.001 | 1.65 | 0.00 | | | |
| *Trachurus* sp. | | | | 0.032 | 1.85 | 0.06 | 0.010 | 1.70 | 0.02 |
| *Trisopterus* sp. | | | | 0.054 | 2.31 | 0.12 | | | |
| *Zeus faber* | | | | 0.003 | 9.42 | 0.03 | | | |

**Table 3.** Recreational shore fishing; Catch composition. First sale price. Catch values in three Spanish coastal regions (**M**editerranean, **A**tlantic, **Can**ary, **B**alearic Isl.).

| Species | % Catch M | € $k^{-1}$ M | € Catch M | % Catch A* | € $k^{-1}$ A | € Catch A | % Catch Can & B | € $k^{-1}$ Can | € Catch Can | € Catch B | € $k^{-1}$ B |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acanthocybium solandri | | | | | | | 0.059 | 2.77 | 0.16 | 0.32 | 5.48 |
| Anguilla anguilla | | | | 0.001 | 66.76 | 0.08 | | | | | |
| Anthias anthias | 0.002 | 1.32 | 0.00 | | | | | | | | |
| Argyrosomus regius | 0.077 | 5.50 | 0.42 | | | | | | | | |
| *Balistes* sp. | 0.024 | 2.98 | 0.07 | 0.007 | 1.93 | 0.01 | | | | | |
| Belone belone | | | | 0.003 | 2.61 | 0.01 | | | | | |
| *Bodianus* sp | | | | | | | 0.012 | 4.98 | 0.06 | 0.07 | 5.48 |
| Boops boops | 0.011 | 0.43 | 0.00 | | | | 0.010 | 0.43 | 0.00 | 0.00 | 0.43 |
| Bothus podas | 0.001 | 3.07 | 0.00 | | | | 0.006 | 3.01 | 0.02 | 0.02 | 3.07 |
| Cephalopods | 0.046 | 7.24 | 0.33 | 0.089 | 5.14 | 0.45 | 0.043 | 4.06 | 0.17 | 0.31 | 7.24 |
| Conger conger | 0.011 | 1.65 | 0.02 | 0.020 | 1.71 | 0.03 | 0.002 | 3.36 | 0.01 | 0.00 | 1.65 |
| Coris julis | 0.006 | 2.07 | 0.01 | 0.020 | 4.31 | 0.09 | | | | | |
| Coryphaena hippurus | 0.045 | 5.28 | 0.24 | | | | 0.030 | 2.54 | 0.08 | 0.16 | 5.28 |
| Ctenolabrus rupestris | | | | 0.007 | 1.93 | 0.01 | | | | | |
| Dactylopterus volitans | | 0.62 | | | | | 0.001 | 0.62 | 0.00 | 0.00 | 0.62 |
| *Dentex* sp. | 0.056 | 17.38 | 0.97 | 0.019 | 4.87 | 0.09 | 0.127 | 5.15 | 0.65 | 2.21 | 17.38 |
| *Dicentrarchus* sp. | 0.034 | 10.25 | 0.35 | 0.065 | 14.18 | 0.92 | | | | | |
| *Diplodus* sp. | 0.051 | 4.83 | 0.25 | 0.118 | 6.06 | 0.72 | 0.033 | 3.45 | 0.11 | 0.16 | 4.83 |
| *Epinephelus* sp. | 0.011 | 22.15 | 0.24 | | | | 0.010 | 5.83 | 0.06 | 0.23 | 22.15 |
| Big Pelagics | 0.102 | 4.32 | 0.44 | 0.086 | 2.79 | 0.24 | 0.057 | 3.21 | 0.18 | 0.25 | 4.32 |
| Helicolenus dactylopterus | 0.009 | 4.04 | 0.04 | 0.006 | 3.40 | 0.02 | 0.012 | 5.87 | 0.07 | 0.05 | 4.04 |
| *Labrus* sp. | | | | 0.054 | 1.93 | 0.10 | | | | | |
| Lichia amia | 0.02 | 4.84 | 0.11 | | | | | | | | |
| Lithognatus mormyrus | | | | 0.010 | 4.94 | 0.05 | | | | | |
| Merluccius merluccius | | 6.92 | | 0.007 | 3.50 | 0.02 | 0.001 | 6.17 | 0.01 | 0.01 | 6.92 |
| Mugilidae | | | | 0.002 | 0.55 | 0.00 | | | | | |
| *Muraena* sp. | 0.001 | 2.59 | 0.00 | | | | | | | | |
| *Mycteroperca* sp. | 0.000 | 22.15 | 0.00 | | | | 0.028 | 5.83 | 0.16 | 0.62 | 22.15 |
| Oblada melanura | 0.008 | 1.71 | 0.01 | | | | 0.005 | 3.06 | 0.01 | 0.01 | 1.71 |

***Continued***

***Table 3 continued***

| Species | % Catch M | € $k^{-1}$ M | € Catch M | % Catch A* | € $k^{-1}$ A | € Catch A | % Catch Can & B | € $k^{-1}$ Can | € Catch Can | € Catch B | € $k^{-1}$ B |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Pagellus* sp. | 0.063 | 5.10 | 0.32 | 0.045 | 6.94 | 0.31 | 0.045 | 4.12 | 0.18 | 0.23 | 5.10 |
| *Pagrus* sp. | 0.055 | 9.52 | 0.52 | 0.011 | 14.06 | 0.15 | 0.035 | 5.74 | 0.20 | 0.33 | 9.52 |
| Parapristipoma octolineatum | | | | | | | 0.005 | 3.95 | 0.02 | 0.03 | 5.48 |
| Phycis phycis | 0.004 | 4.62 | 0.02 | | | | | | | | |
| Platichthys flesus | | | | 0.000 | 9.63 | 0.00 | | | | | |
| Pollachius pollachius | | | | 0.019 | 5.32 | 0.10 | | | | | |
| Pomadasys incisus | 0.019 | 1.25 | 0.02 | | | | | | | | |
| Pomatomus saltatrix | 0.026 | 3.51 | 0.09 | | | | | | | | |
| Sarda sarda | 0.033 | 4.69 | 0.16 | 0.026 | 2.59 | 0.07 | | | | | |
| Sarpa salpa | 0.001 | 0.78 | 0.00 | | | | | | | | |
| Sciaena umbra | 0.013 | 5.57 | 0.07 | | | | | | | | |
| *Scomber* sp. | 0.060 | 1.56 | 0.09 | 0.081 | 1.00 | 0.08 | 0.025 | 0.60 | 0.02 | 0.04 | 1.56 |
| *Scorpaena* sp. | 0.019 | 9.65 | 0.18 | 0.005 | 7.84 | 0.04 | 0.070 | 4.65 | 0.33 | 0.68 | 9.65 |
| Scyliorhinus canicula | 0.001 | 1.94 | 0.00 | | | | | | | | |
| *Seriola* sp. | 0.013 | 10.55 | 0.14 | | | | 0.064 | 3.86 | 0.25 | 0.67 | 10.55 |
| *Serranus* sp. | 0.028 | 2.79 | 0.08 | 0.081 | 4.17 | 0.34 | 0.121 | 4.97 | 0.60 | 0.34 | 2.79 |
| Sparisoma cretense | | | | | | | 0.025 | 5.48 | 0.13 | 0.14 | 5.48 |
| Sparus aurata | 0.040 | 6.93 | 0.27 | 0.024 | 13.95 | 0.34 | | | | | |
| *Sphyraena* sp. | 0.011 | 1.76 | 0.02 | | | | 0.034 | 2.80 | 0.10 | 0.06 | 1.76 |
| *Spicara* sp. | 0.016 | 0.79 | 0.01 | | | | | | | | |
| Spondyliosoma cantharus | 0.019 | 3.53 | 0.07 | 0.030 | 3.64 | 0.11 | 0.030 | 3.37 | 0.10 | 0.11 | 3.53 |
| Stromateus fiatola | 0.000 | 3.71 | 0.00 | | | | | | | | |
| *Symphodus* sp. | | 2.74 | | | | | 0.003 | 1.21 | 0.00 | 0.01 | 2.74 |
| *Synodus* sp. | | | | | | | 0.004 | 6.00 | 0.02 | 0.02 | 5.48 |
| *Trachinus* sp | 0.007 | 4.54 | 0.03 | | | | 0.020 | 2.40 | 0.05 | 0.09 | 4.54 |
| *Trachurus* sp. | 0.042 | 1.16 | 0.05 | 0.051 | 1.85 | 0.09 | 0.010 | 1.64 | 0.02 | 0.01 | 1.16 |
| Trigla lucerna | | | | 0.015 | 5.19 | 0.08 | | | | | |
| *Trisopterus* sp. | | | | 0.089 | 2.31 | 0.21 | | | | | |
| Xyricthys novacula | 0.010 | 7.00 | 0.07 | | | | 0.035 | 7.00 | 0.24 | 0.24 | 7.00 |
| Zeus faber | 0.004 | 16.22 | 0.07 | 0.008 | 9.42 | 0.07 | 0.039 | 4.97 | 0.20 | 0.64 | 16.22 |

**Table 4.** Recreational spearfishing: Catch composition. First sale price. Catch value in three Spanish coastal regions (**M**editerranean. **A**tlantic and **Can**ary Isl.).

| Species | % Catch M | € k$^{-1}$ M | € Catch M | % Catch A | € k$^{-1}$ A | € Catch A | % Catch Can | € k$^{-1}$ Can | € Catch Can |
|---|---|---|---|---|---|---|---|---|---|
| Acanthocybium solandri | | | | | | | 0.029 | 1.470 | 0.043 |
| Argyrosomus regius | 0.012 | 5.498 | 0.067 | 0.000 | 4.935 | 0.001 | | | |
| *Balistes* sp. | 0.027 | 2.980 | 0.082 | 0.026 | 1.930 | 0.050 | 0.015 | 3.520 | 0.054 |
| Belone belone | | | | | | | 0.004 | 2.000 | 0.008 |
| *Bodianus* sp. | | | | | | | 0.008 | 4.980 | 0.041 |
| Boops boops | | | | 0.001 | 0.390 | 0.001 | | | |
| Cephalopods | 0.075 | 7.242 | 0.546 | 0.107 | 5.135 | 0.549 | 0.073 | 4.062 | 0.296 |
| Conger conger | 0.020 | 1.649 | 0.034 | 0.079 | 1.713 | 0.135 | | | |
| *Dentex* sp. | 0.047 | 17.381 | 0.816 | 0.015 | 4.870 | 0.074 | | | |
| *Dicentrarchus* sp. | 0.082 | 10.250 | 0.842 | 0.119 | 14.177 | 1.690 | 0.029 | 3.130 | 0.091 |
| *Diplodus* sp. | 0.182 | 4.826 | 0.880 | 0.296 | 6.055 | 1.793 | 0.125 | 3.452 | 0.431 |
| *Epinephelus* sp. | 0.066 | 22.154 | 1.455 | | | | 0.054 | 5.825 | 0.312 |
| Heteropriacanthus cruentatus | | | | | | | 0.021 | 4.200 | 0.088 |
| *Labrus* sp. | 0.018 | 2.746 | 0.050 | 0.235 | 1.931 | 0.454 | | | |
| Lichia amia | 0.006 | 4.842 | 0.031 | | | | | | |
| Lithognathus mormyrus | 0.014 | 5.691 | 0.080 | | | | | | |
| Mugilidae | 0.024 | 1.650 | 0.040 | 0.015 | 0.545 | 0.008 | 0.007 | 2.235 | 0.016 |
| *Mullus* sp. | 0.036 | 6.658 | 0.238 | 0.016 | 10.268 | 0.168 | 0.031 | 6.340 | 0.194 |
| *Muraena* sp. | 0.007 | 2.590 | 0.018 | | | | 0.038 | 3.620 | 0.136 |
| *Mycteroperca* sp. | 0.005 | 22.154 | 0.103 | | | | 0.060 | 5.860 | 0.352 |
| Oblada melanura | 0.003 | 1.708 | 0.004 | | | | | | |
| Other flat fish | | | | 0.013 | 6.037 | 0.079 | | | |
| *Pagellus* sp. | | | | 0.003 | 6.943 | 0.019 | | | |
| *Pagrus* sp. | 0.028 | 9.521 | 0.262 | 0.001 | 14.063 | 0.018 | 0.006 | 5.830 | 0.035 |
| Parapristipoma octolineatum | | | | | | | 0.004 | 3.950 | 0.014 |
| Phycis phycis | 0.009 | 4.621 | 0.039 | | | | | | |
| Plectorhinchus mediterraneus | 0.095 | 1.180 | 0.112 | | | | | | |
| Pollachius pollachius | | | | 0.016 | 5.315 | 0.085 | | | |
| Pomatomus saltatrix | 0.005 | 3.514 | 0.017 | | | | 0.011 | 3.390 | 0.039 |
| Psetta maxima | | | | 0.001 | 19.000 | 0.010 | | | |
| Rajiformes | 0.001 | 2.346 | 0.001 | 0.005 | 1.847 | 0.010 | | | |
| Sarda sarda | | | | 0.002 | 2.585 | 0.004 | | | |
| Sarpa salpa | 0.006 | 0.775 | 0.005 | 0.002 | 0.590 | 0.001 | 0.012 | 2.050 | 0.025 |
| Sciaena umbra | 0.052 | 5.566 | 0.287 | | | | 0.004 | 1.940 | 0.007 |
| *Scomber* sp. | 0.000 | 1.556 | 0.000 | 0.002 | 1.000 | 0.002 | | | |
| *Scorpaena* sp. | 0.024 | 9.655 | 0.228 | 0.022 | 7.840 | 0.176 | | | |
| *Seriola* sp. | 0.021 | 10.553 | 0.219 | | | | 0.072 | 3.860 | 0.279 |
| *Serranus* sp. | 0.005 | 2.788 | 0.014 | | | | 0.008 | 4.967 | 0.040 |
| Solea solea | 0.037 | 10.793 | 0.396 | | | | | | |
| Sparisoma cretense | | | | | | | 0.298 | 5.480 | 1.633 |
| Sparus aurata | 0.057 | 6.932 | 0.395 | 0.011 | 13.945 | 0.148 | | | |
| *Sphyraena* sp. | 0.022 | 1.763 | 0.038 | | | | 0.086 | 2.800 | 0.240 |
| Spondyliosoma cantharus | 0.008 | 3.526 | 0.028 | | | | 0.003 | 3.370 | 0.010 |
| *Symphodus* sp. | 0.008 | 2.746 | 0.021 | | | | | | |
| *Trachurus* sp. | | | | 0.003 | 1.847 | 0.005 | 0.003 | 1.580 | 0.005 |
| Trigla lucerna | | | | 0.003 | 6.030 | 0.021 | | | |
| Umbrina canariensis | | | | 0.002 | 5.445 | 0.008 | | | |
| Zeus faber | | | | 0.005 | 9.420 | 0.048 | | | |

**Table 5.** Average price of the species caught by fishing modality and region and the average value of 1 k of catch.

| | Avg. Species price present in the catch | | | | Avg. value of 1 kg of Catch | | | |
|---|---|---|---|---|---|---|---|---|
| **Modality** | Mediterranean | Atlantic | Canary Isl. | Balearic Isl. | Mediterranean | Atlantic | Canary Isl. | Balearic Isl. |
| Shore-fishing | 4.87 | 7.13 | 3.49 | | 5.68 | 6.93 | 3.61 | |
| spearfishing | 6.18 | 5.92 | 3.75 | | 7.35 | 5.56 | 4.39 | |
| Boat-fishing | 5.48 | 7.15 | 3.85 | 6.42 | 5.80 | 4.85 | 4.22 | 8.04 |

the highest prices, with the exception of spearfishing species. The value of recreational catches, which result from considering not only the species price but also the corresponding contribution to catch, showed the lowest values for Canary Island catches. On the other hand, the value of the catches by fishing modality does not show a common pattern among regions. In the Mediterranean the maximum was observed for spearfishing catches and in the Atlantic for shore fishing, while differences were negligible in the Canary Islands.

### *Cost-effective economic indicator*

The results showed large differences between the three modalities (Fig. 4a) that follow a consistent pattern in all the regions, with the indicator showing a positive gradient from boat fishing to shore fishing. However, the magnitude of these differences decreases in the Mediterranean, where the CEI indicator for shore fishing and spearfishing was substantially lower than in the other regions. The results of the different spearfishing approaches showed that diving from the boat had the lowest CEI indicator, but it was higher than the value estimated for the boat-fishing modality (Fig. 4a). Regional differences were observed for each spearfishing “sub-modality” (Fig. 4b) and the Mediterranean region was seen to have the lowest CEI indicators.

## Discussion

The results regarding daily expenditures in marine recreational fishing showed a clear increasing pattern starting with shore fishing, followed by underwater fishing and, lastly, boat fishing. This pattern was observed indistinctly for both measures of central tendency: means and medians. The means were considerably higher than the medians, indicating the positive skewness of the distributions, and therefore the medians were considered to be more representative. However, it is worth noting that the mean expenditure estimates did not differ from those estimated by previous studies carried out in some of Spain’s SACs (Morales-Nin *et al*., 2005; Zarauz *et al*., 2013). The mean values presented here were between 50% and 200% higher than the median estimates. Thus, it is necessary to highlight that the indiscriminate use of means when scaling the annual expenditure per fisher to the entire fisher population would overestimate the economic contribution of MRF. If one were to extrapolate the daily expenses estimated in this study to the annual fishing days per fisher and the fisher population size published in Gordoa *et al*. (2019), the annual expenses of recreational fishing, not accounting for costs arising from the purchase of vessels, would be around €580 million, where the contribution by modality would be 62.3% from boat fishing, 35% from shore fishing and 2.7% from spearfishing. However, the choice of the measure of central tendency may not be the only source of bias in the estimation of MRF expenses, as revealed by the mean values estimated in other regions of Spain (Gordoa *et al*., 2004; Soliva, 2006; García-de-la-Fuente *et al*., 2020), which double the mean values estimated in this and previously mentioned studies. This might be related to the bias towards more active fishers generated by voluntary participation, which is known as avidity bias (e.g., Thomson, 1991; Teixeira *et al*., 2016). In general, annual trip-related expenditures per fisher can be expected to be proportional to the frequency of participation (Thomson, 1991). However, this bias is minimised by the procedure used in this study, which works on daily expenses per fisher calculated by dividing annual expenses by declared fishing days. Therefore, it is worth highlighting the possible sources of bias generated when estimating the economic impact of this activity, either due to the skewness of the sample and/or the additional bias created by the calculation procedure.

Variability in daily expenses within the spearfishing and boat fishing modalities merits some attention. Spearfishers can access the sea only from the shore or only from a boat, and the latter doubled the associated costs. There is also a third group that uses both forms of access, and its expenses will depend on the proportion in which each of these are used. Therefore, when scaling cost estimates for this modality, the results would only be accurate if the proportion of each sub-modality in the surveyed sample is representative of the overall spearfisher population. This is an issue that should be considered in future studies, both in the design of questionnaires and when considering the analysis by sub-modalities. On the other hand, the boat fishing results show the low cost of kayak fishing, which was at least four times less costly than with a motorboat. This puts kayaking in an advantageous position for growth, even more so in adverse economic conditions. In some countries this sub-modality can be traced back to the 1940s (Mann *et al*., 2012), and in some cases increases have been detected in the last decade (Parnell *et al*., 2010; McIntosh, 2011). Kayak

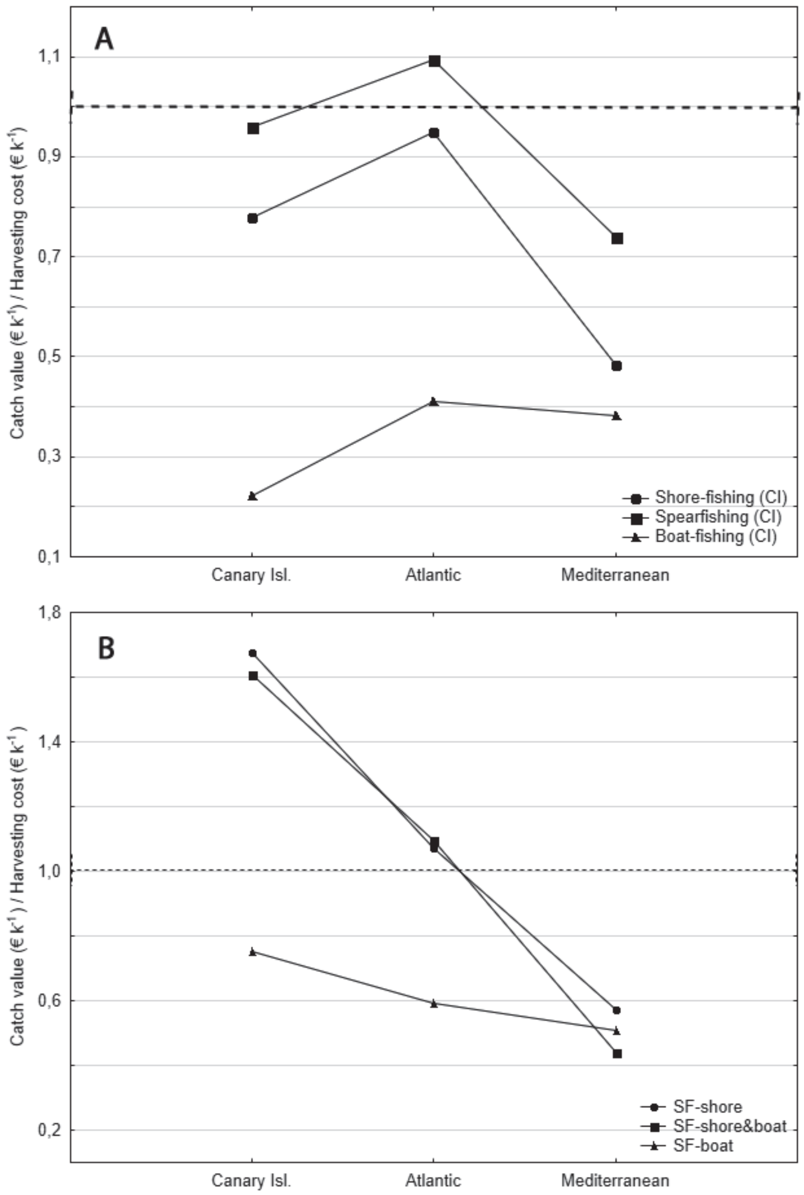


***Fig. 4***: Economic indicator by: A) the main fishing modalities: spearfishing, shore-fishing and boat-fishing and B) spearfishing diving approach.

fishing has benefits for the environment and for fishers; for example, it does not pollute or cause disturbances and encourages exercise. The development of this fishing modality is such that guides on how to fish from this type of boat are available (Kumiski, 2019). However, the small size of kayaks does not mean that catch has to be small and these tiny vessels have access to areas that conventional vessels cannot reach (McIntosh, 2011) and are also difficult to explore with other fishing modalities. Thus, the catch rates and composition of kayak fishing might be different and would require further attention, together with its potential growth.

The results regarding catch rates for each region (kilos per day per fisher) derived from the data published by Gordoa *et al*. (2019) showed the same pattern for all regions. The maximum rates were obtained from boat fishing followed by spearfishing, to the lowest value obtained by shore fishing. However, a more detailed analysis of spearfishing pointed to differences between the daily yields obtained by shore and boat access. The differences in daily catches positively impact harvesting costs (the cost of harvesting 1 kilo of fish) by decreasing the differences in harvesting costs compared with those observed in daily expenditures. Harvesting costs showed regional differences that were the same for shore fishing and spearfishing. The lowest values were seen in the Canary Islands, followed by the Atlantic and the Mediterranean. Although these results might be related to the cost of living, published estimates showed large differences between SACs (Costa *et al*., 2021), but these differences were not observed at the regional level analysed in this study. Another factor that could contribute to the regional differences observed in associated costs would be purchasing power, but this also has to be ruled out based on the results of Costa *et al*. (2021) with the exception of the Canary archipelago, which is below the regional average in the Atlantic and Mediterranean regions.

The average price of the species caught by recreational fishing varies between modalities and regions, with the exception of the Canary Islands where no differences are observed between different modalities. In the Mediterranean, the high value of spearfishing species and, in particular, the proportion of these species in catch point towards effective selectivity of more valuable species. Effective selection by spearfishers positions their attitude towards personal consumption of the catch, one of the four sub-dimensions included in the catch dimension (Cooke *et al*., 2018). However, to some extent, one would expect selectivity towards the most valued species for every MRF catch-and-retention modality, as was observed in the Mediterranean and the Canary Islands. The bias towards higher market value species could contribute to increasing the level of conflict between professional and recreational sectors. If this were the case, we would expect that the Mediterranean would be the Spanish coastal region with the highest level of conflict.

The indicator proposed in this study is a measure of cost-effectiveness in economic terms or a relative distance from non-profitable exploitation, i.e., less profitable, more purely recreational fishing, which would be best represented by the catch-and-release modality. The results presented here show that the market value of catches does not compensate expenses for most fishers, with boat fishing being the least compensated modality and the Mediterranean being the least compensated region. These results cannot be extrapolated to other countries or regions of the Mediterranean basin as there is great cultural and economic diversity that can affect both the value of the catch and the cost of extraction, as well as the variability of the systems that can affect the catches and their yields. Similarly, the results obtained today cannot be expected to remain unchanged over time since neither the socio-economic nor the environmental situations are stable. It could be envisaged which possible scenarios could change the current cost-effectiveness situation in the future. A positive scenario for fishers, a higher cost-effective value, could be caused by an increase in catch rates while costs remain stable. This scenario would require an increase in littoral fish populations, which is unlikely given the current state of fish resources and the overall anthropogenic and environmental pressures on coastal systems (Randazzo *et al*., 2013; Sundblad & Bergström, 2014). Daily catch rates would also increase by extending the fishing day. This extension, increasing the number of hours per day, would be very unlikely for spearfishers due to the physical limitations inherent to this activity. On the contrary, this scenario would be feasible for shore anglers with a negligible increase in associated costs. For boat fishing, it would imply higher costs associated with fuel consumption, but this increase would vary between fishing sub-modalities (e.g., between trolling and stationary fishing). The scenario of an increase in the number of fishing days would not increase the daily catch or economic indicator, but rather annual catch. An extremely high number of recreational fishing days was observed in Turkey, along with high harvesting profitability (Unal *et al*., 2010; Tunca *et al*., 2016). However, such a high amount of catch is unlikely to be ultimately destined for self-consumption and part of the activity was considered to be illegal and/or subsistence fishing.

Although fish are only one input into recreational fishing (Bishop & Samples, 1980), the role of recreational fishing in supporting nutrition is underappreciated (Cooke *et al*., 2018) and the increase in MRF demand might also depend on it. The increase in the number of MRF participants in Europe has been repeatedly asserted, but with little background or baseline information from the past. At present, a rough idea of the MRF population size in European countries is available (e.g., Hyder *et al*., 2018; Gordoa *et al*., 2019), which provides benchmarks for future studies on the growth of recreational fishing. An increase in demand, more fishers and/or more active fishers, might occur in different scenarios and be associated with different fishing typologies. Therefore, if demand is purely recreational then it might increase with a good economic situation or, at the other extreme, if demand results from the need for food, then a shift towards subsistence fishing would be seen. If the qualitative leap is made from the need for food to the need for money with catch sales, this fishing would not be subsistence but illegal in many countries. Although it is not known in which direction MRF may evolve, the risk of evolving towards subsistence fishing can be diagnosed by estimating the baseline situation in each territory with economic cost-effective indicators or alternative approaches. The more compensatory the activity, the greater the possibility of moving away from a purely recreational activity, and higher demand should be expected in poor economic scenarios. Therefore, this economic indicator provides clues as to how recreational fishing may evolve according to its modalities and regions of activity.

The CEI can be understood as a dynamic indicator of the current situation of recreational fisheries, from pure recreation to subsistence. The CEI should be monitored at spatial scales that provide information to regional fisheries commissions to understand recreational fisheries in order to apply management measures adjusted to different needs. Monitoring of the CEI would be of particular interest in the Mediterranean, a paradigmatic basin in terms of socio-economic and environmental diversity.

## Conclusions

To conclude, it is relevant to highlight the importance of estimating and providing MRF information at the fisher and/or management unit level (e.g., fishing day). Fishing units can be scaled to the total population or total effort when these are known and feasible. Furthermore, fishing unit results make it possible to estimate the impacts of a possible increase or decrease in the number of fishers in harvesting and economic terms. Attention should also be paid to the statistics used in analyses to estimate average fisher variables, i.e., median values instead of the means as a general rule. Likewise, to minimise the possible bias generated by avid fishers on annual cost estimation, it is recommended to calculate them per day. To identify the current typologies of MRF and their possible evolution in different economic scenarios, it is helpful to provide cost-effective economic indicator benchmarks in order to compare the current state of MRF between regions and modalities and monitor possible future changes. Furthermore, it is important to remember that MRF should not be treated as a homogeneous sector, as each modality is different in terms of fishing yield, exploited species and associated costs. The CEI is a tool to get a feel for recreational fisheries, and its variations can also be indicative of social and/or environmental changes.

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