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Preliminary Estimation of Marine Recreational Fisheries (MRF) in the Time of COVID-19 Pandemic: The Marche Region Case Study (Adriatic Sea, Italy)

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Marine Recreational Fishing (MRF) is a highly attended complex activity, extremely evident along the coastlines, and mainly practiced among riparian communities. For that reason, this activity plays an important role to effectively contribute to the collective well-being, both from the social and economic points of view. However, it may negatively affect the fish stocks and the marine environment in general, mainly due to the removal of biological resources. The growing need to evaluate the magnitude of marine recreational fishing is recognized worldwide, especially in the last decade, when inclusive fishing programs began to focus their attention on this fishing activity. Based on its unexpected evidence and its wider repercussion on social behavior, the COVID-19 pandemic is considered by the scientific community as one of the most unique opportunities to better understand the social phenomenon and their repercussion on the environment. In this work will be reported very preliminary results on the consistency of marine recreational fishing in the case study of the Marche region (Italy). Number of recreational fishers and fishing effort were estimated through a telephone survey conducted in the Italian side of the Northern Adriatic Sea (FAO GFCM Geographical Sub Area 17) by interviewing 580 households. The sampling strategy also included a recall survey, which was carried out every month on a list of recruited fishers. In this manner, additional information was collected, such as detailed fishing effort, catches, and expenditures. In addition, biological data of catches were estimated through several on-site surveys. The information collected from January and December 2020 was affected by the COVID-19 pandemic in terms of social restrictions and access to marine places, inevitably impacting on marine recreational fishing features, including the biological resources and the related economic aspects.

Keywords: marine recreational fisheries, COVID-19, biological resources, economic impact, restrictions

INTRODUCTION

Recreational fishing, its component, and relative sectors have several definitions (Pawson et al., 2008). Food and Agriculture Organization of United Nations (FAO) defines this activity as "fishing of aquatic animals (mainly fish) that do not constitute the individual's primary resource to meet basic nutritional needs and are not generally sold or otherwise traded on export, domestic or black markets" (FAO, 2012). In fact, recreational fishing is considered a non-profit sporting activity, governed by specific laws [minimum sizes of catches, fishing restricted areas, equipment, etc; (Hyder et al., 2017)]. However, for management, legal and research purposes, it is necessary to have a shared definition of the recreational fishery (Herfaut et al., 2013).

Marine Recreational Fishing (MRF) is an important and popular activity in most coastal areas of the world (Pranovi et al., 2016), with large numbers of participants and significant economic and social impacts. It is estimated that around 9 million Europeans (or 1.6% of the total population of the European Union) are engaged in marine recreational fishing, for a total of 78 million fishing days, generating six billion euros of new capital per year and millions of related jobs (Hyder et al., 2018), representing an important economic engine in some sectors (e.g. tourism), which create benefits in terms of income and employment.

Compared to United States, Canada, Australia, and New Zealand, in Europe the management of this activity has been largely neglected (Cooke and Cowx, 2006), and even if MRF is considered as an economic and sociological opportunity, generating new sources of income, intense marine recreational activities in general, could even be a source of ecological problems (Bellanger and Levrel, 2017).

Potential issues posed by the lack of data about estimates of catch effort and socio-economic aspects to the recreational fisheries were already highlighted by the Scientific Advisory Committee on Fisheries (SAC) of the General Fisheries Commission for the Mediterranean (GFCM). This gap is particularly important for stocks that are overexploited by commercial fisheries and by which recreational fisheries might be an additional component of fishing mortality.

Currently, at Mediterranean level, all catches attributable to MRF are completely unknown and therefore excluded from the assessments of the status of commercial stocks. As a general rule, commercial and recreational (i.e. total) catches should be merged to better understand the dynamics of the main stocks (Freire and Rocha, 2020), even because for some specific resources in certain areas, MRF catches might surpass commercial ones (Coleman et al., 2004; Ihde et al., 2011). Indeed, sustainable management of fisheries requires the estimation of both its commercial and recreational components because the synergy of both sectors is responsible for the total fishing mortality induced on a stock (Gemert et al., 2021). Considering the overexploitation status of many fish stocks (FAO, 2020), estimated only taking into account commercial catches, it becomes imperative to quantify the magnitude of MRF, in order to estimate the total fishing pressure on the resources.

To this purpose, the development of an efficient monitoring system is a key element for understanding (Green et al., 2005) and quantifying the MRF footprint. The main challenge in collecting data from MRF is its geographically disperse nature (Freire and Rocha, 2020), the "nomadism" of the users (Smallwood et al., 2011), and the heterogeneity of practices and their seasonality (FAO, 2012). In the Mediterranean context, another factor increasing variability is that each country has its own legislation for this activity. In fact, even if in some countries, there are examples of mandatory registration programs (Gaudin and De Young, 2007)\, daily catch limit (e.g. Italy and Spain), catch declaration, licensing or registration, which could facilitate effort limits, that are not always required.

With the growing interest that has been observed in this activity in recent years, the EU has called for more regular and adequate information on this sector, not only to better manage shared fisheries resources, but also to meet the interests of various actors in the world of fishing. However, as harvest rates, even the economic impact of this activity on the society is difficult to estimate.

The global pandemic associated with COVID-19 has affected commercial, artisanal and recreational fisheries worldwide. The impacts resulting from the pandemic varied according to the different level of action applied by the various national governments to reduce the transmission of the virus within the community (Ryan et al., 2021). In general, the measures adopted at the global level were the following: social and physical distancing, travel restrictions, and the obligation to stay at home. Lockdown measures, especially during the early phases of the pandemic, led to such dramatic changes in human-environment interactions that some are now referring to this period of reduced human mobility and activity as the "Anthropause" (Rutz et al., 2020). In Italy, the strongest restrictions coincided with the spring season, when in normal circumstances, MRF would be a common activity (Paradis et al., 2020). In particular, lockdowns, as they consist of strict prohibitions against non-essential activities, may have had some effect on fishing effort, along with other typical components of MRF and related activities (Howarth et al., 2021).

Given that the pandemic will maybe persist for years (Billington et al., 2020), there is an urgent need to learn from current and ongoing experiences. Currently, fisheries scientists are learning about the impacts of the COVID-19 on fisheries using traditional assessment tools [e.g., social surveys; (Cooke et al., 2021)]. However, the current moment provides an opportunity to understand what lessons can be learned from the Anthropause for the management of recreational fisheries in the future.

The most widely used methodology around the world to estimate MRF footprint is the survey. A survey is a specific research approach that, through the adoption of standardized construction procedures (questionnaires) and the extraction of a representative sample of subjects, allows the statistical elaboration of a set of information (Mauceri et al., 2020). Different kind of surveys have been tested all over the world, each one with its advantages and limitations (Hartill et al., 2012;

Skov et al., 2021). In general, they differ for the cost-effectiveness of the methods (Bellanger and Levrel, 2017), considering that there are always trade-offs between survey costs and the precision of the estimates (Pollock et al., 2002).

In this sense, the Handbook for Data Collection on Recreational Fisheries in the Mediterranean and Black Sea was specifically designed to pursue the objective to collect robust and timely information on the impacts of recreational fisheries on marine living resources and their interactions with other human activities in the coastal community. It provides a clear methodological framework to allow Mediterranean and Black Sea communities to implement suitably harmonized sampling and survey monitoring schemes for recreational fisheries (Grati et al., 2021).

Here will be presented a pilot study performed in Marche Region, Italy, aimed at estimating the magnitude of MRF in the area, and the possible effects of pandemic-related restrictions. Following the methodology described in Grati et al. (2021), three kinds of survey (telephone, on-site and recall) were performed in parallel and integrated, taking advantage of the strengths of each one.

MATERIALS AND METHODS

Study Area

Marche region has 173 km of coastline, which together with Friuli Venezia Giulia, Veneto, Emilia Romagna, Abruzzo, and Molise, constitutes the Italian side of the Geographical Sub Area (GSA) 17, Northern Adriatic Sea (**Figure 1**). The coast is mainly low, with many beaches (81%) interrupted by high cliffs (19%) in correspondence of the Conero promontory. Moving offshore there are sandy bottoms mixed with mud. From north to south thirteen main rivers flow along this area, including five larger ones (Potenza, Chienti, Tenna, Aso, and Tronto) and minor seasonally dry streams. The high supply of nutrients through river waters determines a high primary production which is reflected in the food chain, leading to high fish productivity and

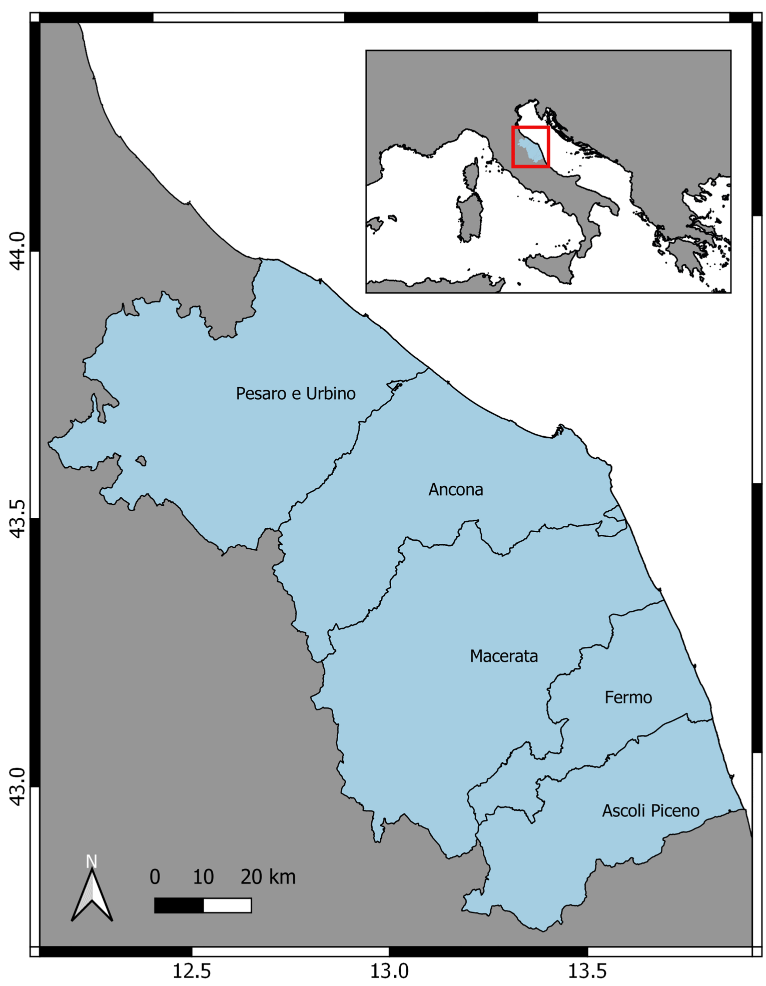

FIGURE 1 | Marche region and its provinces (Italy).

making the Adriatic one of the most productive areas in the Mediterranean for fishing purposes. Along the coast there are a total of 18 between port structures and tourist marinas, which are hotspots for many shore fishers, and at the same time, they are docking points for boat fishers (Ministero delle Infrastrutture e dei Trasporti, 2020).

The study area, as well as the entire world in 2020, was affected by the virus SARS-CoV-2, generating the Covid-19 pandemic. In Italy different typologies of restrictions were put in place (e.g. lockdowns, curfew, prohibition of certain activities, etc.) starting from national restrictions to regional regulations, based on the phases of the contagions. Depending on the type of prohibition imposed, the repercussions on MRF and related activities ranged drastically during 2020 (**Figure S1 Supplementary Materials** and for more details **Tables 1, 2** in **Supplementary Materials**).

Telephone Survey

The telephone survey was a part of a wider pilot study in the Italian GSA 17, involving 6 regions: Friuli Venezia Giulia, Veneto, Emilia Romagna, Marche, Abruzzo, and Molise, started from the 22nd of May to the 8th of June 2020. This task was committed to a specialized company that used two different strategies: CATI (Computer Assisted Telephone Interview) and CAMI (Computer Assisted Mobile Interview). With the integrated use of CATI and CAMI, the problems related to the fact that fewer and fewer people have a home telephone was considered negligible. The telephone numbers for the interviews were extracted by chance from the Italian directory for fixed telephones and, from a list of randomly generated and georeferenced cellular numbers, for mobile ones. RDD (Random Digit Dialing), which has been the strong-point in the research sector for over 30 years (Link et al., 2008), was the basis of these telephone surveys. In this way, the selection of people to be involved in telephone statistical surveys was carried out in a completely random manner. Prior to the telephone survey, all the interviewers were trained by the company about the purpose of the interview. In parallel, this activity was reviewed by verifying the quality of the data collected using automatic quality indicators (length of interviews, number of rejections per interview, etc.) and manuals (listening to interviews in real-time).

The sampling scheme for this activity was organized into two strata:

- Coastal municipalities (considering a buffer of 10 km from the coastline), which were oversampled, in order to obtain more interviews with recreational fishers (Bellanger and Levrel, 2017);
- Inland territories (less populous regions), conducting several interviews.

The sample size was identified considering to have an acceptable margin of error (<5%).

Respondents who resulted to be engaged in MRF were asked for additional personal details (age, sex), preferred fishing modality (from boat, shore or spearfishing), and the number of fishing days performed in 2019. Moreover, it was asked the willingness to be recontacted to take part to the following phase of the recall survey. Who answered positively was included in the panel: a list of fishers to be periodically interviewed on a monthly basis.

On-Site Survey

On-site or *in situ* investigations, although onerous (Hartill et al., 2011), consisted in approaching the recreational fishers directly in the field. The main purpose of this sampling was to try to involve other fishers in the panel, georeferencing their fishing activity in the area. From January 2020, on-site survey was performed from North (Pesaro harbor, PU) to South (San Benedetto del Tronto, AP), randomically extracting the sampling day and the location. The approach to interview was informal, in order to establish a relationship of trust with the fishers. With the aim of collecting harmonious data, it was created a standardised questionnaire centred on personal information, effort and catch and release data (see **Supplementary Materials Table 3**), together with the willingness to be recontacted in the following months.

In this study retained or released catch refers to biological resources subtracted or not from the sea, respectively. The reasons driving anglers to choose the destination of their catch are not taken into consideration in this work.

Recall Survey

This approach is an off-site data collection method which is a valid tool for estimating all recreational fishing activities on a broad geographical scale, compared to the on-site survey. In fact, it allowed collecting data, all-round year, from contacts in the panel. It was carried out by re-contacting, by phone or by e-mail, the recreational fishers who gave their willingness to continue to collaborate, to collect data on catches, fishing effort, and economic information, relative to a specific period.

The standard form for the interviews carried out with this methodology is the same as in **Table 3** of the **Supplementary Material**, with the difference that the data collected refer to a monthly basis period and not to a single fishing trip and also include some aspects aimed at estimating the expenses incurred by those who participate in MRF.

Avidity Bias Evaluation Between Panels

In order to reduce the bias in the avidity evaluation, it is highly recommended to bear in mind how the data is collected. In fact, it exists the possibility that fishers who gave their willingness to be interviewed and included in the panel were those who had a deeper interest in fishing, and represented the most avid and prone to expenditures subpopulation (Wynne-Jones et al., 2014). To verify that the sample was not *a priori* biased in this direction, it was necessary to compare the panel with a known sample, representative of the population in terms of avidity (i.e. the number of fishing days in a year). The whole dataset obtained from the telephone survey conducted on GSA17 area was available to perform this comparison. The distribution of the outputs in the probabilistic sample was compared with the distribution of the panellists' outputs using the Bootstrap methodology. Bootstrapping is a statistical procedure for estimating the sampling distribution of a variable; in this case the mean fishing days, by sampling with replacement from the original sample. When the statistical distribution is unknow, it can be used to produce good approximate confidence intervals. With respect to other numerical methods, in fact, bootstrapping methods shows a lower bias or variance (DiCiccio and Efron, 1996) with the advantage that is not necessary to make any assumption about the shape of the distribution of the variable. Instead of generating observations from a known theoretical distribution, observations were generated from the distribution of the sample itself. Two bootstrap algorithms were applied: the first, bias-corrected and accelerated (BCa) bootstrap, gave the chance to construct confidence intervals of the mean for both the distribution (Dixon, 2002), while the second allowed to compare the two distributions directly. The second algorithm applied was characterized by a non-parametric hypothesis test that assumed the difference in average between the two distributions as a null hypothesis (for more details see for example (Chernick, 2011).

Statistical Analysis

The association between a response variable (fishing days, retained catch, travel expenses, etc.) and the covariate "month" was evaluated by a linear mixed model (Zuur et al., 2009) where the factors "month" and "ID of the fisher" represented the fixed and the random effect, respectively. *Post-hoc* tests were performed with the Bonferroni correction which is more appropriate for an unbalanced design (David, 2019). The statistical analysis was carried in R environment (R Core Team, 2021). In particular, for the linear mixed model, we used the function lmer (package lme4 ver. 1.1-27.1) which is better suited for crossed designs (Hector, 2015). For significant testing, a reference p-value of 0.05 was considered for all hypotheses tested.

RESULTS

Telephone Survey

For the whole GSA 17 a total of 44,651 telephone calls were done: 5,207 calls were considered as valid (11.7%), 20,197 people refused the interview (45.2%) and 19,247 calls were deemed invalid for other reasons (such as: non-existent phone numbers, no quota, 6 attempts reached, other outcomes; 43.1%).

In Marche Region a total of 581 households were reached by the telephone survey and a total of 1,576 people was surveyed (**Table 1**). Of these, 369 calls were referred to landline phone numbers (277 coastal, 92 non-coastal municipalities), while 212 were referred to mobile phone numbers (129 coastal, 83 non-coastal municipalities). The margin of error based on the sample size was estimated as 4.07%. The overall population of Marche Region consists of 1,512,672 people estimated for 2021 (ISTAT, 2021); so, this screening survey reached 1,081 inhabitants living in coastal municipalities and 495 ones living in non-coastal municipalities of the region, representing 895,685 (65.3%) and 475,959 (34.7%) inhabitants, respectively. Among interviewed people, only 34 resulted engaged in MRF, 27 of which belonged to the coastal, and 7 to the non-coastal stratum. This generated a participation rate of 2.1% when considering the whole region, corresponding to a participation rate of 2.5% and 1.4% for the coastal and non-coastal municipalities, respectively (**Table 1**).

The mean yearly fishing days (reference year 2019) estimated with interviews were 14.7 days/year. The total number of fishing days by fishing modality showed that the most relevant was represented by shore fishing (230 days, 46%), followed by boat fishing (183, 36.6%) and by spearfishing (87, 17.4%; **Figure 2**).

On-Site Survey

During the on-site survey a total of 107 people were interviewed in 2020 in the Marche Region; they were all male with an average age of 47.58 years old. About the willingness to contribute to the project, 31 people agreed on contributing to the study as panelists for the recall survey.

Recall Survey

Considering the relatively low number of panellists recruited from the telephone survey, the recall was performed on both the panel recruited with the telephone survey and the one obtained during on-site survey. A total of 39 fishers was regularly recalled on a monthly basis during the whole year 2020 for collecting data on catches, fishing effort and expenditures. Spearfishers were excluded due to the very poor data availability for this fishing modality.

The average fishing days were estimated at 4.18 ± 4.64 days/fisher/month, 86.9% coming from shore fishing and 13.1% by boat fishing (respectively 723 and 109 days; **Figure 3A**). A seasonal oscillation was observed about the monthly average days at sea by modality, especially in late summer/early winter, when boat modality reached the maximum value in July, estimated in 4.83 ± 5.88 days at sea, whereas shore modality highlight highest values in January at 6.75 ± 4.61 (**Figure 3A**).

In terms of hours spent at sea by each angler, the average value was estimated in 16.65 ± 20.28 hours/fisher/month, of

TABLE 1 | Telephone survey in Marche region.

	Coastal	Non-coastal
Home telephone valid calls	277	92
Mobile valid calls	129	83
Total valid calls	**406**	**175**
Population interviewed	1081	495
Representing inhabitants	895.685	475.959
Marine recreational fishers	27	7
Participation rate	**2.5%**	**1.4%**

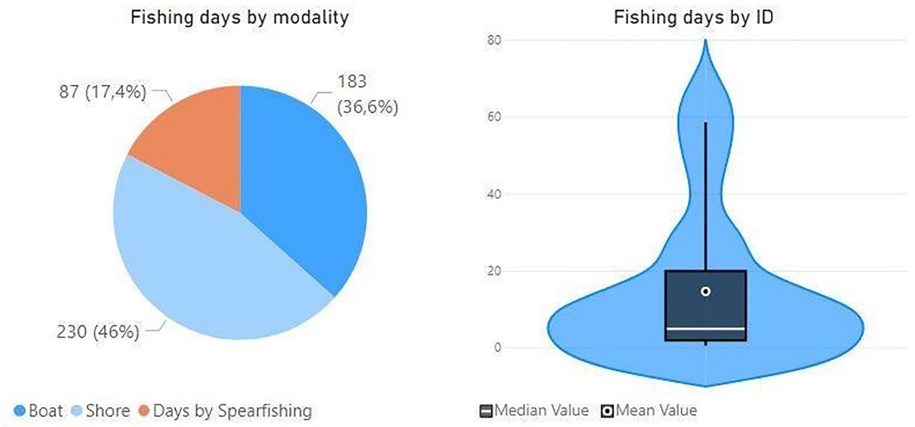

FIGURE 2 | Number of fishing days by modality (left) and mean yearly fishing days (right) of 2019.

which 81.9% from by shore fishing and 18.1% from boat fishing (**Figure 3B**). The average hours at sea for the boat modality showed high values in June (29.8 ± 13.8), while the shore modality reached 22.8 ± 31.7 hours in May (**Figure 3B**).

The average retained catches, referred to as the quantity of resources subtracted from the sea by interviewed, was estimated in 1.53 ± 3.28 kg fisher/month, of which 55.3% from shore fishing and 44.7% from boat fishing (**Figure 3C**). The monthly average values indicated that the highest catches were obtained in July (3.07 ± 4.97 kg). The value of retained catch by modality highlighted September has the highest monthly value (10.22 ± 12.33 kg) for boat modality, instead, shore modality highlighted maximum values in July (2.92 ± 5.05 kg; **Figure 3C**). In terms of released catch, the mean value was estimated at 0.51 ± 1.42 kg fisher/month, of which 58.7% from shore fishing and 41.3% from boat fishing (**Figure 3D**). The monthly average indicated the maximum in June for boat fishing (2.97 ± 3.58 kg), and in July for shore fishing (0.78 ± 1.11 kg; **Figure 3D**).

The expenditures were considered by grouping all the categories (equipment, natural bait, artificial bait, fuel, and travel). The mean value was estimated in 40.86 ± 88.09 € fisher/month, of which 67.7% spent by the shore anglers and 32.3% spent by boat anglers (**Figure 3E**). Considering the great heterogeneity of these values, there is not a significant trend in the monthly average expenditures, indicating the maximum in October for boat modality (132.91 ± 161.83 € fisher/month) and September for shore modality (94.05 ± 179.32 € fisher/month; **Figure 3E**).

Avidity Bias Evaluation Between Panels

From the results of the bootstrapping analysis, it was evident that the two distributions were centred around very close values (**Figure 4**), even if the panellists' one showed a greater variance (CI: 14.11-28.42 and 17.18-20.83, respectively; **Table 4 Supplementary Material**). A p-value of 0.92 (**Table 4 Supplementary Materials**) allowed to strongly refuse the hypothesis of a difference in the distribution of the means, meaning that it was possible to consider the fishers of the panel as representative, at least in terms of avidity.

Statistical Analysis

The statistical analysis performed in order to identify if the factor "month" could affect the other variables revealed no statistically significant effects for most of them. Slight effects of factor "month" were observed only in relation to the variable "Artificial bait" for shore fishers (F value: 2.01, P value: 0.042*) *post-hoc*. All the results obtained from the analysis of variance (ANOVA) were also supported by the linear mixed model analysis (lme) applied to verify correlation among data.

DISCUSSION

This study contributed to estimate the magnitude of MRF in the time of the COVID-19 pandemic. Here we estimated, for the first time, the participation rate, effort, and expenditures of marine Recreational fishers in the Marche Region, Central Adriatic Sea, Italy (GSA 17). In this work the proposed GFCM protocol (Grati et al., 2021) was applied for the very first time, trying to adopt an harmonized methodology among Mediterranean and Black Sea riparian countries.

Three different surveys, each one with specific issues concerning design, coverage, non-response biases, variability (Hyder et al., 2018), and costs, were integrated in order to take advantage of their pros, and try to overcome the cons. It is widely known that there are trade-offs between survey costs and the precision of the estimates, but it is also true that methods that reduce bias in the estimates may be too expensive. In general, the estimates deriving from on-site surveys are very precise, however, they require a network of experts spread throughout the whole coast, interviewing recreational fishers all year round and at all times of the day. For these reasons, they are much more expensive compared to off-site surveys (Pollock et al., 2002). In this case, the use of several survey methods allowed to obtain a satisfactory estimate on MRF

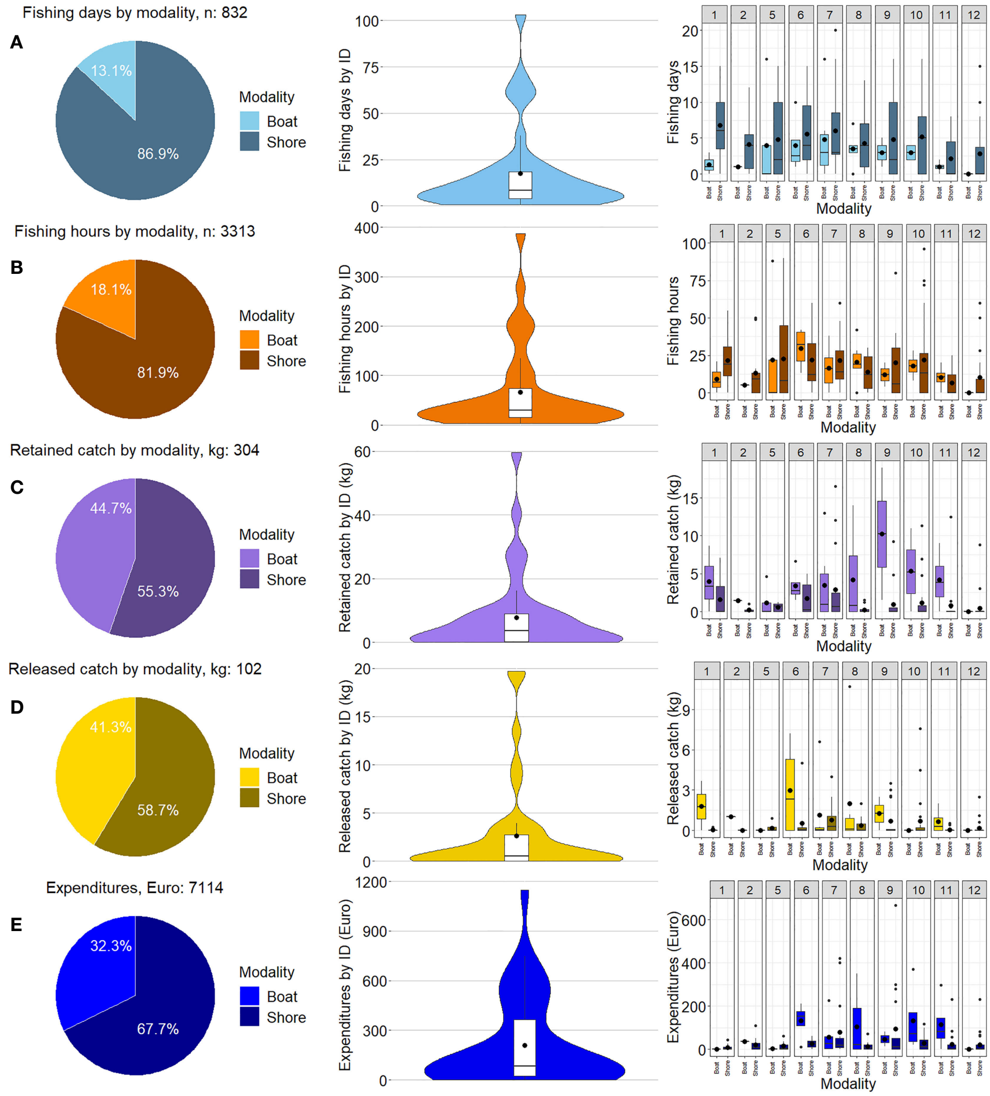

FIGURE 3 | Data on fishing effort, catches and expenditure from the recall survey in the year 2020. From the left pie chart (n and %), violin plot, and box and whisker plot of variables by modality. From the top: fishing days (days, **A**), fishing hours (hours, **B**), retained catch (kg, **C**), released catch (kg, **D**), expenditures (€, **E**).

(Herfaut et al., 2013) and, at the same time, it was a good trade-off for experts' work and total costs. Moreover, the protocol adopted for data collection perfectly fitted the Anthropause induced by COVID-19 restrictions, allowing the study prosecution during 2020. The MRF participation rate estimated in Marche Region (2.1%) was slightly higher than the one calculated by Hyder et al. (2018) for the whole Europe (1.6%), confirming the greater propensity to this activity by people living in coastal areas. Similarly, the average number of fishing days per year was higher in the Marche Region (14.7 days/year in 2019) when compared to what estimated for the European countries (5-10 days/year; Hyder et al., 2018), suggesting that a cultural component and long tradition of the area (Pranovi et al., 2016) could influence the avidity. Given these values of participation rate and avidity, MRF in Marche Region would involve more than 31,000 people exerting a total of 571,000 fishing days/year.

From the results of the telephone survey, shore fishing resulted to be the more popular modality both in terms of people involved and average fishing days/year, confirming the outcomes of many studies conducted in other countries (e. g. Gordoa et al., 2019). Boat fishing was the second most popular modality detected, while spearfishers were fewer. Considering the fragmented information on people participating in this modality and the poor availability of data, spearfishing was excluded from the analysis of this study. It is well known that, due to the nature of this modality, spearfishers are difficult to be involved in on-site surveys (Griffiths et al., 2010), so different strategies to include them in the panel would be needed in future.

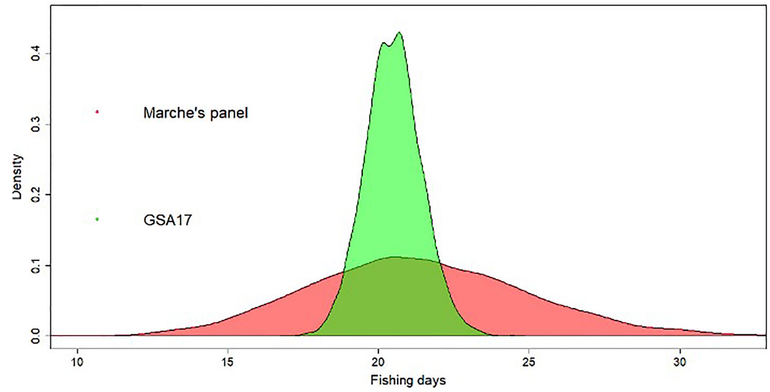

FIGURE 4 | Distributions obtained from 10000 random draws of the bootstrap algorithm: the green shaded area represents the distribution of the mean of annual fishing days for the probabilistic sample of the GSA17 area, while the red shaded area represents the same statistic for the Marche's panel.

The pressure on the resources evaluated through the retained portion of catches has been estimated as comparable between shore and boat fishing, meaning that under the same fishing time, boat modality has higher Catches Per Unit of Effort (CPUE). This difference in pressure could be due to different factors. First of all, fishing by boat in the Italian side of the North Adriatic Sea allows to reach most appreciated fishing hotspots such as deeper areas or submerged structures, principally represented by mussel culture farms, but also by wrecks and rocky reefs that could increase the chance to catch bigger fishes (Pranovi et al., 2016). It is reasonable to assume the catch estimation as an underestimation due to the daily bag limit that is fixed by national law at 5 kg per day per fisher, which probably could lead interviewers to declare their catch under this limit. In addition, considering the results on the expenditures by modality, from which it is evident that a fishing day from the boat is much more expensive than from the shore, a boat fisher could be inclined to invest these amounts of money only for larger and most satisfactory catches.

Data on expenditures represented a huge challenge in this study, as there is a very wide range of goods and services included in MRF, and it is worth to point out that the direct expenditures here reported were just a part of the total economic value generated by MRF (Andrews et al., 2021). Some aspects, for example, due to the difficulty in obtaining this information by recreational fishers, were not taken into account, such as the transport expenditures from home to the fishing point (e.g., fuel, transit costs, etc.). For that reason, in the updated version of the on-site form the ZIP code of place of residence was included, in order to estimate economic behaviour of anglers such as the "willingness to pay" to obtain Services from MRF.

Some loss in expenses directly related to the pandemic effect on recreational fishing have been already expected, but in other hand, fishers investing in new fishing gear were noted in Italy (Pita et al., 2021). Nevertheless, although the expenditures are a useful rough proxy of the economic impact of recreational fisheries, they neglect some components of the total economic value as for example the one associated to the leisure of fishers. This means that the number proposed in the results is very likely to be a strong underestimate of the total economic value generated by MRF in the Marche region, which confirm the need of investigate the magnitude of the phenomenon.

Activities associated with recreational fishing were seriously affected during the confinement imposed by the different government decrees, as reported for the Canary Islands. The effect of the closure inevitably affected the entire tourism industry and leisure activities (Henry and Lyle, 2003; McManus et al., 2011; Guerra-Marrero et al., 2021), in addition once the social confinement was completed, they are not reactivated in a regular way, but reopening was modulated according to the infection intensity in each region (Guerra-Marrero et al., 2021). Such pandemic condition may have had overwhelming effects worldwide, both on environmental, social, and economic point of view. If we consider the possible effect on how citizens could remodel the value attributed to outdoor activities, it is reasonable to assume an increase of the absolute value of ecosystem services provided by MRF. This phenomenon was already showed, highlighting a significant increase in the number of recreational fishing licences immediately after the confinement (Guerra-Marrero et al., 2021; Thomas, 2021), or an overall increase in fishing effort especially for anglers with lost work or lost jobs (Midway et al., 2021). The motivation on how people participate in recreational fisheries has been changed by the pandemic, moving from a simple outdoor activity for non-consumptive orientations (e.g. "to relax and unwind"), to a consumptive orientations (e.g. "to catch a feed") such as obtain fresh and quality food in a simple way (Henry and Lyle, 2003; McManus et al., 2011; Guerra-Marrero et al., 2021).

At the same time, if in one hand the recreational companies were negatively affected by confinement measures such as cancellation of fishing tournament, prohibition of fishing charters and licences suspension, in the other hand an increased demand for reels, nylon, buoys, hooks, spearguns, masks and fins, and other fishing tools was recorded, reaching 60% in relation to the similar period of the previous year (Paradis et al., 2021). This aspect was influenced not only by the possibility to carry out the outdoor activity of recreational fisheries (Guerra-Marrero et al., 2021), but also because in most cases it was encouraged during the pandemic, also listed as an essential activity, as long as it could be performed while adhering to public health guidelines, so that 92% of the 63 North America jurisdictions did not close or delay the 2020 recreational fishing season (Paradis et al., 2021). During COVID-19, changes in fishing activities were attributed in order of importance to: travel restriction (53%), social distancing (45%), the decision to isolate (37%), personal reasons (26%), fishing quality (11%), access (9%) and cost (4%), as showed in Western Australia (Ryan et al., 2021).

Given the Anthropause induced by COVID-19 related restrictions, all the absolute values resulting from this study about MRF in Marche Region should be analysed taking into account that for 2 months, namely March and April, all the activities were banned; in fact, the lockdown effect is evident in the results for all the considered variables. For 2020, the estimated average fishing days/year, fishing hours, retained and released catches, and expenditures could have been even higher without COVID-19 effects.

Considering an average value of fishing days per month per fishers, estimated as more than 4 days, or retained catch per month per fishers, estimated as more than 1.5 kg, and also the total costs, estimated as more than 40 € per month per fishers, it is quite easy to understand the magnitude of the effects of restrictions induced by COVID-19 in terms of impact on the marine resources and related economy.

Midway et al. (2021) highlighted a change in primary reason for fishing during the pandemic. Fishing to help in mental stress and for social and family bonding was reported by many anglers as increasingly important.

Considering the above mentioned results, and avoid to exceed in speculations, assuming Marche Region as representative of the whole Italian peninsula inhabited by 59 million people (ISTAT, 2021), and expanding these results basing on the participation rate to MRF in the area, it is reasonable to assume that the magnitude of Italian marine recreational fishers could reach 1.24 million people, catching more than 22,760 tons/year of fish resources, and generating more than 607 million € expenditures. If compared to the Italian capture production deriving from commercial fisheries (163,764 tonnes in 2019; GFCM, 2021), and income generated by the national commercial fleet (881 million €; STECF, 2021), MRF could represent even 13.9% of commercial landings and around 68.89% of the commercial income generated.

It is reasonable to assume this estimation could be affected by some uncertainty that could under- or overestimate the results. It is possible essentially because regions could demonstrate different propensity to this activity, on the contrary, the social restrictions caused by the COVID-19 pandemic could affect the behaviour of fishers, causing a re-evaluation attributed to the time spent for this outdoor activities.

Other factors could contribute to the distortion of the above estimation, such as the willingness to answer correctly to the recall survey, without thinking about the repercussion of declarations, or different percentage and distribution of fisher typology, differently impacting resources, and expenditures.

In conclusion, this case study estimating MRF in Marche Region confirmed the relevance of the sector, not only in Adriatic Sea, but also at European level. Much remains to be done to fully understand the features of this fishery, especially from the environmental, social, and economic point of view. However, from the estimation produced so far it is evident the need to characterize in detail MRF both at national and basin level, moving toward a sustainable exploitation of the sea and their resources, also considering the value of this activity both as source of economy, health, and well-being for the whole community.

DATA AVAILABILITY STATEMENT

The dataset presented in this article is not readily available because the authors are not the data owners. Requests to access the dataset should be directed to luca.bolognini@cnr.it.

ETHICS STATEMENT

Ethical review, approval, and written informed consent for participation were not required for the study, in accordance with the local legislation and institutional requirements. The study was not directly connected and did not include manipulation of vertebrate animals or cephalopods.

AUTHOR CONTRIBUTIONS

LB, FC, VF, AP, LS, MS, and FG collected the data, FC and SG performed the statistical analysis, LB and MS wrote the manuscript with contributions from all authors. All authors discussed the results. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmars.2022.823086/full#supplementary-material

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