WORKING GROUP ON RECREATIONAL FISHERIES SURVEYS (WGRFS; outputs from 2022 meeting)

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WORKING GROUP ON RECREATIONAL FISHERIES SURVEYS (WGRFS)

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International Council for the Exploration of the Sea
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i Executive summary

The ICES Working Group on Recreational Fisheries Surveys (WGRFS) role is to summarize, and quality assure recreational fishery data and feed into the ICES advisory process on marine recreational fisheries (MRF) issues. In 2022, WGRFS continued to work on many aspects of MRF including collation and review of national survey programmes; assessment of the validity of new approaches; provision of guidance on availability, quality and use of data; supporting regional data collection and storage; the human dimension; and review of workshops organized by the group. The sessions focused on sharing information, assessing the quality of national survey programmes, intersessional groups, and scientific publication plans.

Information was shared on several different topics. New national survey programmes and new survey results were presented for Belgium, France, Ireland, Norway, Sweden, and UK. Perspectives on MRF were provided by the European Commission and the European Angling Alliance. An update on the outcomes of the Regional Coordination Group (RCG) intersessional group on Recreational Fisheries was given. Methods for allocation of catches between recreational and commercial fisheries were highlighted alongside potential approaches that could be applied. Summaries of the outcomes from stock assessments that include MRF were presented.

Two national survey schemes were reviewed using the WGRFS Quality Assurance Tool: Italy and the UK. Issues were highlighted with existing designs and suggestions made for future improvements. The focus of the meeting was to review progress, agree approaches, and set direction for the intersessional groups (ISGs) as the WGRFS' main mode of delivery. The ISGs cover governance; survey methods; quality assurance; regional coordination and data storage; catch and release and animal welfare; stock assessment and reconstruction; novel methods; human dimensions; and communication and engagement. The discussions and outcomes are too diverse to be summarized here, instead details are provided in the text of the report.

The WGRFS has continued to deliver outcomes centred on: creating a broad network to share expertise; developing methods; raising the scientific profile; and providing the scientific evidence of inclusion of recreational data in fisheries management. WGRFS has expanded the network beyond Europe to generate more collaborations and wider learning, with around 115 members from 30 countries. The profile of the group has been raised at the international congress and through a presentation in the European Parliament by WGRFS members. Several papers have been published and a further manuscript being developed that resulted from collaborations within the WGRFS.

ii Expert group information

Expert group name	Working Group on Recreational Fisheries Surveys (WGRFS)
Expert group cycle	Multiannual fixed term
Year cycle started	2019
Reporting year in cycle	3/3
Chairs	Kieran Hyder, UK
	Estanis Mugerza, Spain
Meeting venues and dates	Year 1: 15–19 June 2020, online meeting, (50 participants)
	Year 2: 14–18 June 2021, online meeting, (54 participants)
	Year 3: 13–17 June 2022, Las Palmas, Gran Canaria, Spain, (60 participants)

1 Terms of reference

Working Group on Recreational Fisheries Surveys (WGRFS)

Term of reference	Addressed in this report
Collate and review quality of national estimates of recreational catch and effort, catch-and-release impacts, and socio-economic benefits for candidate stocks, identify significant data gaps in coverage and species, and support the ICES TAF.	Yes
Assess the validity of traditional knowledge, new survey designs, novel methods (e.g. citizen science, apps), and innovative statistical methods for data provision.	Yes
Provide guidance to ICES and respond to ad hoc requests from ACOM on the availability of data, design of data collection programs, data storage systems, use of data in assessments, and catch allocation.	Yes
Develop approaches for regional data collection programmes that generate robust data for end-users and support the ICES TAF.	Yes
Evaluate the use of economic (e.g. impact, valuation), social (e.g. governance, behaviour, welfare, health), and communication (e.g. participatory process, messaging) to support the assessment and management of recreational fisheries.	Yes
Review outcomes of the workshops organized by the group.	Yes

2 Summary of the work plan

Year	Work Plan
Year 1	1) Establish intersessional groups and leads within WGRFS to progress key tasks including governance, survey design, quality and analysis, regional coordination, data storage, catch-and-release impacts, novel methods, assessment and catch allocation, human dimensions, and communication. (a, b, c, d, e)
	2) Plan at least three WGRFS publications within the period 2020-22. (a, c, e, f)
	3) Update the existing quality assessment tool (QAT) and embed this in the TAF. (a,d)
	4) Evaluate the quality of up to three national survey programmes using the QAT. (a)
	5) Investigate animal welfare issues related to recreational fisheries (e.g. catch and release) and identify how these could impact management. (a)
	6) Assess the impact of recreational fisheries on a broad range of stocks using data from the pilot studies. (a, c, d)
	7) Create a framework for inclusion of recreational data in stock assessments and scope a workshop to design approaches. (a, c, d)
	8) Collate advances in survey methods that could be used to improved national approaches. (b)
	9) Develop a solution for storage of data within RDBES and agree with ICES. (c, d, f)
	10) Review existing governance structures and develop understanding of 'world class' recreational fisheries management that could be embedded in a future revision of the CFP. (e)
	11) Review outcomes from WKHDR and agree approach for inclusion of angler behaviour in future surveys. (f)
Year 2	1) Evaluate the outcomes from the intersessional work and agree approach for the next year. (a, b, c, d, e, f)
	2) Review national programmes including assessment of quality of up to three programmes and provide feedback on tasks requested by ICES. (a)
	3) Assess the potential of novel survey methods to deliver recreational fisheries data (e.g. citizen science approaches, smartphone apps, traditional knowledge). (b)
	4) Develop a framework for allocation of catches between sectors based on a review of existing systems and provide best-practice guidance. (c,d)
	5) Develop MSE approaches to assess the impact of uncertainty in recreational catches on assessment and regional sampling programme. (d).
	6) Review and share methods for engaging with stakeholders and the potential for particpatory approaches. (e)
	7) Assess outcomes of workshop on inclusion of recreational data in stock assessments. (f)
Year 3	1) Evaluate the outcomes from the intersessional work and agree approach for the next year. (a, b, c, d, e)
	2) Review national programmes including assessment of quality of up to three programmes and provide feedback on tasks requested by ICES. (a)
	3) Evaluate post-release mortality estimates, potential sublethal effects, and reasonable extrapolations across species and fisheries for inclusion in stock assessments. (a)
	4) Assess novel approaches for surveys (e.g. combining probabilistic and non-probabilistic sampling) and analysis methods (e.g. treatment of outliers, machine learning). (b)
	5) Assess the potential for impact of climate change on species caught by recreational fisheries and how that coud impact on DCF and regional species requirements. (c, d)
	6) Review the potential for food safety and human health issues from consumption of recreational caught fish (e.g. environmental toxins). (e)
	7) Evaluate progress against three year plan and develop new ToRs. (a, b, c, d, e, f)

3 List of outcomes and achievements of the working group in the current delivery period (2020–2022)

The latest WGRFS terms of reference were approved for a three-year term starting in 2020, so it is now possible to include some information on the outcomes and achievements in this delivery period (2020–2022). The COVID-19 pandemic has led to large changes in ways of working and has slowed progress as individuals adapt. However, the aim is to build upon the success between 2017–2019 that centred on: creating a broad network to share expertise; developing methods (surveys, assessment, regional cooperation, assessing quality, novel methods); raising the scientific profile (presentation, conference sessions, papers); and providing the scientific evidence of inclusion in fisheries management. This will include broadening the scope of the group and expanding the network beyond Europe to generate more collaborations and wider learning.

Creating a broad network to share expertise: there are currently 115 members (permanent and chair-invited) of the WGRFS from 30 countries. We have increased participation in countries from South America, the Caribbean, Africa, and Australia, alongside broadening participation across Europe. This represents the largest and most diverse working group of scientists focusing on marine recreational fisheries (MRF) globally.

Developing methods: we have introduced intersessional groups as our main mode of delivery covering governance; survey methods; quality assurance; regional coordination and data storage; catch and release and animal welfare; stock assessment and reconstruction; novel methods; human dimensions; and communication and engagement. These have led to several joint publications and surveys. The WGRFS Quality Assessment Tool (QAT) has been updated and six national survey programmes have been assessed between 2020 and 2022.

Raising the scientific profile: members of the WGRFS have raised their profile at the World Rec Fishing Congress and convened a session on recreational fisheries at the World Fisheries Congress. In addition, work has been presented at the RecFish Forum in the European Parliament. Finally, at least 12 manuscripts have been published that resulted from WGRFS collaborations (see Section 4.6) and further manuscripts are being developed.

Providing the scientific evidence of inclusion in fisheries management: surveys have been completed in many countries across Europe and support has been provided to review the outcomes of the MRF pilot studies from Member Countries. In addition, marine recreational fisheries data were compiled across countries for the North Sea cod benchmark and included as an issue in the scientific advice for the first time. Contributions have also been made to pollack and Irish Sea cod benchmarks. Finally, members of the workgroup have provided support in discussions around the revisions of the EU Control Regulation.

4 Progress report on terms of reference and work-plan

4.1 Country updates (ToR a)

Recreational fishing surveys are carried out across Europe covering a range of species and areas. In EU member states, all species and areas are required under the DCF (EC 199/2008, 2010/93/EU, 2016/1251/EU, and 2016/1701/EU) and control regulations (EC 1224/2009) are covered.

Annex 3 includes a table that provides an overview of the current/most recent surveys countries have in place to estimate marine recreational catches. The tables cover four major sea areas as defined by the current DCF:

- Baltic Sea (ICES subdivisions (SD) 22–32).
- North Sea (ICES areas 3.a, 4 and 7.d) and Eastern Arctic (areas 1 and 2).
- North Atlantic (ICES areas 5–14 and NAFO areas).
- Mediterranean Sea and Black Sea.

These tables relate solely to surveys of recreational fishing defined by WGRFS (ICES, 2013):

> **"Recreational fishing is the capture or attempted capture of living aquatic resources mainly for leisure and/or personal consumption. This covers active fishing methods including line, spear, and hand–gathering and passive fishing methods including nets, traps, pots, and set–lines".**

An overview of the most recent economic surveys of marine recreational fisheries can be found in Annex 4: country updates were presented for Belgium, France, Ireland, Norway, Sweden, and the UK.

4.2 Perspectives from end-users

4.2.1 European Commission update

Representatives from the European Commission (EC) provided an update on the current legislative (EU) framework for MRF and upcoming proposals at the EU and GFCM levels. This reiterated the European position on sustainable use of the ocean, and its fish stocks being key to meeting the EU climate-neutrality commitments within the European Green Deal. Where recreational fisheries play an important role, it is important that the MSY objective of the Common Fisheries Policy is met, as for certain species recreational catches represent a significant portion of the total catches and can affect sustainability. The EC is aware and concerned that MRF can have an impact on the state of some stocks, including Baltic cod, European sea bass, and European eel. In some instances, recreational catches are more important than commercial ones. The EC is monitoring the situation closely and proposes measures for recreational fisheries on a case-by-case basis, as was the case for sea bass, European eel, Eastern Baltic Cod and Western Baltic cod for the fishing opportunities of 2022 (EC, 2022a).

Reliable and uniform data collection remains vital for the EC to assess the impact of recreational fishing on specific stocks and to set appropriate measures. The various multiannual plans (Western Waters, Baltic, North Sea and the Western Mediterranean) contain provisions for the Council being able to set non-discriminatory catch limits when scientific advice indicates that recreational

fishing is having an impact on the fishing mortality of a stock. As well as a reference that Member States shall take the necessary and proportionate measures for monitoring and collection of data for a reliable estimation of the actual recreational catch levels. The obligation to provide data on MRF for some stocks under the Data Collection Framework was mentioned, as well as the financial support under the new European Maritime, Fisheries and Aquaculture Fund (EC, 2021a) where recreational fishers are eligible for support insofar as their projects help achieve the fund's objectives. For example, they can participate in actions that protect the marine environment and in partnerships on sustainable maritime tourism in local communities.

The new requirements for data collection on recreational fisheries are detailed in the EUMAP (Multiannual plan; EC, 2021b; c). Member States are required to "implement statistically robust multispecies sampling schemes that allow catch quantities to be estimated for stocks agreed at regional level, in accordance with the relevant end-user needs". A list of species is provided per area for which catch quantities are to be estimated if no such schemes exist (Table 4 in EC, 2021b). The mandatory species are the same as in the previous EUMAP. Biological sampling is to be carried out "where recreational catches affect the development of fish stocks" in accordance with end-user needs as agreed at the marine region level. The new EUMAP moves from pilot studies to regular sampling schemes, and there is a further strengthening of the regional coordination, following the overall regionalisation principle in the CFP. EUMAP explicitly refers to the need to coordinate data collection activities at regional level, recognizing that many DCF requirements can be better catered for when MS agree and coordinate their activities. Eventually, /this coordination should result in regional work plans for data collection.

MS submitted their national work plans in October 2021, and they were adopted, following STECF and Commission assessment in January 2022. These last for a minimum of 3 years with some MS adopting programmes for 6 years including Estonia, Ireland Netherlands and Spain. In summary, nearly all MS are implementing routine recreational data collection programmes in their new work plans, that cover, at minimum, the listed species in the EUMAP. Often, scientific data collection on recreational fisheries complements mandatory reporting to cover sectors or species not covered by licenses and/or reporting obligations. As in the pilot studies, MS combine large-scale offsite surveys with targeted onsite surveys and self-sampling schemes. Sampling of catches occurs through interviews and by observers at sea and onshore. Biological sampling is carried out on selected species by many MS. Sampling plans are in place for recreational fisheries on diadromous species for both the marine and freshwater, especially in the Baltic. In the Mediterranean, MS follow closely and integrate GFCM initiatives in their submitted work plans.

The Commission's proposal for the revision of the Control Regulation (EC, 2018) introduces a general requirement to monitor the number of recreational fishers through a licensing or registration system alongside data collection or catch registration system for all recreational catches to improve control and monitoring. This proposal is currently being negotiated with the co-legislators. At the request of the European Parliament, DG MARE launched a pilot project to develop and test a "control scheme for recreational catches of sea bass" (MARE 2019/006) in November 2019. An external contractor has developed an integrated IT tool to allow recreational fishers to record daily catches using an app "FishFriender" or a web-based interface[1]. A report has been published showing that it is possible to have an integrated EU catch reporting system for recreational fisheries (EC, 2020) and summarized in a webinar[2]. The Commission aims to further develop the system targeting four areas:

1.   Maintenance and support.

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[1] https://recfishing.eu/

[2] https://oceans-and-fisheries.ec.europa.eu/news/webinar-recreational-fisheries-monitoring-and-control-2020-12-04_en

2. Incremental improvements:
   a) Including of up to 50 species (for which the ICES WGRFS may propose criteria to select the species and propose a list of 50 species based on these criteria).
   b) Implementation of useful ways to visualize the data.
3. Repatriation and support for European Commission guidelines.
4. Possible integration of new/other reporting applications, testing and certification.

The Commission highlighted developments in the General Fisheries Commission for the Mediterranean (GFCM). The 44th session of the GFCM in November 2021 reviewed a recommendation of the minimum rules for sustainable recreational fisheries in the Mediterranean Sea (GSAs 1 to 27) aimed at promoting the regulation. In March 2022, the GFCM Working Group on Recreational Fisheries (WGRF) provided feedback on the proposal, and recommendations on the research needs for recreational fisheries and agreed on a work plan for 2022–2023 that included a regional research programme.

The EU Blue Economy report (EC, 2022b) recognizes recreational fisheries as an ecosystem service, linking it with a case study of France on individual and collective benefits deriving from the functions and services provided by the ecosystems of the French maritime domain of metropolitan France. Recreational fishers are highlighted as recreational activity – a cultural ecosystem service – but also creating individual benefits of expenditure by recreational fishers. Marine pollution is seen as one important pressure on the marine ecosystem – threatening the health of the marine environment with corresponding impacts on commercial and recreational activities.

By the end of 2022, the Commission will deliver a report on the functioning of the Common Fisheries Policy for which a targeted stakeholder consultation has been carried out. A report analysis of the contributions by stakeholders on an online questionnaire has been published (EC, 2022c). Based on feedback from stakeholders, this concluded that the CFP Regulation remains a good framework for fisheries management and had generated results. However, improvements are necessary for: both further implementation and control and enforcement; proper inclusion of an ecosystem-based; and the precautionary approach. Respondents identifying as stakeholders in the recreational fishing sector emphasized that recreational fishing must be integrated in the CFP, and highlighted that data collection should be improved, and scientific advice should be provided in a timely manner. Multiannual plans were identified as tools to include specific measures for better management of fishing activities of small-scale- and recreational fisheries. The Commission closed the stakeholder consultation with a stakeholder event on 10 June 2022.

4.2.2   Regional Coordination Groups

The RCG NANSEA and RCG Baltic proposed creating an Intersessional Subgroup on Marine Recreational Fisheries (ISSG MRF) in 2020. For this Subgroup to work properly, it is necessary to ensure that the right people are involved, including experts from WGRFS (and other relevant Working Groups), DCF, RCG LP, RCG MED&BS, and RCG ECON. National Correspondents (NC) need to be approached to ensure that relevant bodies are contacted to ensure expert participation.

During the WGRFS 2022, the main discussions from the RCG NANSEA and RCG Baltic annual meeting were presented. The species list for surveys in each region and the criteria used for it was considered as one of the priorities by these RCGs, to incorporate them into the EUMAP. In addition, the incorporation of the MRF data into the RDBES is considered a key tool for sampling coordination at regional level. The progress made under this topic and future actions were discussed. These two key points were covered by the WGRFS in recent years, providing recommendations to the RCGs. The RCG intersessional group meeting was postponed to the end of 2022,

and the outcomes from this group will be discussed during the RCG NANSEA and Baltic technical meeting in 2023.

WGRFS will continue to provide scientific input to the RCGs and to the specific subgroup on the topics considered essential by these groups.

4.2.3   Recreational fishing community

Most fishery managers tend to consider recreational fishing solely or primarily from the perspective of its impact on stocks and the delivery of MSY. Typically this means fishery managers only become interested in recreational fishing when they become aware of a problem with the stock and are considering restrictions.

However, fish are a societal asset, and the European Anglers Alliance (EAA) believes fishery managers have a duty to use that asset to deliver the greatest possible long-term benefits to society, particularly to the coastal communities that are most dependent on the value generated by fishing. We call this approach Maximum Sustainable Benefit (MSB).

To date, most fisheries science and management has been driven by the paradigm of Maximum Sustainable Yield (MSY), which is focused purely on maximizing the total amount of fish removed from a fishery and ignores economic value added or social benefits. Maximum Economic Yield (MEY) is an attempt to improve on MSY but fails to consider social benefits and there is little agreement on how to define or target MEY, so it remains little used in actual fisheries management.

In 2004, the UK government's Cabinet Office recommended adopting the MSB approach in a paper called "Net Benefits" (UK, 2004) which stated that "The overarching aim of fisheries management should be 'to maximize the return to the UK of the sustainable use of fisheries resources and protection of the marine environment'. The paper went on to state that the government has a responsibility to manage marine activities "to ensure the best value is made of the UK's marine resources and biodiversity is preserved". However, this recommendation was never adopted by the UK government. We believe that this was because MSB is novel and there is not yet a roadmap or framework for implementation. As a result, it has been easier for fishery managers to continue down the known path of targeting MSY, although it is suboptimal.

To target MSB, fisheries managers will need help from fisheries scientists to gain a deep understanding of economic and social benefits, including what type of benefits; where are the benefits generated; how to measure the value of benefits (especially benefits that do not have an obvious financial value, such as social benefits); how benefits arise; and, most importantly, how benefits from fisheries can be maximized.

Recreational fishers too can play an important role in persuading fisheries managers to move to MSB. Where recreational fishing is an important part of a fishery, recreational fishing organizations are becoming increasingly successful in establishing themselves as major stakeholders that have legitimate needs that need to be addressed, needs that can only be met through the targeting of MSB. If this political pressure for MSB is supported by scientific research, we believe recreational fishers and fisheries scientists will be able to dramatically improve the management of our fisheries.

In our WGRFS presentation, we identified several areas where additional fisheries science research could assist the pursuit of MSB, and these are discussed below.

4.2.3.1   Changing baselines
To appreciate what MSB can deliver and to create pressure for change, we need to better understand what our fisheries looked like in the past. Younger recreational fishers can only benchmark

their fishing experience by reference to a short time frame and have little or no appreciation of how the recreational fishing experience has declined over the last 50 or 60 years.

Recreational fishing as a source of historic fisheries data has been somewhat overlooked by fisheries scientists and managers. We urgently need to record the experiences of recreational fishers in their seventies and eighties who can provide valuable data on Catch per unit effort ("CPUE"), size of catches, variety of catches, effort, economics, social conditions, etc. This kind of project might lend itself well to a citizen science approach, with the provision of some guidance and training.

Additionally, some recreational fishing clubs have maintained records over a long period that could be a valuable source of recreational fishing data. However, fishing clubs are seeing rapid declines in membership, increasing the risk that as time passes valuable data will be lost.

4.2.3.2 Large stock strategy
We believe that a key part of MSB should be to aim for a large stock strategy. This would aim to deliver:

- Stocks that are more resilient to pressures such as poor recruitment, overfishing and climate change.
- Natural age/size structure.
- More and bigger fish that are highly valued by recreational fishers and have superior reproductive capacities.
- Higher CPUE.
- Higher yield-per-recruit as more fish survive to live longer

We need fisheries scientists to identify stock levels resulting from different levels of fishing pressure over different time frames, and the social and economic benefits for different stakeholders both in the short and long term.

4.2.3.3 Stock valuation
Currently, fisheries assessments do not place a value on fish stocks, they look only at tonnage. This makes it easy for fishery managers to suboptimally target MSY rather than MSB. It also means that when fisheries ministers decide to set fishing opportunities above the scientific advice, they can do so without having to confront the negative impacts of those decisions on the value of the fish stock and the socio-economic benefits of stakeholders in future years.

Money talks and perhaps the biggest fisheries management change that fisheries scientists could affect in the short term would be including stock valuation in stock assessments. If fishery managers had to face the fact that setting a Total Allowable Catch above the scientific advice would reduce the present value of the stock, they would be less likely to view this as an acceptable trade-off. Stock valuation would also make it easier for stakeholders to hold fishery managers to account for allowing overfishing.

4.2.3.4 Catch allocation
Fishery managers currently have little information to help them decide how to allocate fishing opportunities between different allocations between recreational and stakeholders. When attempting to allocate sea bass fishing opportunities the EU Commission has talked about the need to be "fair" or "proportionate", but these concepts are very much in the eye of the beholder. To target MSB, fisheries managers need to have good estimates of how different allocations will change the social and economic benefits for each stakeholder in the fishery and the trade-offs between different choices.

4.2.3.5   Drivers of participation

In fisheries where recreational fishing is a large stakeholder, the EAA believes that MSB involves increased recreational fishing participation if the value per fish extracted is far higher for recreational fishers than commercial fishers (MRAG, 2014). Accordingly, it is important for fisheries managers to understand what drives recreational fishing participation and how to increase recreational fishing participation. A UK Sea angler testimony from the 1970s suggests abundance of fish is an important factor: "I remember weekends if you didn't get on the beach by 6 pm you didn't have a hope in hell of getting a spot to fish when the cod were about" and "When the fish were in, you literally couldn't get a space to fish at most Cod beaches… hundreds of anglers out fishing every Friday and Saturday nights". In the south of the UK, the situation has suffered a dramatic decline in the availability of cod to recreational fishers, meaning that it is rarely, targeted and the tackle trade has stopped providing equipment for this purpose.

4.2.3.6   Regional valuation

In the UK, Regional Fishery Managers have very limited data on recreational fishing socio-economics in their area. As a result, they:

- Do not know the value of recreational fishing to their local economies.
- Do not know the social benefits recreational fishing delivers to their coastal communities.
- Spend most of their time on commercial fishing issues, not sea-angling issues.
- Tend to ignore sea angling when drafting laws and when carrying out Impact Assessments

The picture is similar in the Netherlands. There is a desperate need for recreational fishing data at a regional level to allow Regional Fishery Managers to assist in the task of targeting MSB.

4.2.3.7   Localized overfishing

Many recreational fishers complain about their local area being "fished-out" by localized overfishing – usually by commercial fixed netters. Species such as sea bass, which display a high level of site fidelity are particularly vulnerable to localized overfishing and areas that have been overfished are likely to take years to recover. However, there is little science on this topic. Fishery managers would benefit from understanding how localized overfishing by one stakeholder group impacts other stakeholder groups and local social and economic benefits. A related blindspot is industrial-scale fishing. Has any work been done on potential negative impacts on stock and stakeholders of the removal of large amounts of a given species in a relatively small area over a short period of time? For example super-trawlers operating in the English Channel.

4.2.3.8   MCRS increases and selectivity improvements

Recreational fishers place a high value on large fish and for this reason, many recreational fishers support increases to MCRS. However, bycatch of undersized fish is a barrier to MCRS increases since fishery managers worry that increasing an MCRS will increase commercial discards. To deal with this problem, MCRS increases should be accompanied by increases in minimum mesh sizes. However, more data are needed on how to improve selectivity, either through gear modifications or spatio-temporal avoidance. More specifically, it would be useful to understand:

1. Real-world selectivity of fixed nets with different mesh sizes, where nets can be set with different hang ratios and can be made from different materials with different catching attributes.
2. What mesh sizes are in use, what species are being targeted with what mesh sizes and what are the social and economic impacts of moving to larger mesh sizes.

In commercial fisheries, fishery managers are increasingly collecting both positional data and landing data per trip. However, fishery managers have no experience or tools to allow them to use this information to obtain a deep understanding of commercial fishing activity. There is an opportunity for fisheries scientists to help fishery managers gain this deep understanding and help them balance the needs of all stakeholders, including recreational fishers.

4.2.3.9   Registration

The absence of a registration system for recreational fishers in many countries creates real problems for fisheries scientists attempting to study recreational fishing (number of sea anglers, geographical spread, age, etc). It also creates difficulties for fishery managers, for example in communicating changes to fishing regulations. The EAA strongly supports obligatory registration for recreational fishers.

4.3   Stock assessment

The inclusion of MRF in stock assessments takes a long time as it is complex and requires significant effort. First, the impact of MRF on the stock needs to be identified (e.g. Radford *et al.*, 2018) and added to the assessment issue list. This results in MRF being included in the data call at the next benchmark and consideration of how best to include it in the assessment process. Inclusion in the assessment and advice depends on several factors including both the data available and the modelling approach. The MRF data needed for an assessment should ideally include retained and released catches; sizes of fish retained and released; biological information (e.g. age–length keys); and estimates of post-release mortality. Time-series should be provided for the whole period of the assessment. However, MRF data can be challenging to collect, with different countries employing varied methods based on their culture, fisheries, and budgets. As a result, MRF data tends not to cover the entire assessment period and may be missing for some gears, and often assessments of uncertainty (e.g. errors) are not available. Often post-release mortality studies are lacking but are important as release rates for many recreational species are high (e.g. Ferter *et al.*, 2013).

Where data are sparse, it is necessary to develop bespoke solutions based on the model used and the relative level of MRF removals. Hence, it is possible to either use MRF data to inform advice or use it in the assessment (Figure 1). Informing advice can be done through, for example, sensitivity analysis or inclusion on the advice sheet as part of a precautionary approach (Figure 1). Using MRF data in the assessment usually involves reconstruction of time-series, assumptions around how catch varies over time or between countries, or expert judgement (Figure 1).
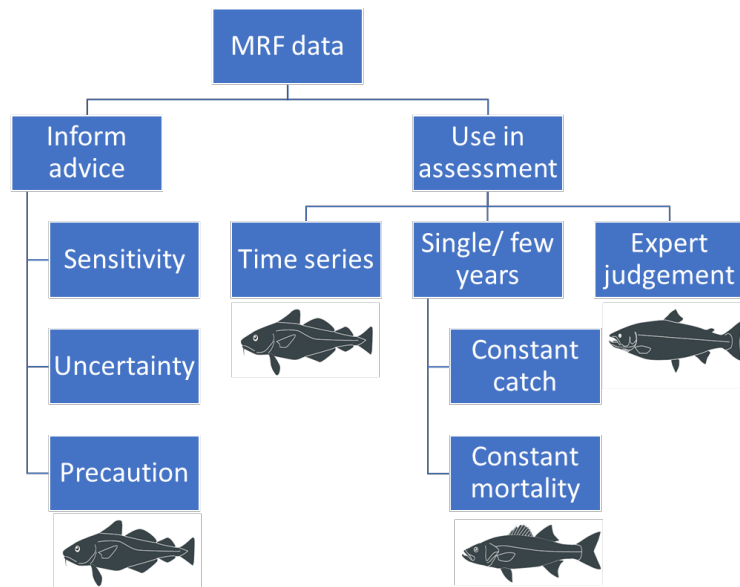
Figure 1. Potential approaches for inclusion of MRF in ICES assessments and advice. The fish indicate where different approaches have been used in Europe.

Inclusion of MRF in assessments and advice in Europe is currently limited to cod (North Sea, Irish Sea, Western Baltic), sea bass (northern, Biscay), pollack, and Salmon (Baltic). For North Sea cod, MRF is included in the advice sheet from 2020 with the proportion of removals over the period 2010–2019 outlined (ICES, 2022a). It was not possible to include MRF data in the SAM model as a time-series catches by age was needed from 1963 to present. There was variation in MRF data, timing and accuracy between the 8 countries exploiting the stock, meaning that re-construction was not possible nor was inclusion in the SAM model (ICES, 2022a). Instead, catches were documented and included in the advice (ICES, 2022b). For Irish Sea cod, a stock synthesis 3 (SS3) approach was used, but a stable model could not be generated that included the recreational catches (ICES, 2022c). Again, MRF catches were included on the advice sheet highlighting that recreational catches could be significant, but more information was needed to include them in the model (ICES, 2022d). Western Baltic cod is the best example of inclusion in the assessment models as a long time-series of German catches exist, meaning that a time-series for the whole assessment period could be generated with limited assumptions, and post-release mortality estimates for boat-based catches exist (ICES, 2022e). Recent updates have focused on incorporating Danish and Swedish catches. Outputs form the model indicate that recreational removals were about 47% of the total in 2021 (ICES, 2022e). For sea bass, MRF data were included in the SS3 model that runs from 1985 to present (ICES, 2022c). MRF data were limited to a single year with no data after the implementation of management measures in 2015, and a single post-release mortality study was available. To include MRF in the SS3 model, recreational fishing mortality was estimated in 2012 and assumed to be constant throughout the period before management was introduced, and the impact of management measures was modelled then applied as a re-duction in mortality (ICES, 2022c). Finally, Baltic salmon was assessed using a Bayesian model from 1987 to present and used catches reconstructed based on expert opinion (ICES, 2021a).

There is a need to consider the inclusion of MRF as a default in all stock assessments, but this would require significant effort to achieve. MRF targets many species, so approaches are needed to prioritize which stocks to focus resources on initially. In addition, including MRF in assessments and advice is complex, so a framework is required for this based on the MRF data and modelling approach. These are being developed by the Stock Assessment and Reconstruction Intersessional Group (see Section 4.5.6).

4.4 Catch allocation

As management of marine recreational fisheries becomes more common in Europe, allocation decisions will need to be made between commercial and recreational fisheries. Most fisheries legislation, including the CFP, encompasses the need to account for biological, social and economic factors in management decisions. This suggests that catches within safe biological limits should be allocated to parts of the fishery in a way that maximizes societal benefits, and that this allocation should drive management measures. This 'explicit allocation' is found in some parts of the world (e.g. Australia, New Zealand, USA), where catches are allocated between the commercial and recreational sectors (e.g. a constant proportion of the total allowable catch (TAC) based on historical catches) and then set management measures that result in the recreational share of the TAC. However, catch allocation between the recreational and commercial sectors has generally been implicit in Europe, where management measures drive catch shares between the sectors. For example, there have been changes in the relative proportion of recreational and commercial catches from the assessments for sea bass and western Baltic cod, with large changes since the implementation of management measures. Hence, transparent and consistent approaches for the explicit allocation of catches between recreational and commercial fisheries that account for social and economic benefits are needed in Europe.

Social-ecological systems provide one potential approach to achieve this and have been applied to recreational fisheries (Arlinghaus *et al.*, 2017). The approaches are flexible adaptive and permitting rather than command and control, but there are challenges in including feedback, and external drivers of changes in state and social and ecological diversity (Arlinghaus *et al.*, 2017). Potential approaches were discussed including economic impact (e.g. Armstrong *et al.*, 2013; Hyder *et al.*, 2017; 2018; Robert *et al.*, 2017), economic value (e.g. Andrews *et al.*, 2021; Lewin *et al.*, 2021), social value (e.g. ICES, 2021b), and systems approaches (e.g. Tidbury *et al.*, 2021).

Many approaches are being applied across the globe, but few approaches account for economic and social benefits. The need for catch allocation will increase in Europe as management measures for recreational fisheries are introduced for more stocks. Further research is needed to develop best practices for catch allocation that could be applied in Europe.

4.5 Intersessional groups (ToRs a–e)

The ICES WGRFS covers a large range of topics, with many of these topics being quite specific and requiring expert knowledge and in-depth work. During the yearly meetings, there is not enough time to cover these topics thoroughly, so the WGRFS has decided to establish nine intersessional groups. These will cover governance, survey methods, quality assessment of surveys, regional coordination and data storage; catch and release and fish welfare; stock assessment and reconstruction; novel methods; human dimensions; and communications and engagement. The groups consist of WGRFS members and-invited experts that will meet regularly to address agreed goals. They will be led by two members of the WGRFS, who will be responsible for reporting progress to the WGRFS. A summary of the progress for each group is provided below.

4.5.1 Governance

Leads: Fabio Grati and Kieran Hyder

MRF governance varies greatly between countries (Arlinghaus *et al.*, 2019; Potts *et al.*, 2020), with effective governance requiring a clear legal definition, policy, co-management, monitoring, and cost recovery, and must be adaptive (Potts *et al.*, 2020). In Europe, MRF is not effectively

embedded in fisheries governance, but there is increasing recognition of the importance of MRF and moves to include it more effectively in future. The role of the governance intersessional group is to consider how this could be done and support future integration. While acknowledging the general increasing recognition of the importance of MRF worldwide, one of the aims of the governance intersessional group is to discuss how to effectively embed MRF in the broader European fisheries governance, which currently mostly prioritizes commercial fisheries.

To assess the key issues for effective governance in Europe, the framework of Potts *et al.* (2020) was used. In 2021, we discussed each of the key principles and the current situations in Europe, before developing a SWOT analysis and highlighting bright spots of effective national governance. A draft manuscript has been developed for publication on European governance of MRF which will be submitted to Marine Policy. The focus of the ISG session was to go through the manuscript and seek input from the group to shape the messaging.

The governance group will likely need to continue for the next 3 years as there are still many issues at a European level. The aims of the group will be reviewed at the next meeting in the context of the ICES ToRs to develop the approach.

4.5.2   Survey methods

Leads: Annica de Groote and Stephen Taylor

In many regions, MRFs are difficult to survey due to the diverse and dispersed nature of the activity. MRF can be sampled from a list of licence holders (i.e. a registry) cost-effectively when such activities are legislated. However, for many fisheries, a registry of fishers is unavailable. Many different probabilistic survey methods are available (e.g. onsite roving creel, offsite diary), each of which has its advantages, limitations, and sources of bias (see Pollock *et al.*, 1994; Jones and Pollock, 2012). This makes each survey challenging to design, implement, and analyse, meaning that bespoke approaches are needed based on the fishing situation and the resources available. Given the complexities involved in designing robust recreational fishing surveys, pilot testing new survey methods and consulting with survey design experts in other jurisdictions are both considered to be pragmatic ways to optimize survey outputs.

Response rates in screening surveys are decreasing, making representative samples more difficult to obtain. Emerging evidence also indicates that recall bias can compromise the accuracy of estimates in offsite surveys. This has implications on the cost of surveys, the accuracy of the survey outputs and the need to future-proof survey designs. Non-probabilistic sampling is an alternative method that is often used when it is unfeasible or impractical to conduct probabilistic sampling (see Pennay *et al.*, 2018). The use of non-probabilistic approaches is increasing, but the impact on data quality is largely unknown. The main problem is that it is difficult to generalize research findings from non-probabilistic surveys and to assess sampling variability and identify possible biases. For MRF surveys, non-probabilistic sampling methods may be particularly relevant in the study of specialized fishers that take a large proportion of the catch but are too rare within existing sampling frames to be sampled cost-effectively using probabilistic methods. Additional categories of non-probabilistic sampling of relevance for recreational fisheries surveys include network sampling (including snowball sampling); opt-in web panels; and opt-in app surveys.

The overall aim of this intersessional group is to assess traditional and novel approaches for surveying MRF. This includes the design, implementation, and analysis processes, and the potential utility of the data generated. The overall leads for the group are Annica de Groote and Stephen Taylor, with ideas also being developed by Jon Helge Vølstad, Jeremy Lyle and Kieran Hyder. The primary focus of the intersessional group is on the use of probabilistic and non-probabilistic methods to estimate broad-scale estimates of catch and effort. This may also include the

design of regional validation studies to evaluate the utility of non-probabilistic sampling, describing the assumptions that must be met for non-probabilistic samples to yield accurate results, and gathering empirical evidence on the accuracy of non-probabilistic surveys.

The group leads compiled a web questionnaire that was distributed to all members of the intersessional group between April and May 2022. The survey was designed to improve the level of understanding of how surveys are being conducted by the various members, what additional support is required, and what are perceived to be the key opportunities and challenges relating to undertaking recreational fishing surveys. The results of this survey were summarized at WGRFS 2022 and provided useful context to assist the intersessional group in the overarching aim of assessing traditional and novel approaches. A series of online seminars will be scheduled over the next 3-years (2–3 a year), each of which will involve presentations from international experts. Based on those areas of support highlighted by survey respondents, the first online seminars will include: dealing with sampling frame errors, dealing with missing data, and how to choose a data collection method specific to the research objective. The first seminar will occur in November 2022, featuring several presentations by European and Australian experts in recreational fishing surveys. The feasibility of compiling a "best practice" standards document for recreational fishing surveys will also be considered by the intersessional group to assist in promoting consistency between surveys conducted within the various member states.

4.5.3   Quality assessment of surveys

Leads: Pedro Veiga, Mafalda Rangel, and Bruce Hartill

The WGRFS Quality Assurance Toolkit (QAT) was created in 2013 (ICES, 2013). It was developed to ensure the quality of recreational catch estimates from national surveys and to document bias in data collection to satisfy ICES and EU MAP requirements. This evaluation aimed at providing statements of the quality of MRF data for end-users including stock assessment scientists and identifying potential improvements to survey design (ICES, 2018).

Since its development, the QAT has been used to assess the quality and provide guidance on the design and implementation of multiple types of national survey programmes. In 2018 and 2019, the tool was reviewed to assess if it were still fit for purpose and/or if improvements could be made to the whole assessment framework. A thorough update was undertaken to address the subjectivity of some of the existing questions, provide a more logical flow of the questions, and create different assessment criteria for onsite and offsite surveys. Examples of text or what needs to be considered to answer the questions were also added to the QAT template. The main intent was to minimize different interpretations of the questions and increase consistency in the QAT assessments. Since then, the assessment template is reviewed and improved on an annual basis.

Intersessional working groups (ISG) have been in place since 2020. One of the core objectives of these groups is to ensure continuous work and discussions among the respective members between WGRFS meetings. One of the ISGs is dedicated to the Quality Assessment Toolkit (QAT) of surveys. In 2022, and following up on previous work, the QAT ISG session focused on three main points: (1) Review former recommendations and lessons learned to improve the latest quality assessment template and the current assessment process of the country surveys; (2) Continue the discussion around a potential QAT related publication; and (3) Develop the 2022/23 workplan, with the key milestones, and format of the intersessional work and meetings.

For the review of the QAT, the remaining subjectivity gaps in some of the existing questions of the template were discussed. The group also discussed the existing weaknesses in the current assessment process of the country surveys. In terms of the process of the quality assessment of surveys, the following was proposed and agreed upon by the group. The type of assessment of the quality of the survey should depend on the stage a survey is at. i.e. for:

Surveys that are at an initial stage (e.g. sampling design), the support from the WG should be more informal and in the format of recommendations. The support could be provided by one or more volunteer experts (from a pre-existing list of experts, also to be developed by the ISG), which could take place via e-mail (with moderation by the group chairs), or via a potential online platform forum for all WGFRS members. The ISG would also compile a library of all the QATs conducted so far, potentially organized by survey type (in part to provide examples, which might be helpful at the planning and sampling design stage).

The formal assessment process and existing template would then be used only for surveys that are in an advanced stage (e.g. already being implemented in the field, or at the data analysis phase). Here, the group discussed the need to develop a clear workflow of the review process (e.g. identify tasks, roles, and communication format and strategy). To foster the process, the QAT template should also be pre-filled (and shared) in advance of the formal evaluation, along with a summary (short report or presentation) that covers all the needed details to evaluate the quality assessment. The formal discussion would then focus on reviewing the pre-filled template, clarify any pending questions, and develop a formal recommendation on the survey being assessed.

In terms of the QAT related publication, the group revisited the idea of a concept note explaining the QAT, which would be a potential interesting first paper from this intersessional group. The overall idea remains around a concept paper, which would include a problem statement that led to the development of the QAT, the evolution of the tool since 2013, its current format structure, and, finally, how well it adapts to evaluating recreational fishing surveys in multiple contexts. The main discussed limitations for the paper were that it lacks some sort of measurement of quality. Despite this, the group agreed the paper on the overall idea of the paper, but we still need more data (assessments). The idea of also conducting a metanalysis of the QATs that the EU countries developed to evaluate their recreational fisheries pilot survey studies was also discussed as material for another potential paper. Nevertheless, this needs to be further discussed before the group formalizes the idea of the paper.

The 2022/23 workplan is:

1. Finish the draft workflow and decision tree, with the key steps, and roles and responsibilities in the quality assessment of surveys process.
2. Develop a template for a list of experts to be provide scientific support to the ISG. This would involve several ISGs working together to complete the list as it would serve multiple ISGs.
3. Compile a library of all the QATs conducted so far by the WGRFS.
4. Review, complete, and discuss the potential to merge with other existing ICES fisheries related glossaries.
5. Develop a rough outline for the first QAT potential paper, define the list of authors and expected timelines.

The ISG is planning a follow up call in early 2023, to discuss advances and next steps in each of the proposed items of the 2022/23 workplan.

4.5.3.1 Assessing the quality of national survey programmes

The quality of the Italian and UK national survey programmes were assessed using the QAT. The full QATs for each programme can be found in Annex 5, but the outcomes are summarized below.

4.5.3.1.1 Italy

The Italian MRF survey objective is to contribute addressing the environmental Target 3.3 defined by the Italy in relation to MRF; assessing the potential effects of MRF on marine resources,

either commercial or non-commercial, and on ecosystems. A telephone screening survey was carried out in 2020 to assess the Italian population of marine recreational fishers. Data collection is carried out on a probabilistic panel of fishers though a 1- month recall survey, where fishing effort, catches (including retained and released individuals), and expenditure by fishing modality are collected. A set of onsite observations are also associated, in a range of regions, with surveys carried out on a weekly basis on selected sites (each site is visited once a month). WGRFS concluded:

- The three components of the evaluated survey (screening survey, panel recall survey, and onsite survey) are comprehensive and fulfil most of the requirements of the QAT. The survey is still ongoing and some categories of the QAT could not be evaluated.
- There are some components of the target population that were not addressed in the onsite survey (charter boats, non-Italian not English speakers; night fishers; some regions and private access points not sampled) and it is recommended that in future surveys these components are acknowledged if possible
- For the off-site survey the WGRFS recognizes the considerable sampling effort, however, there are components of the target population that were not included in the survey (fishers without a listed phone number or mobile phone, inland regions). These limitations could be addressed in future studies.

4.5.3.1.2   UK

The UK sea angling survey generates estimation of participation, effort and catches. The survey is well constructed, but there are some issues around the convenience sample used to generate the diary panel. However, this was necessary as there is no list of sea anglers (e.g. license) and response rates to postal and telephone surveys are low. A postal survey of 3 regions generated very similar demographics to the convenience sample suggesting that that the approach used to recruit diarists has limited impact, instead driven by the types of anglers that are willing to keep a diary. A second issue is with the non-response of some of the diarists and missing data. Statistical approaches have been developed to try to address the potential biases, which perform better than simple post-stratification. However, the outcomes are still higher than pervious onsite surveys, so further work is needed to validate the catch levels (e.g. onsite surveys). WGRFS concludes the UK survey programme is well designed, appropriate analysis has been done to account for bias in the diary approach, and the outputs can be used for decision-making with appropriate caveats and sensitivity testing. Further work is needed to assess potential bias in the levels of catches driven by the diary approach that should include running a parallel onsite survey.

4.5.4   Regional coordination and data storage

Leads: Lucia Zarauz and Estanis Mugerza

It is important that marine recreational fisheries (MRF) data are included in ICES systems, so that they are available to stock assessors and fisheries scientists. The ICES Regional Database and Estimation System (RDBES) is being developed and will be the repository for all survey data, so this should include MRF surveys. Given the characteristics of the current MRF data, the preferred solution to have a database that holds raised tonnages and numbers of fish caught and released by area and year, alongside length–frequency distributions.

A data model for MRF catch and effort data has been proposed but was out of date. As a result, the data model was updated, and a voluntary data call was developed during 2022 to collate MRF data to test the system. Seven countries responded to the data call, providing the outcomes from a specific for all or part of the country. Despite only partial data being submitted, it was

still useful as the main objective of the test was to assess the utility of the current data models for MRF.

The ISG reviewed the data provided and concluded that there were no large issues with the existing data model based on the data provided. However, some specific needs were highlighted in the coding of some variables and the measurement if effort, alongside some issues that required broader discussion (i.e. between WGRFS, WGRDBESGOV, and assessment groups including WGEEL and WGBAST).

For diadromous species, WGEEL and WGBAST had data from recreational fisheries. WGEEL has its own complex database developed by the group that is focused on their specific assessment needs. However, RCGs require eel catch and effort data to be incorporated into the RDBES to coordinate the regional sampling. This means that collaboration between WGEEL and WGRFS, RCGs and WGRDBESGOV is essential to find the best solution. WGRFS will lead coordination between these groups and will organize a meeting to develop an approach. WGBAST is trying to adapt the RDBES MRF data model to their specific needs. A proposal for adaptation of the data model has been shared for ICES data centre experts and WGBAST to test.

The other main issue identified was related to the representativeness of the data. The RDBES needs to flag cases where the MRF estimates provided are not complete. This could be due to the estimates provided not covering all gears (e.g. only charter boats data, only spearfishing data etc.) or geographical areas of the country. It is also essential to make include an assessment of bias to help the end-user of the data understand how best to utilize the data. In the current data model, it is not clear if the bias assessment is related to the population sampled or because the information provided is incomplete. The main objective of the RDBES is to have the total catch and effort estimates for the country.

WGRFS will provide feedback to the WGRDBESGOV and participate in the design of the roadmap for the following years. The proposal will be to launch a general data call for MRF in 2023 to continue testing. The inclusion of the MRF data in the RDBES also needs to be included in the ICES development plan, and MRF experts need to engage with the core group, so that the data can be integrated within the context of existing RDBES features

WGRFS will launch an official data call for the 2023 meeting that will allow collection of the latest data generated by all countries. Many countries have been able to incorporate MRF surveys in their routine national plans, and most countries have conducted pilot studies between 2019 and 2022 under the EUMAP. This information must be incorporated to the RDBES, so data call will provide an overview of the current situation and used to identify how best to upload MRF data into RDBES.

The use of apps to collect MRF data are increasing globally, which is shown by the large number of apps that have been developed. Approaches need to be considered to collate these data and consider how best to include it in the RDBES. Therefore, WGRFS needs to start working on how best to do this based on the experience of the group around these issues.

4.5.5 Catch and release and animal welfare

Leads: Simon Weltersbach and Keno Ferter

Globally, catch and release (C&R) is a common practice in marine and freshwater recreational fisheries. This is also the case for many species in European marine recreational fisheries (Ferter *et al.*, 2013). C&R can have both lethal and sublethal impacts on the released fish. To ensure sustainable fisheries management that includes recreational fisheries, it is therefore of fundamental importance to consider release rates and lethal and non-lethal effects of C&R in stock assessments and in the development of fisheries management measures. Although an increasing

number of studies evaluating impacts of C&R on European marine species has been conducted in recent years (e.g. Alós *et al.*, 2009; Weltersbach and Strehlow, 2013; Ferter *et al.*, 2015a; Ferter *et al.*, 2015b; Pinder *et al.*, 2017; Lewin *et al.*, 2018; Watson *et al.*, 2020), there is still a lack of knowledge of potential negative impacts of C&R for several European marine recreational fisheries and species. This session aimed to discuss the current state of C&R impact studies for European marine recreational fisheries, animal welfare issues, and future research needs. In total, 30 people participated in the session. An important part of the session was the presentation and discussion of several planned, ongoing or recently finished research projects on potential lethal and sublethal C&R impacts for various species.

In Italy, there are plans to study post-release survival of several Mediterranean species in a multispecies marine fishery using a containment study in the Adriatic Sea. This study was planned for 2021 but postponed for several reasons including delay of approval of the experimental protocol by the animal ethics committee. Individuals will be caught with angling gear equipped with three different sizes of barbed hooks at about 60–70 m depth, tagged with spaghetti tags, and put into cages which are lowered to the seabed for 72 h. In addition, a "pseudo" control group will be captured using barbless hooks, tagged and put into the same cages. Various factors such as hooking location, capture depth, dehooking method etc. will be recorded and used for analyses. The research protocol, the experimental design and open questions were discussed by the group.

Results from two studies on C&R practices and lethal and sublethal impacts of C&R on sea trout in recreational fisheries were presented (Skov *et al.*, 2022; Skov *et al.*, under review). Information about angler behaviour, C&R practices, distribution of hooking location, level of injury and bleeding, as well as post-release impacts on survival and growth were largely missing for this species. A citizen science study and a C&R angling experiment in a flow-through seawater raceway focusing on sublegal (<40cm) sea trout. This was used to investigate C&R practices of Danish sea trout anglers and impacts on the survival and growth of sea trout for up to 29 days post release. The citizen science data confirmed that C&R is a very widespread practice in the Danish recreational sea trout fishery, as around 80% of all sea trout are released, mainly because due to the minimum landing size. The citizen science data indicated that 25% of the released sea trout bled upon release, of which 2% showed heavy bleeding. Bleeding was related to hooking location (deep hooked fish bled the most) and to fishing method (fly caught sea trout bled less than fish caught on spin fishing gear), but the role of these two factors varied with fish length (Skov *et al.*, 2022). The C&R angling experiment confirmed that bleeding is common among angled sea trout but differed between angling treatments (spin fishing with treble hook (size 4), spin fishing with single hook (size 1/0) and fly fishing with single hook (size 12)). No mortality and no significant differences in growth were found after 26–29 days among a control group and the three treatment groups caught during standardized experimental angling. Most fish had no or only minor hooking injuries upon inspection at study termination, but 6% showed signs of poor wound healing and infections. The latter also showed signs of reduced growth and was dominated by fish hooked with treble hooks. These results indicate that adverse effects of C&R on coastal sea trout may be limited and may not pose a significant population problem. Nevertheless, further studies in the field are needed to corroborate these results (Skov *et al.*, under review).

In Portugal, a study is planned to investigate immediate and short-term post-release mortality and sublethal impacts of two white sea bream species (*Diplodus* spp.). White sea bream is among the most important recreational target species in Portugal and releases rates are high, but limited information is available regarding post-release mortality and sublethal effects. The study design comprises experimental angling with two different sizes of the same J-hook and blood sampling (glucose, lactate, and cortisol) after capture, death, or 4 and 24 h after C&R. Various parameters will be recorded for each fish including fight time, fish length, bleeding, air exposure, and vitality

score. The fish will be tagged after capture and held in the cages for 24 h. The research protocol, the experimental design and open questions were discussed by the group.

Initial results from a study on sublethal impacts of C&R on Atlantic salmon (*Salmo salar*) in Latvia were presented. Salmon migration behaviour after C&R was studied in the Salaca river using acoustic telemetry. In total, 39 salmon (25 control fish caught with fykenets and 14 fish caught with rod and line) were radio-tagged in autumn 2021. The study revealed that salmon caught with rod and line performed a shorter spawning migration in the river compared to control fish, but that there was no difference in post-release survival. Furthermore, rod-and-line-caught fish migrated faster back to the sea after spawning.

Results from analyses of long time-series (from the 1950s) of recreational catches of elasmobranchs and tagging programs based on rod-and-line-caught and released sharks in the UK were presented. The study revealed that recreational fisheries, and in particular C&R angling can be an important source of information helping to study migration, distributions shifts and stock developments of data-limited species such as is the case for many elasmobranchs.

Due to the lack of knowledge of the post-release survival of several frequently released European marine species, studying post-release mortality is a high priority. However, prioritization is needed, and studies should aim to cover species and fisheries with high relevance of the recreational fisheries sector on total fishing mortality. Species for which such studies should be conducted include DCF species such as Atlantic bluefin tuna and other species with high release rates. Furthermore, methods need to be developed and applied to extrapolate mortality rates in data-limited situations between similar species and fisheries. In addition, it is sensible to study sublethal impacts of C&R simultaneously so that the results of lethal and sublethal impact studies can be used to develop guidelines that minimize negative C&R impacts, thereby improving fish welfare (Brownscombe *et al.*, 2017; Ferter *et al.*, 2020).

At the end of the session, three paper ideas were presented and discussed by the group. Two of the ideas had already been presented in last year's meeting but little progress was made since then due to limited time and funding. The first paper could be a review study on C&R rates and lethal and sublethal C&R studies in European marine recreational fisheries, including the development of a review framework and simple quality assessment tool for C&R studies like the QAT developed by ICES WGRFS or the critical review questions develop by ICES WKMEDS (ICES, 2015). The second paper could be an assessment of C&R attitudes and general C&R practices among marine recreational fishers in Europe. For this, a survey among recreational anglers could be conducted in several countries for comparison. The third paper would aim to develop a general framework which can be used to estimate post-release mortality rates based on (e.g. fish anatomy, life history, fishing-related parameters etc.). This would allow the estimation of post-release mortality rates for inclusion in stock assessments in situations where no information on a specific species or fishery are available. The group agreed that these are important studies and discussed funding opportunities to make progress.

4.5.6 Stock assessment and reconstruction

Leads: Martina Scanu and Zachary Radford

The main aims for the Intersessional Group were: (i) the species prioritization for MRF data collection; and (ii) the development of an inclusion tool (e.g. decision tree) for incorporating MRF data into the assessment process.

The criteria used by General Fisheries Commission for the Mediterranean (GFCM) to select MRF priority species were highlighted. Experts at GFCM-WGRF in 2021 used the priority species identified in the Data Collection Reference Framework (DCRF) and identified important species

for MRF by subregion based on 7 criteria: (1) high volume of MRF catches; (2) significant social impact for MRF (e.g. quality of recreational fishing experience, preference of fishers, etc.); (3) economic relevance for MRF (e.g. species driving tourism, etc.); (4) risk of overexploitation and/or for which a steep decrease in abundance has been observed; (5) species of conservation interest (e.g. endangered, vulnerable); (6) non-indigenous species (NIS); and (7) species of commercial interest for small-scale fishing (GFCM, 2021; GFCM, 2022). It was highlighted that this list of species does not correspond to the mandatory data collection as MRF surveys focus on multispecies in the Mediterranean Sea.

4.5.6.1 Species prioritization for MRF data collection and stock assessment

This aimed to develop an objective way of prioritizing species to be included into data collection and stock assessment. An initial species list per sea basin was compiled and the participants were asked to fill out the questionnaire for each species, following an approach like a Productivity Susceptibility Analysis (PSA; e.g. McCully Phillips *et al.*, 2015). Experts were asked to assign a ranking (from 1 to 3) for 14 questions divided into 4 broad categories: catchability, MRF biological importance, existing regulation, and socio-economic relevance. These had to be separately evaluated and weighted, generating a ranking of species. Each question was also paired with uncertainty estimation to be incorporated into the result. Productivity parameters extracted from FishBase[3] (www.fishbase.org) will be integrated into the results.
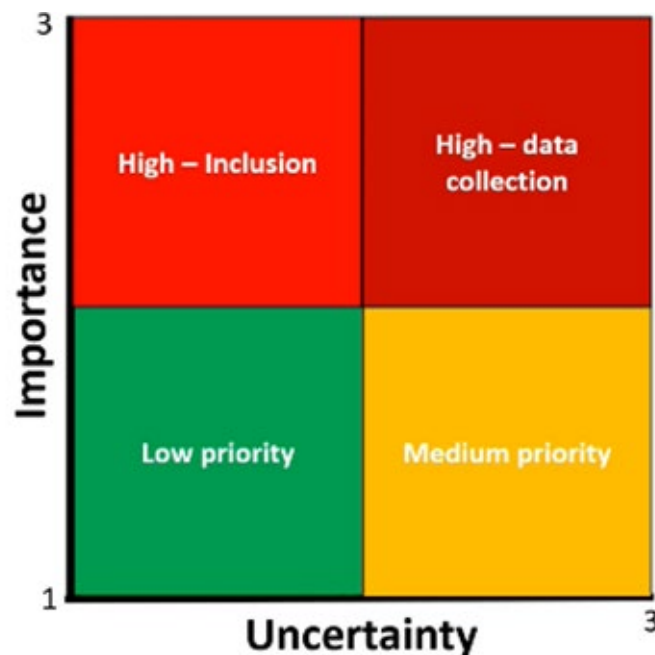
Figure 2. Provisional result categories from the prioritization exercise.

An initial exercise performed using input data provided by experts before the meeting was presented and discussed. This focused on refining each step of the procedure. Suggestions mainly focused on weighting methods for the different categories, for example, exclude normalization or averaging for the whole category, using the maximum value for each category, include thresholds to distinguish between results, weighting estimation through models, and other approaches (e.g. Torres *et al.*, 2022). The WG agreed on the choice to keep the weighting approach as simple as possible, although modifications to the method presented were required. Based on the

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[3] www.fishbase.org

feedback on the categories and questions, the excel spreadsheet and all the single questions were revised and/or rephrased. The next steps were to complete the spreadsheet for different ecoregions and assess the outcomes in the context of stock assessment. The aim is to support the EC in identifying species for inclusion in the EUMAP and publishing a paper on this topic.

4.5.6.2   Development of an inclusion tool for incorporating MRF data into the stock assessment process

Existing stock assessments have highlighted the challenges with inclusion of MRF data into stock assessment and advice, and the variety of approaches that have been used (see Section 4.3; Figure 1). Hence, there is need to develop consistent approaches for inclusion of MRF in stock assessment and advisory process, which is the focus of this task. Issues were highlighted including patchy time-series, possible strong interannual variation, limited post-release mortality (PRM) data, no uncertainty in estimates, and lack of consistency between when the assessment is carried out and when MRF data are ready. The following key steps were identified as a structure for the process of inclusion of MRF in stock assessment:

1.   **Inclusion in the assessment and advice:** there is need for a workshop to generate a consistent approach to ensure MRF are included in assessment and advisory processes that is co-developed by experts in recreational fisheries and stock assessment. This would establish a dialogue between the parties, maximizing the use of the existing MRF data, refining the output of the models including all the different fishing pressures acting on a single stock, and potentially improve data collection. Initial steps toward this are: to map the possible existing overlap between scientists having expertise in MRF (participating in the WGRFS or being involved in MRF surveys) within stock assessment groups; directly engaging stock coordinators; discuss connections between different ICES WGs mapped by WGMARS; and propose an ICES workshop on this topic.

2.   **Data processing:** there is need for focus on possible techniques for reconstructing MRF time-series. The main gaps in time, space, and components were listed and discussed. PRM studies were also considered during the discussion, and since they are expensive and difficult to achieve for all species and fishing situations (see Section 0).

3.   **Modelling:** once all data available on a certain species are collated, consider the stock assessment model limitation, the combination of errors and the need of a fine reconstruction process, were the major issue identified. The intersessional WG discussed all these considerations and concluded that work is still needed to develop a tool to select if to include MRF data into the model or at least in the final advice.

ToRs for the next three years were identified as: prioritization of stocks for inclusion in assessments; and test the PSA approach across regions. To perform the exercise on all the existing stocks would be impossible, founded on expert judgement, some species will be selected based on their importance from an angling perspective. In parallel, the work on the inclusion tool will be taken forward as an ICES workshop with stock assessors. The aim is to publish the outcomes as peer-reviewed papers.

4.5.7   Novel methods

Leads: Christian Skov and Paul Venturelli

Novel methods to collect data from recreational fisheries to supplement or even replace existing, more traditional methods are emerging in recent years, and are a focus of the WGRFS. Examples of novel methods are Internet scraping, Internet search volume, social/online listening, georeferenced photographs, trail cameras/car counters and Smartphone Applications (apps). During 2020–2022, the aims of the "Novel method" group have been to encourage the development and

evaluation of non-probability sampling methods, comparisons to traditional methods, the exploration of opportunities and limitations, and encourage fisher cooperation and engagement (e.g. through citizen science) as appropriate. Below we list several activities that the group has engaged in to support these aims during 2020 to 2022.

The group has used its expertise and influence to provide recommendations, encourage cooperation, and establish standards in relation to the development of new apps. In the period, we gave guidance and input, e.g. to groups from Australia, France, Japan, and Lithuania. We also gave a presentation at a Webinar: Recreational fisheries monitoring and control, Brussels, 4 December 2020 relating to the Danish experiences from collecting app data and provided recommendations and input during the discussions at the webinar.

The working group has facilitated networking that has improved international collaborations and insights into the use of novel methods. Members from the group have collaborated around several papers. Some of these have evaluated novel data (e.g. angler app, citizen science) against traditional methods (Gundelund *et al.*, 2021; Johnson *et al.*, 2021; Dainys *et al.*, 2022) and others have illustrated how novel methods can produce novel insights into recreational management. (Gundelund and Skov, 2021; Gundelund *et al.*, 2022, Cooke *et al.*, 2021; Weir *et al.*, 2022). The group also produced a study that, among WGRFS members, surveyed availability, use, and potential of apps in recreational marine fisheries (Skov *et al.*, 2021). Moreover, the group has developed and shared an online spreadsheet for members to log their ongoing and planned activities related to novel methods.

During the annual meetings, the group has had invited speakers present different novel method topics as inspiration for the working group members. In 2021, David Lusseau from the Technical University of Denmark gave an inspiring talk about estimating effort and catch (and more!) from social media data. In 2022 Asta Audzijonyte from the University of Tasmania, Australia/Nature Research Center, Lithuania gave a presentation about the use of fixed wing drones to count anglers. To engage WGRFS in the novel method topic outside the meetings, we held a virtual meeting in November 2021. Here we had three invited speakers: Valerio Sbragaglia, Institut de Ciències del Mar, who shared his experience with the use of social media for drawing insights about recreational fisheries; Casper Gundelund, DTU Aqua, who shared his work on studying angler demography as well as biases between data collected from citizen science platforms (e.g. Apps) and onsite surveys; and Jessica "Jit" Weir, Ball State University, who shared her work on studying angler movement and distribution of invasive species using app data and machine learning.

We believe that the Novel method intersessional group is relevant to maintain in the coming three years, and that its aims are still relevant. Focus in the coming three years could be on: (i) using its expertise and influence to provide guidance, encourage cooperation, and establish standards in relation to the development and inclusion of novel methods in the monitoring of recreational fisheries; (ii) maintaining the online spreadsheet for members about ongoing and planned activities related to novel methods; (iii) increasing cooperation with the intersessional group on survey methods to develop a rigorous approach to non-probability sampling in general and app data in particular; and (iv) continuing to publish exploratory (e.g. potential of novel data) and comparative research (novel vs. conventional sources).

4.5.8 Human dimensions

Leads: Harry Strehlow and Christian Skov

The human dimension of recreational fisheries is a multidimensional topic covering different research areas. In recreational fishing, it is commonly accepted that management of the fisheries to a wide extent involve management of humans, and that the human dimension side of management needs to be acknowledged. During the WGRFS meetings the human dimension

intersessional group have had invited speakers to elucidate the working group members of different human dimension aspects. However, the focus of the WGRFS intersessional group on the human dimension is to explore ways to capture angler heterogeneity and integrate aspects of it into data collection, stock assessment and management. In November 2019 WGRFS members ran a workshop titled "Integrating Angler Heterogeneity into the Management of Marine Recreational Fisheries" (WKHDR). This aimed to develop approaches for integrating the human dimensions into the future assessment and management of marine recreational fisheries. To collect these data in ongoing national recreational fisheries surveys, the aim was to identify a standard minimum set of questions that would capture angler heterogeneity adequately. The outcome of WKDR and following discussions of the members was a condensed set of questions that required testing if these questions perform as expected. During 2020–2022 the human dimension intersessional group have collected data and tested the condensed set of HD questions. This include a proposal of standardized questions regarding different aspects of the anglers' personal investments into the leisure activity that recreational angling is including two questions that explore the anglers skills, three questions that explore the how central angling is to the anglers lifestyle and two questions that explore aspects of the anglers behaviour. When these questions are analysed in combination they may capture angler heterogeneity in a standardized way, which could then be implemented across countries. Several countries (Denmark, Germany and UK) have used the questions suggested from the WKHDR workshop, and the extent to which these questions can explain angler heterogeneity is being tested. Analysis of the results from these surveys in underway, but the results suggests that the condensed set of questions can capture angler heterogeneity across countries although some variation among countries exists. Within country, e.g. in Denmark, the questions perform similar between survey types and between years. It has not been possible to explore the influence of these factors on catch rates, but this planned for future years. In the coming period the group is expecting to publish the outcome of WKHDR, and the performance of the condensed set of questions (Denmark, Germany, NN) will be tested further.

Communication and engagement

Leads: Pablo Pita and Sean Tracy

A session was held at the WGRFS 2022 meeting in which the progress made during the last period was presented, and next steps were discussed. It has been challenging to make progress in this area, so the focus of the discussions was to review the and update objectives in order to focus the future outputs from the group.

The aim of this intersessional group is to progress knowledge and provide content to allow the development of communication skills in the recreational fishing research sector. This will be achieved by: 1) raising the profile of communication and engagement in research funding and result dissemination; 2) reviewing strategies to improve communication and engagement with the recreational fishing community; and 3) developing measures to assess effectiveness of communication and engagement strategies.

A communication strategy for the WGRFS has been drafted and was reviewed during the session. The strategy was based on the outcomes from an online survey in 2021 that sought opinions of the WGRFS about how to improve the communication and engagement between academics, managers and policy-makers, recreational fishers, and other stakeholders, NGOs, and civil society. The strategy was agreed by the group and is based on the multichannel approaches as follows:

4.   **Reports.** The format and content of the WGRFS report is not the most appropriate to establish effective communication with many stakeholder groups, it can be used to connect mainly with scientists.

5. **Policy-briefs.** A brief that accompanies the launch of the report will be written as a tool to connect with policy-makers and representatives of sectoral organizations.
6. **Infographics.** An infographic will be produced about the recreational and disseminated to connect with recreational fishers, other stakeholders, NGOs, and civil society. A contact list is being created, and WGRFS is working with the ICES secretariat to share widely.
7. **Webinars.** A biannual webinar on important issues relating to the WGRFS and recreational fisheries in general is planned. This will be helpful to connect with the broader scientific community, recreational fisheries community, and decision-makers.
8. **Scientific papers.** A policy-brief-type paper will be developed about improving the engagement between academics, managers and policy-makers, recreational fishers, and other stakeholders, NGOs, and civil society. This will include a toolbox to help to develop communication and engagement strategies, with a focus on available communication frameworks, and on potential utility to develop adaptive management.

4.6   Publications

It is important to highlight the outputs that have been generated and plan for future outputs to raise the profile of the group. The focus of this discussion was on peer-reviewed papers due to the lead times, as broader communications materials (e.g. blogs, reports, and social media) will be covered by the Communications intersessional group. The following papers have been published that were generated from collaborations within WGRFS:

- Bachiller, E., Korta, M., Mateo, M., Mugerza, E., and Zarauz, L. 2022. Assessing the unassessed marine recreational fishery in the Eastern Cantabrian coast. Frontiers in Marine Science: 1–15.
- Weir *et al.* (2022). Big data from a popular app reveals that fishing creates superhighways for aquatic invaders. PNAS Nexus 1, 1–9.
- Pita *et al.* (2022). Recreational fishing, health and well-being: findings from a cross sectional survey. Ecosystems and People 18: 530–546.
- Lamb *et al.* (2022). Estimating discard survival of European sea bass (*Dicentrarchus labrax*) in the UK commercial hook-and-line fishery. Fisheries Management and Ecology 29: 105–114.
- Skov *et al.* (2021). Expert opinion on using angler smartphone apps to inform marine fisheries management: status, prospects, and needs. ICES Journal of Marine Science 78: 967–978.
- Gundelund *et al.* (2021). Evaluation of a citizen science platform for collecting fisheries data from coastal sea trout anglers. Canadian Journal of Fisheries and Aquatic Sciences 78: 1576–1585.
- Pita *et al.* (2021). First assessment of the impacts of the COVID-19 pandemic on global marine recreational fisheries. Frontiers in Marine Science 8: 735741.
- Gundelund *et al.* (2020). Insights into the users of a citizen science platform for collecting recreational fisheries data. Fisheries Research 229: 105597.
- Hyder *et al.* (2020). Marine recreational fisheries – current state and future opportunities. ICES Journal of Marine Science 77: 2171–2180.
- Pita *et al.* (2020). Assessing knowledge gaps and management needs to cope with barriers for environmental, economic and social sustainability of marine recreational fisheries: the case of Spain. Frontiers in Marine Science 7: 23
- Pita *et al.* (2020). The use of recreational fishers' ecological knowledge to assess the conservation status of marine ecosystems. Frontiers in Marine Science 7: 242.
- Potts *et al.* (2020). What constitutes effective governance of recreational fisheries? Fish and Fisheries 21:91–103.

- Vølstad *et al.* (2020). Field surveying of marine recreational fisheries in Norway using a novel spatial sampling frame reveals striking under coverage of alternative sampling frames. ICES Journal of Marine Science 77: 2192–2205.

Further papers are in development on governance, assessment of quality, impacts and allocation, novel methods and big data, non-probabilistic approaches, and angler heterogeneity. Workshop on novel methods and survey methods occurred, and further workshops are being developed covering animal welfare in fisheries; and interactions between recreational fisheries and marine protected areas.

5 Revisions to the work plan and justifications

All the ToRs and tasks were covered, but tasks around climate impacts and food safety were delayed. The focus of the meeting was on the intersessional groups with parallel sessions to allow more time for discussions, WGRFS potential contributions to the design of national and regional sampling plans, and collaboration with the angling community. No further changes are requested at this stage. The group was consulted to find out how the meeting went and especially about the new way of hybrid working.

6   Next meeting

The next meeting of WGRFS will be held in Ancona (Italy) from 19–23 June 2023. It will be hosted by Fabio Gratti at the National Research Council (CNR) Institute for Biological Resources and Marine Biotechnologies (IRBIM).

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Annex 1: List of participants

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Annex 2: Resolutions

2019/2/EOSG07[4] The **Working Group on Recreational Fisheries Surveys (**WGRFS**)**, chaired by Kieran Hyder, UK, Keno Ferter, Norway, Estanis Mugerza*, Spain, will work on ToRs and generate deliverables as listed in the table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2020	15–19 June 2020	Online meeting	Interim report by 01 November 2020 to EOSG	Keno Ferter's 3 year term as chair ends. Incoming chair in 2021: Estanis Mugerza
Year 2021	14–18 June 2021	Online meeting	Interim report by 01 November 2021 to DSTSG	Kieran Hyder's 3 year term as chair ends. Incoming chair in 2022: Kieran Hyder
Year 2022	13–17 June 2022	Las Palmas, Gran Canaria	Final report by 01 November 2022 to DSTSG	

ToR descriptors

ToR	Description	Background	Science Plan codes	Duration	Expected Deliverables
a	Collate and review quality of national estimates of recreational catch and effort, catch-and-release impacts, and socio-economic benefits for candidate stocks, identify significant data gaps in coverage and species, and support the ICES TAF.	Most coutnries are engaged in data collection. This activity collates national participation, catch and socio-economic datasets together, understands the quality of data, and highlights where new data are needed. This is important for supporting the ICES TAF.	5.4	Regular activity in each year, with specfic intersessional tasks to develop new approaches.	Report WG perspectives and publication of scientific papers
b	Assess the validity of traditional knowledge, new survey designs, novel methods (e.g. citizen science, apps), and innovative statistical methods for data provision.	Recreational data can be collected in many ways, with different associated biases. This supports improvement of analysis of existing surveys and understanding the utility of new methods. This will lead to the most robust and broad evidence-base to	3.1, 3.2, 3.3, 3.6, 4.1, 4.3, 5.4	Regular activity in each year	Report WG perspectives and publication of scientific papers

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[4] Note that WGRFS became part of the new DSTSG (Data Science and Technology Steering Group) during the three-year term.

ToR	Description	Background	Science Plan codes	Duration	Expected Deliverables
		underpin asessment and advice.			
c	Provide guidance to ICES and respond to ad hoc requests from ACOM on the availability of data, design of data collection programs, data storage systems, use of data in assessments, and catch allocation.	Recreational catche are not included in many assessments and data collection is limited to a few species. This activity suports data collection requirements, access to data and methods needed. This will facilitate embedding recreational fisheries into fisheries management.	3.1, 3.2, 3.3, 3.6, 5,1	Regular activity in each year, with specfic intersessional tasks to develop new approaches.	Report WG perspectives and publication of scientific papers
d	Develop approaches for regional data collection programmes that generate robust data for end-users and suport the ICES TAF.	Regionalisation is an important goal, but implementation is unclear This is a challenge for recreational fisheries due to the different actors, gears and survey instruments. This will underpin generation of transparent and robust regional data to support end-users needs.	3.1, 3.2, 3.3, 3.6,	Regular activity in each year.	Report WG perspectives and publication of scientific papers
e	Evaluate the use of economic (e.g. impact, valuation), social (e.g. governance, behaviour, welfare, health), and communication (e.g. participatory process, messaging) to support the assessment and management of recreational fisheries.	Recreation fisheries have broad benefits and behavioural responses are difficult to predict due to diverse motivations. Hence, understanding of the human dimension is needed. This develops understanding of the data and methods needed for comanagement to ensure enagement in the process.	7.1, 7.4, 7.6	Regular activity in each year, with specfic intersessional tasks to develop new approaches.	Report WG perspectives and publication of scientific papers
f	Review outcomes of the workshops organized by the group.	Recreational fisheries is a diverse topic, so not all aspects can be adressed at WGRFS. A number of workshops on specific topic have been done (e.g. WKHDR) or are in the workplan (e.g. inclusion in	5.4, 7.1, 7.4	Activity-dependent on workshop	Report WG perspectives and publication of scientific papers

ToR	Description	Background	Science Plan codes	Duration	Expected Deliverables
		assessment). This reviews outcomes of the workshops and the implications for recreational fisheries.			

Summary of the work plan

Year 1	
1)	Establish intersessional groups and leads within WGRFS to progress key tasks including governance, survey design, quality and analysis, regional coordination, data storage, catch-and-release impacts, novel methods, assessment and catch allocation, human dimensions, and communication. (a, b, c, d, e)
2)	Plan at least three WGRFS publications within the period 2020-22. (a, c, e, f)
3)	Update the existing quality assessment tool (QAT) and embed this in the TAF (a,d).
4)	~~Evaluate the quality of up to three national survey programmes using the QAT. (a)~~
5)	Investigate animal welfare issues related to recreational fisheries (e.g. catch and release) and identify how these could impact management. (a)
6)	Assess the impact of recreational fisheries on a broad range of stocks using data from the pilot studies. (a, c, d)
7)	Create a framework for inclusion of recreational data in stock assessments and scope a workshop to design approaches. (a, c, d)
8)	Collate advances in survey methods that could be used to improved national approaches. (b)
9)	Develop a solution for storage of data within RDBES and agree with ICES. (c, d, f)
10)	Review existing governance structures and develop understanding of 'world class' recreational fisheries management that could be embedded in a future revision of the CFP. (e)
11)	Review outcomes from WKHDR and agree approach for inclusion of angler behaviour in future surveys. (f)

Year 2	
1)	Evaluate the outcomes from the intersessional work and agree approach for the next year. (a, b, c, d, e, f)
2)	Review national programmes including assessment of quality of up to three programmes and provide feedback on tasks requested by ICES. (a)
3)	Assess the potential of novel survey methods to deliver recreational fisheries data (e.g. citizen science approaches, smartphone apps, traditional knowledge). (b)
4)	Develop a framework for allocation of catches between sectors based on a review of existing systems and provide best-practice guidance. (c,d)
5)	Develop MSE approaches to assess the impact of uncertainty in recreational catches on assessment and regional sampling programme. (d).
6)	Review and share methods for engaging with stakeholders and the potential for particpatory approaches. (e)
7)	Assess outcomes of workshop on inclusion of recreational data in stock assessments. (f)

Year 3	
1)	Evaluate the outcomes from the intersessional work and agree approach for the next year. (a, b, c, d, e)
2)	Review national programmes including assessment of quality of up to three programmes and provide feedback on tasks requested by ICES. (a)
3)	Evaluate post-release mortality estimates, potential sublethal effects, and reasonable extrapolations across species and fisheries for inclusion in stock assessments. (a)

4) Assess novel approaches for surveys (e.g. combining probabilistic and non-probabilistic sampling) and analysis methods (e.g. treatment of outliers, machine learning). (b)

5) Assess the potential for impact of climate change on species caught by recreational fisheries and how that coud impact on DCF and regional species requirements. (c, d)

6) Review the potential for food safety and human health issues from consumption of recreational caught fish (e.g. environmental toxins). (e)

7) Evaluate progress against three year plan and develop new ToRs. (a, b, c, d, e, f)

Supporting information

Priority	High—the biological, social and economic impact of recreational fishries is becoming increasing recognized and needs to be included in the fisheries assessment and management processes.
Resource requirements	None.
Participants	The WG is normally attended by around 40 members and chair-invited experts.
Secretariat facilities	Normal backstopping support in the organization of the group.
Financial	None.
Linkages to ACOM and groups under ACOM	ACOM, WGBFAS, WGEEL, WGBAST, WGCSE, WGNSSK, WGBIE, WGMEDS, and benmarks workshops for stocks that have recrational catches.
Linkages to other committees o groups	PGDATA, WGCATCH.
Linkages to other organizations	• EC, STECF, Regional Coordiantion Groups, Advisory Councils. • WECAFC/OSPESCA/CRFM/CFMC/MEDAC Working Group on Recreational Fisheries. • Many linkages to (inter)national angling associations, since WGRFS members estimate national marine recreational catches. • Links to broader organizations with interests in angling and fisheries management including EIFACC and FAO.

Annex 3: Marine recreational fish surveys (biological data)

Table 1. Most recent survey of MRF catches. This may relate to most completed or ongoing surveys.

Country	Objectives	Approach	Contact and references
Belgium	The aim is to generate reliable data on all species caught by marine recreational fishers in Belgium.	Belgium has a continuous multispecies survey running from 2017 onwards. On-site surveys (beach, marinas, aerial, interviews) are combined with a logbook survey (on trips basis) to estimate catches (numbers and weights).	Thomas Verleye: thomas.verleye@vliz.be Verleye *et al.* (2022) https://www.recreatievezeevis-serij.be/wp-content/up-loads/2022/07/BIN-Recreatieve-Zeevis-serij-2022-2017-2021-1.pdf
Denmark	The overall aim is to be able to generate reliable estimates of the total catches (harvested and released components) for the mandatory species (EU 2021/1167). To collect biological data from relevant MRF to be able to include catches in stock assessment where relevant.	Two different types of surveys are providing information on catch, effort and biological data. Biannual offsite recall web-based survey (questionnaire) targeting both angling and passive gear fishing (Sampling frame = license list). Yearly 6000–7000 respondents (ca. 50% respondent rate). Running since 2009 and providing data on catch and effort on the mandatory species (EU 2021/1167). Onsite survey (on-board) for charter vessels. Targeting charter vessels in the ICES SD23. PPS sampling (number of trips). Strata = Quarter of the year. Providing catch and biological data for Western Baltic cod (WBC). The data are used for tuning of the off-site survey and yearly estimates of the total catches are included in the WBC stock assessment since 2019. As a supplement to the above studies a digital citizen science platform collects angling CPUE, length distributions and human dimension aspects	Hans Jakob Olesen: hjo@aqua.dtu.dk Sparrevohn *et al.* (2012); ICES (2019); Gundelund *et al.* (2021) Link: https://www.rekrea-fisk.dk/english/eng/cod
Estonia	To estimate catches of cod, eel and salmon by marine recreational fisheries in Estonia.	Catch reporting has been mandatory since 2005. The data are reported and stored in the Estonian Fisheries Information System (EFIS) for passive gears (gillnets, longlines) and salmon and sea trout angling in rivers. Latest recreational fishery survey was carried out in 2016 and was based on phone call approach.	

Country	Objectives	Approach	Contact and references
Finland	The objectives are: 1) to estimate recreational catches of the internationally managed commercially exploited fish species and catches of the PETS fish species to be transferred to the Commission and the expert working groups for further analyses; and 2) to produce the Official Statistics of Finland for the recreational marine and inland fisheries.	A nationwide biennial recreational fishing survey is conducted for all species and gears. A stratified sample of 11 000 household dwellings was carried out for 2020 with a decreasing trend in response rate, being only 25% after three contacts. A telephone interview was targeted for a sample of the non-respondents. Harvested catch and released catch were inquired by species.	Pentti Moilanen: pentti.moilanen@luke.fi Link: https://stat.luke.fi/en/recreational-fishing
France	The objective is to provide reliable catch estimates for the species listed under the EU 2021/1167 regulation, and for all other relevant species. The data collected includes catch and release estimates, fishing effort and biological data when necessary.	Multispecies survey divided into three steps: (1) Screening survey, using an online panel tool to sample 10 042 individuals to whom a short questionnaire was delivered. This panel was representative of the French socio-demographics using the quota method, based on the INSEE data. (2) Additional survey on a target sample of 2646 fishers, excluding onshore hand-gathering fishers. The aim is to characterize fishers' activity on a large sample. The individuals were recruited through social media advertising, fishing federations and using the screening survey answers (3) Panel survey on a target sample of 900 fishers. The aim is to follow a whole year of recreational fishers' activity. Panellists will record all information on their fishing sessions on the FishFriender phone/web application. This information will include: fishing location, fishing mode, catches and weight and/or length of the catch. Panellist catch volumes will be weighted according to the stratum they belong to and the results of the 2017 or 2021 screening survey.	Jules Selles: jules.selles@gmail.com Amélie Régimbart: amelie.regimbart@ifremer.fr

Country	Objectives	Approach	Contact and references
Germany	Germany has been collecting marine recreational fisheries data on an annual basis since 2005 in the framework of the German marine angling program (DMAP). The main objective is the collection of robust and representative data on the number of recreational fishers, fishing effort, catch and harvest rates to estimate total catches (harvest and releases) considering all relevant species as well as socio-economic impacts of recreational fishing.	Three different surveys are carried out on a regular basis: Offsite telephone diary survey: a representative telephone screening survey (CATI) using random digit dialling (RDD) of the general German population combined with a one-year diary study is carried out every 5–7 years. This marine and freshwater multispecies survey aims to collect nationwide data on angling effort, socio-demographics and harvest and release rates. The last survey (screening of 50 000 households) was conducted in 2014/2015 (Weltersbach *et al.*, 2021). A subsequent survey (screening of 150 000 households) has been initiated in 2020 and will run until 2022. Multiannual on-site access point survey: a stratified random on-site access point intercept survey (79 access points) is annually conducted since 2005 along the Baltic coast. The survey follows a multi-annual survey design and collects information based on completed fishing days on socio-demographics of anglers, fishing characteristics, and catch rates for stock assessment purposes, in particular western Baltic cod (*Gadus morhua*), although all species are considered (Strehlow *et al.*, 2012). Remote camera survey: a remote camera survey supplemented with an onsite access point intercept survey is conducted annually since 2017 to monitor the highly specialized recreational salmon (*Salmo salar*) trolling fishery in the Baltic Sea from December until May (Hartill *et al.*, 2020).	Harry Strehlow: harry.strehlow@thuenen.de Simon Weltersbach: simon.weltersbach@thuenen.de Strehlow *et al.* (2012); Hartill *et al.* (2020); Weltersbach *et al.* (2021). Link: https://www.thuenen.de/en/of/fields-of-activity/research/german-marine-angling-program/
Greece	A pilot study for the period 2017–2019 has been done with the aim to estimate, as accurately as possible, a number of parameters relating to recreational fishers and their catches in Greece. The study has been extended for the period of 2020–2021 during which only the ''onsite'' survey has been done. The aim of the onsite multispecies survey is to enhance the results and conclusions of the pilot study completed in 2019. The primary objectives for the years 2020–2021 are: a) to record recreational fishers practices and activity; and b) to collect biological and quantitative data of their catches. The study covers all types of recreational fisheries in Greece namely boat, shore, and spearfishing.	Management of recreational fishing during the 2020–2021 period of pandemic included long periods of prohibition and severe restrictions. Recreational fishing was practically prohibited for prolonged periods creating significant setbacks to the sampling efforts and undermining the consolidation of cooperation and the future application of the sampling programme. In an effort to increase representation (during periods when the survey was possible), the FRI mobilized its collaborators who work as correspondents in areas of interest and managed to extend the onsite sampling geographically in North Aegean and Ionian Sea. This was not possible in the South Aegean and Crete. The originally expected outcomes of the pilot study were achieved for the number of the scheduled seasonal sampling trips when the opportunity was given and by expanding the network of interviewers resulting in increasing the spatial coverage. The total fishing trips recorded during 2020 were 1527 in all areas of sampling. For the period 2021, the on-site survey is realized when the conditions allow it.	Anastasios Papadopoulos: apapadop@inale.gr Paraskevi Karachle: pkarachle@hcmr.gr

Country	Objectives	Approach	Contact and references
Ireland	The objective of the Irish Marine Recreational Angling (IMREC) pilot study (2019–2021) was to develop and test methods to produce robust estimates of participation, effort and catches of nominated species by sea anglers resident in Ireland	To estimate sea angler participation rates and annual effort, an independent survey company carried out a phone-based random omnibus survey. Over 5000 Irish residents were interviewed to provide, for the three major sea angling types in Ireland (shore, small boat and charter angling), an estimate of (a) participation rates and (b) their average number of annual fishing trips in the previous year. Several survey methods were applied to estimate multispecies CPUE (number of fish caught by species per angler day) in Ireland. Onsite survey methods were: for shore angling – stratified roving creel approach; for small boat angling – stratified access point approach and for charter angling – stratified onboard sampler approach. Offsite survey methods were: for charter angling – charter skipper angling diary; for all sea anglers, a web-based sea angling diary app. The angler diary was released on a trial basis in July 2021 and allows self-selecting anglers to provide multispecies catch data for all angling trips. Total annual catch of all retained and released species will be estimated by combining participation and effort data with CPUE data. Consistent with pilot study objectives these data streams are currently being reviewed and refined. In due course, they will be used to provide preliminary estimates of the total annual catch of all retained and released species. The pilot study has provided valuable information which will be used to improve survey design.	Diarmuid Ryan: diarmuid.ryan@fisheriesireland.ie William Roche: william.roche@fisheriesireland.ie Link: https://www.fisheriesireland.ie/what-we-do/research/marine-recreational-fishery-in-ireland-mrec
Italy	Italy has been collecting marine recreational fisheries data: a) since 2018 in the context of the pilot study foreseen by the European Data Collection Framework, and b) since 2020 in the context of the Marine Strategy	There are two main approaches: In the framework of the DCF pilot study, a preliminary assessment of the list of marine recreational fishers registered on a Ministerial (MIPAAF)	Adriano Mariani (coordinator pilot study DCF): a.mariani@unimar.it

Country	Objectives	Approach	Contact and references
	Framework Directive. The main objectives of both surveys are: i) to determine the number of marine recreational fishers in Italy; ii) to monitor fishing activity in terms of gears used and time dedicated to this activity; iii) to collect information on retained and released catches (species, weight and number); and iv) to collect macro-data on the overall economic impact of the recreational activity. At sea basin level (Northern Adriatic Sea) a further pilot study was funded by GFCM to collect data on marine recreational fisheries in the Italian GSA17 by testing the methodology of the "Handbook for data collection on recreational fisheries in the Mediterranean and the Black Sea". This study started in 2019 and was carried out in the framework of a GFCM project including other four pilot studies across the Mediterranean and Black Sea: Turkey BS, Algeria, Tunisia, and Lebanon.	database was performed. Due to the strong weaknesses of the MIPAAF database, during 2020 a telephone survey was carried out on a sample of Italian families. This survey allowed estimates the number of fishers, their distribution and the overall fishing effort. In 2021, a panel of fishers obtained from the telephone survey was recruited for a logbook survey, to estimate effort and volume of the catches, and to better tune the results of the telephone survey. Three different surveys were carried out: A telephone survey carried out on the whole Italian territory, aimed at quantifying marine recreational fishers in Italy, collecting data and information on fishing practices and intensities, and creating a panel of recreational fishers for the subsequent recall survey. The recall survey was carried out at a monthly level in all marine administrative regions collecting data (effort, catches, expenditures) through interviews. Onsite survey in selected Italian Regions (2–3 administrative regions by MSFD subregion, i.e. Veneto, Marche, Apulia, Sicily, Tuscany, Campania, Liguria) aimed at collecting information on fishing practices, abundance and biomass of retained and released species, size of catches.	Sasa Raicevich (coordinator data collection for MSFD): sasa.raicevich@isprambiente.it Fabio Grati (coordinator of the five GFCM pilot studies): fabio.grati@cnr.it Luca Bolognini (coordinator of the GFCM pilot study Italy GSA17): luca.bolognini@cnr.it
Latvia	The objective is to provide reliable catch estimates for the species listed under the EU 2021/1167 regulation, and for all other relevant species. The data collected includes catch and release estimates, fishing effort and biological data when necessary.	The program consists of several surveys that are run annually: Logbook survey – part of marine recreational fisheries (self-consistence fishery) is obliged to fill logbook after every fishing activity. Onsite surveys – in the case of salmon and sea trout trolling contracted trained volunteers from NGO (what is representing a major part of trollers in Latvia) is collecting catch and biological data (length, weight, age data, fin clipping). Due to critical status of cod stock in the Eastern Baltic, cod recreational fishery is closed in one part of the sea (SD 26), while in other (SD 28) – no interest from anglers due to low abundance of cod. Therefore, cod surveys were stopped.	Didzis Ustups: didzis.ustups@bior.lv Jānis Dumpis: janis.dumpis@bior.lv
Lithuania	Catches of cod, eel and salmon are estimated using different approaches.	All recreational fishers are licensed (with exceptions of anglers under the age of 16, retired, or with disabilities). **Cod:** All the vessels/boats are registered. From 2013 Lithuania implemented a new system of data collection. Total number of charter vessels	Justas Poviliūnas: justas.poviliunas@zuv.lt

Country	Objectives	Approach	Contact and references
		and boats engaged in recreational fishing can be obtained from daily reports of the coast guard. The total catch and catch per boat are gathered from the direct interviews. **Eel:** Information on catch volumes can be obtained from the census, direct interviews and questionnaires only. Respondents selected by visiting known fishing spots (The Curonian Lagoon, lakes and rivers) where they come to fish from all over Lithuania. Eel is only caught in inland waters. Recreational eel catches at sea are forbidden. Recreational eel catches are observed under the DCF programme annually. **Salmon:** Separate recreational fishing licence for salmon or seatrout is mandatory (while fishing in inland waters). All salmon catches have to be reported to the Ministry of Environment, but the number of reported fish is very low. An online survey, a face-to-face interview survey and a personal interview survey was implemented in 2015 as a pilot study to estimate recreational salmon catches.	
Netherlands	In 2009 the Recreational Fisheries Programme commenced at Wageningen Marine Research under the Statutory Tasks ('Wettelijke Onderzoekstaken') on behalf of the Ministry of Agriculture, Nature and Food Quality. The aim of the programme is to collect data on recreational fisheries catches as obliged under the DCF. However, the programme is a multispecies programme	The programme consists of several surveys that are run biannually: **Screening survey**: Online panel survey conducted by the company Kantar that surveys a large number (~ 50 000 households) of Dutch citizens on their participation in recreational fisheries. The participants reflect the demographics of the entire Dutch population. Data collected are used to	Tessa van der Hammen: tessa.vanderhammen@wur.nl Esther Beukhof: esther.beukhof@wur.nl van der Hammen *et al.* (2016).

Country	Objectives	Approach	Contact and references
	and information on all fresh and marine species is collected.	estimate the total population of anglers in the Netherlands and their demographic profile. It is also used to select participants for the logbook survey. **Logbook survey**: Participants (~ 2500) are asked to keep a monthly logbook of their recreational catches in which they report trip information, number and length of species caught and whether fish was retained or released, among other things. Participants are mostly recruited via the screening survey, but some are recruited through social media and recreational fishing websites. Collected data are used to estimate the yearly catch per angler. **Onsite survey**: Trained volunteers and/or Wageningen Marine Research employees visit marine fishing sites and collect data on fishers' catches in terms of species' length and weight. The length-weight measurements are used to calculate the total biomass of recreational catches based on the estimated total number of anglers (from screening survey) and the yearly catch per angler (logbook survey). **Gillnet survey**: Methods as in the logbook survey, but with only recreational gillnet fishers.	
Norway	Norway has conducted a study funded by the Norwegian Research Council (NRC) from 2017–2020 where the primary objective was to increase knowledge of the extent and development of the marine recreational fishery in Norway with respect to catch, effort and socio-economic dimensions. The aim was to estimate participation, activity and catches and releases for resident recreational anglers nationally, and to develop methods for studying non-resident anglers that cannot be accessed via telephone registries. The project aimed at developing cost-effective off-site and on-site probability-based survey sampling methods with multiple sampling frames to improve sampling coverage of resident and non-resident recreational fishers.	A national phone diary was conducted to estimate participation and catches. In addition, roving creel surveys were conducted in three study regions. Furthermore, 20 tourist fishing businesses were selected from the national tourist fishing business registry, and a combined on- and off-site survey was conducted to estimate catches.	Keno Ferter: keno@hi.no Jon Helge Vølstad: jon.helge.voelstad@hi.no Link: https://prosjektbanken.forskningsradet.no/en/project/FORISS/267808
Poland	A pilot study was done of diadromous fish in 2017 and led to regular monitoring since 2020. The aim of monitoring recreational sea fisheries for diadromous species is a development of a current map of the Polish Exclusive Economic Zone with spatial and temporal distribution of salmon, sea trout, and eel	The following approaches are taken occur: The five main methods are applied to monitor the trolling recreational sea fishery. Remote CCTV cameras installed in ports identified as the most important for salmon and seatrout recreational fishery. The cameras record boat movements between 04:00 and 18:00 each day. A high image frame rate: HD format (25 images per second) is set to ensure full coverage of the	Adam Lejk: adam.lejk@mir.gdynia.pl Krzysztof Radtke: krzysztof.radtke@mir.gdynia.pl

Country	Objectives	Approach	Contact and references
	recreational fisheries by species and fishing techniques. Depending on the target species and fishing techniques used, the monitoring covers the period from late autumn to late spring. This is done to determine areas and times with highest recreational fisheries activities and to provide reliable monitoring data for estimates of fishing effort as well as catch volume and composition for recreational fisheries for salmon, sea trout and eel. Catch estimates are provided each year following the data call of ICES Baltic Salmon and Trout Assessment Working Group (WGBAST) and ICES Working Group on Eels (WGEEL) for sea trout and eel respectively. Quality of the data provided are discussed and verified during the group meetings. In Poland, there is a dedicated fleet segment of private boats and registered charter boats adapted to cod recreational fishery – angling with fishing rods (LHP). For the purpose of sampling this segment under DCF, the Primary Sampling Unit is vessel/trip, and the target population was defined as the total number of recreational sea-going trips targeting cod. The size of this target population varies between years with decreasing trend over the last years. Each year, 24 randomly sampled fishing trips were monitored.	activity at each monitored marina and correct identification of trolling boats. In addition, monthly on-site questionnaire interviews are conducted. Trolling boats are randomly sampled from both groups, commercial recreational boats and private fishing boats. The number of interviewed boats is selected randomly. The App dedicated to the survey is used by the observers. The refusal rate is recorded. The number of anglers on boat and fishing rods are recorded in the protocol. In addition, sociological data are collected. This is supported by onboard observations when biological samples (length, weight, sex, age, maturity stage) and catch composition are collected. Furthermore, a fishing logbook, containing cruise data as well as biological data of fish caught are distributed among the trolling boats' skippers/owners to fill-in on a voluntary basis and an annual offsite survey is targeting in general sea recreational fishing in Polish Maritime Waters with a particular emphasis of diadromous fish species. In the case of Sea trout and eel, the on-site questionnaire interviews covering the period from late autumn to late spring (sea trout) and from late summer to early autumn (eel) is conducted. In the case of eel, a pilot study revealed that onsite questionnaire interviews highlighted the difficulty of distinguishing anglers targeting eel from total number of anglers interviewed. The recreational fishery for cod (*Gadus morhua*) in Poland is monitored using effort information (number of angling trips in sampling frames - ICES Subdivision and quarter) provided by Harbour Master Offices and mean weight of cod per trip in the given sampling frame calculated from onboard observed trips. Four types of data were collected in order to monitor the development of *Gadus morhua* recreational fisheries and to estimate the catch level: Data on the number of recreational sea-going trips and the number of anglers participating in those trips were collected from Harbour Master Offices' registers. Data on total weight of fish caught and biological data (length, weight, sex, maturity and age) were collected and processed from angling trips with observers on-board. Daily reports of recreational catch delivered until 2018 to regional inspectorates of marine fisheries and from 2019 to General Inspectorate of Marine Fisheries by owners of charter boats (mandatory catch reporting since March of 2015).	Link: https://dcf.mir.gdynia.pl/wp-content/uploads/2021/05/Sampling-Plan-Marine-recreational-fisheries-for-Diadromous-species_rev1.pdf Link: https://dcf.mir.gdynia.pl/wp-content/uploads/2021/05/PS1-PL-2021_Report.pdf Radtke and Dąbrowski (2016); Radtke, and Wójcik (2020).

Country	Objectives	Approach	Contact and references
		Interviews with anglers (questionnaires' survey) during onboard observer trips.	
		Data on number of recreational sea-going trips and the number of anglers participating in those trips collected from Harbour Master Offices' registers are the comprehensive data source on marine recreational fisheries status. Each angling vessel's departure, including number of anglers onboard, is recorded in Harbour Master Offices' documents. Data on number of recreational fishing trips in the given year can be collected from Harbour Master Offices during the following year.	
Portugal	The pilot project *Pescardata* (September 2017–December 2018) was defined for studying DCF recreational fisheries in mainland Portugal aiming at characterizing several aspects of this fishery, describe catches and define robust catch estimates. A subsequent national offsite survey was launched in March 2020. The online survey aims at filling some important gaps (e.g. night fishing) that were identified during the *Pescardata* onsite project.	The *Pescardata* project consisted of collecting data on fishing effort, catch (on all captured species), and fisher demographics, for all marine recreational fishing modes in Portugal mainland. The study took place between January and December 2018, and the data were collected via both onsite and offsite methods. **Onsite methods:** a stratified random sampling design was followed to select the areas to sample and conduct face-to-face questionnaires (using ODK Android application) to active recreational fishers. Roving creel surveys were conducted for shore angling and spearfishing, and access point surveys were used for boat angling and spearfishing. Further data on boat	Mafalda Rangel: mrangel@ualg.pt

Country	Objectives	Approach	Contact and references
		angling was also obtained via onboard observers of boat angling fishing events. **Offsite methods:** angling logbooks and historical data on fishing competitions were also used and analysed to further complement the data from the onsite surveys. For the onsite survey, a total of 995 questionnaires were validated for shore angling recreational fishery and 429 for boat-angling. For spearfishing, the number of valid questionnaires (n = 31) was considered low, consequently, this fishing mode was not considered in the data analysis. Data collection on logbooks and fishing competitions is still ongoing. For *Pescardata2* (ongoing), we used a web-based survey to collect information on recreational fishing. The survey was promoted via a text message to the license holders, social media, and recreational fishing associations, to maximize participation and representativeness of the active recreational fishing population. The dedicated webpage for the study is www.pescardata.pt.	
Spain (Andalusia)	A survey is in place to generate annual estimates of participation, effort, and catches of recreational fishers in the Autonomous Region of Andalusia	Two approaches are underway: Sea angling APP: a record of the daily activity (spearfishers and boat anglers). Onsite survey. monthly visits to selected fishing sites for shore anglers and spearfishers.	Matias Lozano: matias.lozano@ieo.es
Spain (Balearic Islands)	The Marine Resources Service of the Autonomous Government of the Balearic Islands maintains a permanent sampling system aimed at recreational boat fishing (the main recreational modality in the Balearic Islands) to obtain estimates on targeted fish biology and ecology, and on recreational fishing effort and catches.	The system has two complementary surveys: Standardized fishing samples done approximately twice a month to collect data on sizes, species, and fishing performance. Obtaining basic data on catches through the App "Diari de Pesca Recreativa" is mandatory for recreational fishers who access marine protected areas.	Antoni M. Grau: agrau@dgpesca.caib.es
Spain (Basque Country)	A routine monitoring programme is running since 2015 to estimate catch and effort for DCF mandatory species. In addition, since 2020 multispecies surveys are carried out to estimate effort, catch estimates for	Two approaches are being used: An offsite routine survey to respond to DCF0specific request: mandatory species catch and effort estimates.	Estanis Mugerza: emugerza@azti.es Lucia Zarauz: lzarauz@azti.es

Country	Objectives	Approach	Contact and references
	main target species and human dimensions of the activity.	An onsite survey and an electronic application developed to collect catch, effort, length and human dimension information.	
Spain (Catalonia)	A monitoring system has been established with an aim to generate a continuous stream of data on participation, effort and effort distribution, fishing yields, catches (including catchweight and size), social profile, expenses, and human dimensions of the activity.	Two complementary surveys are implemented: Onsite surveys: a spatio-temporal model is applied to cover shore angling, boat angling, and spearfishing along the Catalan coastline. Online surveys: distributed to large subsets of the e-mail registry of license holders.	Full report expected in 2022.
Spain (Murcia)	A pilot study was performed in 2020 in this Autonomous Region to estimate spatial and temporal distribution of effort and catches, and of the demographic structure of the catches of different recreational fishing modalities.	An on-site sampling program was carried out focused on recreational fishing competitions.	Martínez-Baños *et al*. (2020)
Sweden	Estimates of participation and catches by Swedish recreational fishers.	A national annual recreational fishing screening survey (postal), including most frequently fish and crustacean species targeted in recreational fisheries in subareas and for most common gears have been ongoing since 1990. A new improved design was implemented in 2013. New updated data are available for years 2013–2019. This survey does not cover tourist fishers and Swedish residents younger than 16 years as well as Swedish residents older than 80 years of age. **Census of recreational Swedish cod fishery in Sd 23 (Western Baltic cod):** Sweden routinely collects information on volumes of landed cod in SD23 through voluntary lo books from tour boat operators. In addition, on-board sampling of randomized trips is performed quarterly to collect biological information, length, weight and otoliths. Assumed landings from private	Andreas Sundelöf: andreas.sundelof@slu.se Hege Sande: hege.sande@slu.se

Country	Objectives	Approach	Contact and references
		boats are raised to the tour boat landings by fractions of catches taken by the different segments during 2017–2019.	
		Camera assisted marina sampling core sites – CAMS-CS, design 2019: fully random design of a sampling scheme to estimate recreational catches needed a highly stratified structure (SLU-MRFS 2017–2018). Several strata in both space and time distributed the sampling effort and most of the sampling time was spent observing zero fishing trips within a sampling unit as sites and times did not represent a representative sampling frame. The estimation procedure was straightforward as effort and catch were sampled in parallel, but variance measures very unsatisfactory large. Ways to sample a representative sampling frame was explored in order to reduce the variance of future estimates.	
		Through the work described in this report, it was possible to assess the appropriate sampling frame. Following the efforts made in 2017 and 2018 of counting boats and assessing boat types at all access points the sampling frame could be reduced to cover active times for fishing. Although fishing was observed during all types of work shifts during the day of the SLU-MRFS sampling during 20:00 and 06:00 could be disregarded due to negligible fishing effort. As the number of boats with signs of fishing was counted at all access points it was also possible to revise the sampling sites and set up a frequency-based probability of site selection. Effort was recorded by a set of cameras registering the number of trips at a certain access point and catch rate was sampled through an onsite creel survey (Figure 1).	
		Prerequisites of the CAMS-CS:	
		Boat counts of different types of boats	
		Cameras covering traffic patterns of a large component of potential fishing boats	
		Creel to sample catch rate targeted sets of days with a forecast optimistic for fishing conditions	
		Boat counts and activity patterns from 2017–2018 were used in the design of the effort and catch rate sampling for 2019.	
UK	The overall objective is to generate annual estimates of participation, effort, catches, economics and social benefits of sea angler's resident in the UK.	Two independent surveys provided data on effort and CPUE:	Kieran Hyder: kieran.hyder@cefas.co.uk Link: www.seaangling.org

Country	Objectives	Approach	Contact and references
		Watersports Participation Survey (WPS): a face-to-face survey of 12 000 households across the UK that provided a population-level estimate of the numbers, demographic profile, and activity of sea anglers in the UK.	Armstrong *et al.* (2013); Hyder *et al.* (2020, 2021)
		Sea angling diary: a year-long online catch diary tool and app that provided a record of the trip-by-trip catches from a self-selecting UK-wide panel of sea anglers. Mean CPUE in terms of annual catch of each species per angler was estimated from the diary.	
		The total annual catch of a species in any defined stratum (e.g. region, age) was estimated by multiplying an estimate of the number of sea anglers in that stratum (using the WPS) by an estimate of the annual catch per angler for that stratum (CPUE) in the sea angling diary panel.	
		In addition, surveys were done of the diary panel during the year to assess expenditure to generate information on total economic impact, and other areas of interest (e.g. impact of COVID-19).	

Annex 4: Economic information by country[5]

Table 2. Most recently carried out, ongoing and/or planned marine recreational fishing surveys.

Country	Survey Methods (description of method, assumptions made, and applicable species)	Economic Value (direct, indirect, and induced), trip spend, and willingness to pay estimates	Contact and references
Belgium	The onsite interviews at the beaches and in the marinas, part of the Belgian monitoring program, also included socio-economic questions which provided first quantitative insights into the expenditures of Belgian recreational fishers (expenses big material (rod, etc.), small material (bait, etc.), travelling costs, boat-related costs).	The direct expenditures of the Belgian marine recreational fisheries sector are estimated at a minimum 8.6 million euro on an annual basis.	Thomas Verleye: thomas.verleye@vliz.be Verleye *et al.* (2019) Link: https://www.recreatievezeevis-serij.be/wp-content/up-loads/2021/06/BIN-Recreatieve-Zeevis-serij-2018_FINAL.pdf
Denmark	1. Web panel (1500 respondents; no tourism) Economic impact analysis (input/output) Jacobsen (2010); Ministry of Food, Agriculture and Fisheries of Denmark (2010); Jensen *et al.* (2010). 2. Tourism; Economic impact (input-output). Unclear how the number of tourists is found and how relative share of angling related economic activity is established (but see Jacobsen, 2010; Jensen *et al.,* 2010). 3. CE analysis (DK angler = no distinction between marine and freshwater (Kromand *et al.*, 2010), Web panel 1500 respondents) 4. Tourism (German web panel, no distinction between marine and freshwater fishing) CE analysis, (Jensen *et al.,* 2010). (Table 6.1)	1. Economic impact: Total 388 536 824 euro (2 900 000 000 DKK) Excluding taxes and leakages 147 376 037 euro (1 100 000 000 DKK). An average angler spends 543 euro (4051 DKK) per year, but specialized sea anglers (trolling fishers) spend on average 3349 euro (25 000 DKK). 2. Economic impact from Tourism: Total 50 241 830 euro (375 000 000 DKK), excluding taxes, leakages 33 896 488 euro (253 000 000 DKK). 3. CE Analysis: Average WTP is about 100 euro (736 DKK) angler, but a methodological very insecure estimate. Important WTP estimates (ranked from highest to lowest) 1) Nature component (beautiful scenery), 2) Water quality, 3) catch opportunity (numbers). Note that in a higher quality study (Toivonen *et al.*, 2000) WTP for Danish anglers was estimated to be 82 euro (616 DKK) at 1999/2000 prices. 4. Tourism CE analysis: WTP −34 to 59 euro (−255 to 444 DKK); positive WTP for increased catch opportunity, Increased size of fish, beautiful surroundings and improved water quality. Negative WTP if the distance to fishing water is increased and/or if the number of other anglers increases.	Hans Jakob Olesen: hjo@aqua.dtu.dk Toivonen *et al.* (2000) Jacobsen (2010); Ministry of Food, Agriculture and Fisheries of Denmark (2010); Jensen *et al.* (2010); Kromand *et al.* (2010).

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[5] This includes only the most recent marine recreational fishing surveys.

Country	Survey Methods (description of method, assumptions made, and applicable species)	Economic Value (direct, indirect, and induced), trip spend, and willingness to pay estimates	Contact and references
Estonia	No data are currently collected.		
Finland	Several surveys have been done in Nordic countries to evaluate the economic value of recreational fisheries including Toivonen (2002) and Toivenen *et al.* (2004). A comparison of the economic effects of salmon fishing: commercial vs. recreational with input-output model (Storehammer *et al.*, 2011).	The estimated value of a fishing day in Finland (EUR 104) indicates that people are willing to pay more for fishing than other water recreation activities. The estimated total recreational use value for fishing was EUR 528 million in Finland in 2018 (Pokki *et al.*, 2020).	Heidi Pokki: heidi.pokki@luke.fi Toivonen (2002); Toivenen *et al.* (2004); Storehammer *et al.* (2011); Pokki *et al.* (2020).
France	Between 2011 and 2013, a nationwide survey was implemented in two steps: a random-digit-dialling (RDD) survey combined with a diary survey. RDD survey produced an initial estimate of the population of recreational fishers and a description of the diversity of their fishing practices. Diary survey provided more precise information about the diversity of practices, catch characteristics (size, weight etc.) and expenditures. Data were compared and then used in combination to provide a reliable estimate of the socio-economic value of recreational fisheries activity in France (Levrel *et al.*, 2013).	According to the 2011–2013 survey, fishing expenditure was estimated at 200 million euro: recreational sea anglers spend an average of €146 per year on equipment, including €83 for fishing gear and €36 for bait and lures. Approximately 25% of recreational sea anglers have a boat. Boat-related expenditures are estimated at around 1000 € per year on average (with 50% for anchorage and trailer, 30% for maintenance and 20% for insurance purposes; Levrel *et al.*, 2013).	Amélie Régimbart: amelie.regimbart@ifremer.fr Levrel *et al. (*2013).
Germany	In 2014/2015, a nationwide telephone-diary survey with quarterly follow-ups was initiated contacting 50 000 households. This survey produced estimates of marine anglers, effort and expenditures per category for the North and Baltic Sea. During the screening, survey respondents were asked to provide a 12-month recall estimate of annual expenditures for recreational sea angling. Furthermore, participants of a complementary one-year diary study were asked to report quarterly expenditures for marine angling. In 2021, a similar survey (150 000 households) will be conducted to update the 2014/2015 data.	There were approximately 200 000 sea anglers in Germany in 2014/2015, with the majority (161 000) going angling in the Baltic Sea. Average annual expenditure was 938.8 € per angler resulting in an overall expenditure of 184.6 million €.	Harry Strehlow: harry.strehlow@thuenen.de Simon Weltersbach: simon.weltersbach@thuenen.de Weltersbach *et al.* (2021).

Country	Survey Methods (description of method, assumptions made, and applicable species)	Economic Value (direct, indirect, and induced), trip spend, and willingness to pay estimates	Contact and references
Greece	During the 2017–2019 pilot study, a nationwide telephone survey was conducted with 16 501 households. The survey allowed for estimates of the number of RF in the country, effort and expenditures. During the survey respondents were asked to provide a 12-month estimate of annual expenditures for marine recreational fishing.	Results suggest that 8% of the population, approximately 700 000 residents in the country engage in marine recreational fishing. Regarding annual expenses 13% spends no money, 43% spend between 1–50 €/year, 13% 51–100 €/year, 12% 101–250€/year, 7% 251–500€/year and 8%500+ €/year. On average fishers spend 181 €/year (median 38 €/year) and that amounts to 126 700 000 €/year nationally.	Anastasios Papadopoulos: apapadop@inale.gr Paraskevi Karachle: pkarachle@hcmr.gr
Ireland	'Socio-economic Study of Recreational Angling in Ireland' (TDI, 2013), commissioned by IFI, was based on a sample size of 903 participants (692 face to face interviews, 211 online). Findings include an estimated 406 000 individuals (aged 15+) who participated in recreational angling in 2012 (252 000 domestic, 113 000 overseas, 41 000 Northern Irish). An omnibus survey was carried out in 2015 to estimate total domestic participation in angling (MB, 2015). Results indicate a total of 273 600 Irish individuals aged 15+ who consider themselves to be 'anglers. Of these, approximately 4% consider themselves to be bass anglers (11 000) and a further 24% consider themselves to be sea anglers who target other sea species (65 600). Lower bound estimates for overseas anglers in 2014 are in the region of 132 000. These combined figures give a total value of angling in 2014 in the region of €836 million; of this approximately €71 million relates to bass angling and €158 million relates to angling for other sea species. A study, 'Economic Impact of Irish Angling Events' (based on a sample of 314 anglers in 2013; IFI, 2013) found that competitive anglers fish more often, stay for longer and spend more money than 'ordinary' anglers. The travel cost model was used to estimate consumer surplus in this study.	The estimated value of angling to the Irish economy in 2012 of €755 million revised up to €836 million in 2014. Using the contingent valuation method, Irish anglers were asked their willingness-to-pay (WTP) to preserve Ireland's natural fish stocks and the current quality of Irish angling—WTP estimates of €67 per angler per annum (2012) were estimated. Study of Irish angling events (festivals/competitions) estimates a much higher consumer surplus for participants using the travel cost method; results indicated a consumer surplus of up to €252 per angler per day (see below). Per trip expenditure range of €858–€1027 per person for overseas anglers. Domestic anglers' annual expenditure estimated at €1740. From the omnibus survey and an increase in overseas angling tourism the total value of angling in 2014 in the region of €836 million; of this approximately €71 million relates to bass angling and €158 million relates to angling for other sea species. Case study sea angling event with 124 participants was estimated to be worth nearly €200 000 to the host region in southwest Ireland. Consumer surplus estimates of €252 per angler per day.	Diarmuid Ryan: diarmuid.ryan@fisheriesireland.ie William Roche: william.roche@fisheriesireland.ie Link: http://www.fisheriesireland.ie/media/tdistudyonrecreationalangling.pdf
Italy	Italy has been collecting marine recreational fisheries data in the context of: i) the pilot study foreseen by the European Data Collection Framework, ii) for the Marine Strategy Framework Directive, and iii) for the GFCM in	Economic data collected in the different surveys are still under assessment.	Adriano Mariani (coordinator pilot study DCF): a.mariani@unimar.it

Country	Survey Methods (description of method, assumptions made, and applicable species)	Economic Value (direct, indirect, and induced), trip spend, and willingness to pay estimates	Contact and references
	the framework of a pilot study (GSA17 only). Expenditures and macro-data on the overall economic impact of the recreational activity are collected in all the three types of survey by means of logbooks and monthly recall surveys on probabilistic panels of fishers recruited through the national screening surveys.		Sasa Raicevich (coordinator data collection for MSFD): sasa.raicevich@isprambiente.it Fabio Grati (coordinator of the five GFCM pilot studies): fabio.grati@cnr.it Luca Bolognini (coordinator of the GFCM pilot study Italy GSA17): luca.bolognini@cnr.it
Latvia	Value of landings in self-consumption fishery	9762 EUR	Didzis Ustups: didzis.ustups@bior.lv Jānis Dumpis: janis.dumpis@bior.lv
Lithuania	Have not been performed similar studies in Lithuania	No data on economic value, no economic-social surveys have been done.	Justas Poviliūnas: justas.poviliunas@zuv.lt
Netherlands	Screening survey (50 000 households) in 2009 followed by 12 months logbook Survey in 2010 (1377 marine participants, 2238 freshwater participants; van der Hammen and de Graaf, 2013). In following logbook surveys the questions about economics are not repeated.	200 € per fisher per year, 341 € million (accommodation, travel, durable equipment, consumables, etc.).	Tessa van der Hammen: tessa.vanderhammen@wur.nl Esther Beukhof: esther.beukhof@wur.nl van der Hammen and de Graaf (2013)
Norway	In 2009, a survey using a sampling frame of 434 fishing tourism enterprises was conducted to compile data on fishing tourism season, capacity in number of beds and rental boats, the number of fishing tourism guest nights and the length of stay (nights) of fishing tourists. Additional data on expenditure during a fishing tourism holiday in Norway was collected from 597 tourists (that had	Average daily expenditure by fishing tourists visiting Norway was 173 euro and an average length of stay 7.4 days (this implies that the total average expenditure on a fishing holiday in Norway is 1280 euro). Total expenditure from fishing tourists that visited the 434 enterprises in the year 2008 was 104 million euro.	Trude Borch: trude.borch@akvaplan.niva.no Keno Ferter: keno@hi.no

Country	Survey Methods (description of method, assumptions made, and applicable species)	Economic Value (direct, indirect, and induced), trip spend, and willingness to pay estimates	Contact and references
	visited Norway to participate in tourist fishing the previous year). The data were used in an input-output model to calculate total economic impact from fishing tourism in 4 regions (including indirect and induced effects). For more information about results see Borch *et al*. (2011a; 2011b), In 2014, a profitability study was performed of businesses that offer marine angling services to tourists in Arctic Norway (Borch and Svorken 2014). The most important findings in this are that profitability varies with distance to airport, number of beds relative to boats available for rent and with capacity utilization of beds throughout the year. For example, if the businesses have other types of guests during winter season like skiing or aurora borealis tourists. In 2017, a valuation study was performed in Arctic Norway on the value of the coast for outdoor recreational activities. This study concluded that marine recreational fisheries were the most important outdoor recreational activity in this region. For more results see Aanesen *et al.* (2018).		Jon Helge Vølstad: jon.helge.voelstad@hi.no Borch *et al*. (2011a; 2011b); Borch and Svorken (2014); Aanesen *et al.* (2018).
Poland	Have not been performed similar studies in Poland.	No data on economic value, no economic-social surveys have been done.	Adam Lejk: adam.lejk@mir.gdynia.pl Krzysztof Radtke: krzysztof.radtke@mir.gdynia.pl
Portugal	The pilot project Pescardata (September 2017–December 2018) was defined for studying DCF recreational fisheries in mainland Portugal aiming at characterizing several aspects of this fishery, describe catches and define robust catch estimates. A subsequent national offsite survey was launched in March 2020. The online survey aims at filling some important gaps (e.g. on night fishing and spearfishing) that were identified during the Pescardata onsite project. Both surveys include socio-economic	Estimates on the economic contribution of this activity in Portugal will be made available as soon as possible, and will come from results from both Pescardata (pilot onsite survey) and Pescardata2 (web-based survey). The outputs will also include other socio-economic data on Portuguese recreational fishers (e.g. demographics, motivations for fishing, attitudes towards existing regulations).	Mafalda Rangel: mrangel@ualg.pt

Country	Survey Methods (description of method, assumptions made, and applicable species)	Economic Value (direct, indirect, and induced), trip spend, and willingness to pay estimates	Contact and references
	characterization of fishers and direct expenditures esti-mates.		
Spain (Andalusia)	A survey is in place to generate annual estimates of the economic impacts of recreational fishers in the Autono-mous Region of Andalusia	Two approaches are underway: Sea angling APP: a record of the daily activity (spearfishers and boat an-glers). Onsite survey. monthly visits to selected fishing sites for shore anglers and spearfishers.	Matias Lozano: matias.lozano@ieo.es
Spain (Basque Country)	A postal survey was carried out during 2009 and 2010. The target population was the vessel owners and skip-pers of the recreational fleet, but shore anglers and spearfishers were not included in this study. The contact details for skippers could not be obtained because of confidentiality, so AZTI contacted recreational fisheries associations and federations in the Basque Country. Postal and face-to-face surveys were done with approxi-mately 2000 surveys sent and 549 completed. More questionnaires were completed with face-to-face than in postal surveys. The name of the vessel, registration number and the home port were obtained from Basque Country administration and additional vessel infor-mation including length, vessel and mooring were ob-tained from field sampling and google Earth. Three cate-gories of vessels were defined: sailing, *txipironeras* (typi-cal Basque vessel), and motor vessels. For the economic survey, the same methodology was used as described above.	Direct expenditure for the same sample. The raising was made using the statistically significant variables, such as port, and length of the vessel and the category. The value of the catch was not used in the estimation of the total direct impact. The induced effect was calculated using the input-out-put tables of the Basque Country published by EUSTAT. The multipliers of income, value-added, and employment were calculated. The direct impact was around 34 million € /year and the total impact including the induced effect was almost 54 million € and maintaining 624 FTE/year. No survey on WTP has been carried out. Only covers recreational boat owners. Spear-fishing and shore fishing is not included.	Estanis Mugerza: emugerza@azti.es Lucia Zarauz: lzarauz@azti.es
Spain (Catalonia)	Participation is estimated using the licensed fisher regis-try and estimating the number of un-registered fishers based on a pilot study (ICATMAR, 2020). Estimates of CPUE, catch compositions and catch size distributions were generated using data from the onsite survey. Effort, effort distribution and expenses are estimated from the responses to the online survey. Data from all respond-ents are classified according to a four-tier avidity class. Total catch per species estimated for each season and for	A 2019 pilot study (ICATMAR, 2020) revealed recreational fishing total di-rect expenses in 30M€, and indirect associated expenses in an additional 60M€. Shore anglers spent a total 16M€ in direct expenses, and 30M€ in indirect expenses; for boat anglers in was 12 and 53M€ respectively and spearfishers spent a total 1M and 5M€ respectively. The average shore an-gler spent a 943€ annually, boat anglers spent 2937€. Spearfishers initiat-ing the activity from land spent an annual 1020€, while those initiating the activity from a boat averaged 2906€.	Catalan Institute of Research for Ocean Governance (ICATMAR) dg.05.daam@gencat.cat ICATMAR (2020).

Country	Survey Methods (description of method, assumptions made, and applicable species)	Economic Value (direct, indirect, and induced), trip spend, and willingness to pay estimates	Contact and references
	each avidity class using participation, CPUE, catch compositions and effort data from the different sources.		
Spain (Galicia)	Online and face to face survey of 363 recreational fishers in 2017 from a total population of 60 000 recreational fishers. Recreational associations were involved in the survey dissemination.	Direct expenses were obtained, and when raised to total numbers (corrected by avidity classes, platform and other strata) it was estimated that per year recreational fishers spend 85.6 €M (CI95% = 54.9–112.3 €M), while boat owners spend another 10.6 €M (CI95% = 5.8–13.0 € M). Mean total individual annual expenses reported by the fishers were 1637 € (CI95% = 1595–1871 €) per year. Boat anglers spent 15474 € (CI95% = 12644–18026 €) to buy their boats, mostly in the second-hand market (61% of total). The mean annual boat-related expenses were 2902 € (CI95% = 2233–3502 €) per boat (Pita *et al.,* 2018). A relatively small number of interviews. Some problems derived from online interviews. However, avidity bias was corrected.	Pablo Pita pablo.pita@usc.es Pita *et al*. (2018).
Sweden	National postal survey, approximately 22 000 questionnaires (in 2019) sent three times a year (recall time four months) to randomly selected individuals (permanent residents of Sweden found in the Swedish population register).	1.6 million Swedes (age 16–80) engaged in recreational fishing at least once during 2019. The number of days fished in marine and coastal waters was 4.3 million days in 2019. The total number of fishing days (marine and freshwater combined) was approximately 12.7 million days. Total expenditures for recreational fishing during 2019 was 10.6 billion SEK. Short-term expenditures amounted to 5.0 billion SEK, while long-term investments amounted to 5.6 billion SEK.	Andreas Sundelöf: andreas.sundelof@slu.se Hege Sande: hege.sande@slu.se
UK	An economic survey was conducted with anglers who were part of the catch diary (see Table A3.1) in order to obtain estimates of annual expenditure on sea angling. Diarists provided expenditure on capital (major) items and a breakdown of spending on their most recent trip in the preceding month. The methodology used to estimate total economic impact, jobs, and GVA. Estimates of the numbers of anglers in the UK were combined with the spend diaries to estimate the total expenditure by UK sea anglers.	The total expenditure estimate per adult angler in the UK was £1108 in 2016 and £1318 in 2017 (Box 5). Removing imports and taxes and scaling to the UK gave total direct expenditure estimates of £696 million in 2016 and £847 million in 2017. This resulted in a total economic impact of sea angling in 2016 of £1.58 billion, providing £326 million of Gross Value Added (GVA) and supporting almost 13600 jobs. Total economic impact in 2017 was £1.94 billion, providing £388 million of GVA and supporting around 16300 jobs in 2017.	Kieran Hyder: kieran.hyder@cefas.co.uk Zachary Radford: zachary.radford@cefas.co.uk Armstrong *et al.* (2013); Roberts *et al*. (2017); Hyder *et al.* (2018; 2020).

Country	Survey Methods (description of method, assumptions made, and applicable species)	Economic Value (direct, indirect, and induced), trip spend, and willingness to pay estimates	Contact and references
	The total expenditures by sea anglers in the UK was calculated for each individual category of trip (effort-based) and capital (major item/investment). Taxes and imports were removed from the total expenditure by sea anglers in the UK and expenditure was split between industries. Standard errors were estimated for each category and the trips and capital expenditure was summed to give a total expenditure by sea anglers in the UK.		

Annex 5:   Assessment of national survey programmes using the QAT

Italy

The survey is part of the Italian Monitoring program under the MSFD implementation (EC/56/2008), funded by the Italian Ministry of Ecological Transition, coordinated by ISPRA (Italian National Institute for Environmental Protection and Research) in collaboration with CNR-IRBIM and other Italian research institute including SZN and ConiSMA (CIBM). Its objective is to contribute addressing the environmental Target 3.3 defined by the Italy in relation to MRF; in particular assessing the potential effects of MRF on marine resources, either commercial or non-commercial, and on ecosystems.

A telephone screening survey was carried out in 2020 (and will be repeated each three years) to assess the Italian population of marine recreational fishers (i.e. participation rate). Data collection is carried out on a probabilistic panel of fishers though a 1- month recall survey, where fishing effort, catches (including retained and released individuals), and expenditure by fishing modality are collected.

A set of onsite observations are also associated, in a range of regions, with surveys carried out on a weekly basis on selected sites (each site is visited once a month). Data are meant to complement recall survey data, in relation to biological data (e.g. length–frequency distributions), and also establishes a second panel (non-probabilistic panel) to integrate/compare information from the probabilistic panel.

DESIGN				
	QUESTION	ANSWER	OFF-SITE SURVEY COMMENTS (if not applicable, type NA)	ON-SITE SURVEY COMMENTS (if not applicable, type NA)
Target population	Have all components of the target population been identified?	Yes / No	*Yes for the Italian population.*	*Yes.*
	Is there a component of the target fishery that is not covered by the survey and if so, what was it?	Yes / No	*Fishers under 16 and fishers without a listed phone number or mobile phone were not covered. Inland regions not sampled.*	*Charter boats and non-Italian speakers were not considered. Night fishing was not sampled. Some regions not considered*
	Are there elements of the target population that are not accessible, and if so, what are they (e.g. private access points or unlisted telephone numbers)?	Yes / No	*Fishers without a listed phone number or mobile phone were not covered.*	*Private access points not surveyable.*
Sampling frame	What is the sample frame(s) and the associated PSU?		*National list of landline phone numbers for coastal regions Random digitate approach for mobile numbers.*	*Once per week (weekdays or weekends) in a list of predefined potential sites.*
	Does the sampling frame adequately cover the target population?	Yes / No	*Yes.*	*Yes.*
	Are there elements of the sample frame that have been	Yes / No	*Yes – non-residents and landlocked regions.*	*Yes – night fishing and some regions that were not considered.*

	QUESTION	ANSWER	OFF-SITE SURVEY COMMENTS	ON-SITE SURVEY COMMENTS
	deliberately excluded, and if so and what were they (e.g. quiet season)?			
Stratification	Are the strata well defined, known in advance (spatial/temporal)?	Yes / No	*Phone stratification was done by region and by coastal and non-costal municipalities. With 70% of effort on coastal and 30% non-costal.*	*List of sites randomly selected without stratification.*
	Is there adequate sampling within each stratum (e.g. days surveyed during weekend/summer)?	Yes / No	*Yes. Monthly recall.*	*Yes. One site per week per region.*
Selection	Is sampling probability based (e.g. stratified random, PPS - Proportional to Population Size)?	Yes / No	*Yes – based on population size considering the stratification (coastalvs.non-coastal). A minimum number of 500 calls per region was considered.*	*No.*
	Has the survey been designed to achieve target precision in an analytically optimal fashion?	Yes / No	*Yes. Less than 5%.*	*No.*
	Have issues associated with ethics/ permits and privacy been addressed?	Yes / No	*Yes.*	*Yes.*

IMPLEMENTATION (FILL OUT IF THE SURVEY HAS STARTED)

	QUESTION	ANSWER	OFF-SITE SURVEY COMMENTS (if not applicable, type NA)	ON-SITE SURVEY COMMENTS (if not applicable, type NA)
Selection	Has the survey followed the sampling design?	Yes / No / Unknown	*Yes. Recall still running.*	*Yes. Still running.*
	Have sampling protocols been documented and followed at each stage (selection of individuals, times, boats, biological samples)?	Yes / No	*Yes. Recall still running.*	*Yes. Still running.*
	Have contingency protocols been specified to deal with issues such as incomplete interviews of un-surveyable weather and were they required?	Yes / No	*Yes. Recall still running.*	*Yes. Still running.*
	Has there been any major departure from the survey design (frequent refusal to take observers on board a charter vessel)?	Yes / No	*Yes. There was an expected decrease in the number of panellists.*	*No.*
	Is there a language barrier (tourist fishery)?	Yes / No / Unknown	*No*	*Yes*
	Have the planned number of sampling events and/or interviews taken place and	Yes / No	*Recall still running.*	*Still running.*

	have the completion rates been documented?			
Nonresponse	What were the following non-response rates were relevant? - Screening – blocked contact - Screening – no reply - Screening – language problem - Panel survey – not contactable - Creel survey – refusal - Creel survey – language problem - Other	Yes / No / Unknown	*For the screen phone survey they were relevant. For the panel we observed a relevant decrease, but the recall is ongoing.*	*No relevant so far. Survey ongoing.*
Recall	What is the recall period and is it appropriate to the questions asked?	Yes / No / Unknown	*Recall-1month.*	*Not applicable. Data refers to the fishing day in question.*
Effort	How is effort defined (unit, fishing mode, target species, location) and related to CPUE measures?		*Fishing mode, fishing trip.*	*Fishing mode, fishing trip.*
	Was the measure of effort clearly communicated to the fisher (i.e. time spent with gear in the water)?	Yes / No / Unknown	*Yes.*	*Yes.*
	Is it possible to record incorrect fishing areas?	Yes / No	*Yes.*	*Yes - for boat fishers.*
Catch	Is the retained catch verified by surveyors (e.g. all filleted, don't show)?	Yes / No	*No.*	*Yes.*
	Is species identification and naming reliable?	Yes / No / Unknown	*Yes.*	*Yes.*
	Is there a clear division between fish kept and fish released?	Yes / No	*Yes.*	*Yes.*
	Is it possible that an individual will have also reported the catch of those fishing with them?	Yes / No / Unknown	*Yes. We ask for the cumulative catch.*	*Yes. We ask for the cumulative catch.*
	Is there a digit preference in the reports (catch numbers and/or length frequencies)?	Yes / No	*Yes.*	*No. We measure the fish.*
ANALYSIS and REPORTING (fill out if the survey is complete)				
	QUESTION	**ANSWER**	**OFF-SITE SURVEY COMMENTS** **(if not applicable, type NA)**	**ON-SITE SURVEY COMMENTS** **(if not applicable, type NA)**

General	Does the estimation procedure follow the survey design?	Yes / No	*Yes. Participation rate, number of fishers and preliminary results from the recall were done.*	*It was used for length distribution for some target species in some selected regions.*
	Has imputation been used to account for missing observations and, if so, is the procedure documented?	Yes / No	*No.*	*NA.*
	Has there been weighting to correct for nonresponses/avidity bias	Yes / No	*Data on avidity is available on the survey. A non-response survey was not considered.*	*NA.*
	Has the precision of estimates been calculated and, if yes, how have they been calculated and where are they documented?	Yes / No	*Only for the screening survey.*	*NA.*
	Were estimates estimated with acceptable precision.	Yes / No	*Yes - for the screening survey.*	*NA.*

WGRFS ASSESSMENT OF SURVEY

WGRFS concludes:
- **The three components of the evaluated survey (screening survey, panel recall survey, and onsite survey) are comprehensive and fulfil most of the requirements of the QAT. The survey is still ongoing and some categories of the QAT could not be evaluated.**
- **There are some components of the target population that were not addressed in the onsite survey (charter boats, non-Italian not English speakers; night fishers; some regions and private access points not sampled) and it is recommended that in future surveys these components are acknowledged if possible**
- **For the off-site survey the WGRFS recognizes the considerable sampling effort, however, there are components of the target population that were not included in the survey (fishers without a listed phone number or mobile phone, inland regions). These limitations could be addressed in future studies.**

UK

The objective of the survey program is to quantify the population of marine recreational anglers in the UK, what and how much they catch and spend, and other characteristics (e.g. attitudes, health and wellbeing), which change each year. The UK survey has two phases, the effort survey, named the watersports participation survey (WPS), and the sea angling diary (SAD), which collects the catch and socio-economic data. The WPS is a probabilistic face-to-face survey collecting information on participation profiles for many watersports activities, including sea angling, for around 12 000 UK households. The SAD survey is a non-probabilistic, self-selecting, diary panel of around 2500 people that submit their catch information for each of their fishing trips. Fishers can submit their catches using an online tool, a physical logbook, or a mobile-phone app. Substantial effort is put into getting responses from diarists that do not fill out catch records throughout the year, but nonresponse is still an issue. For the analysis, Bayesian multi-level regression and post-stratification (MRP) models are used to extrapolate the participation, avidity, catch, and weight to the population. MRP is a cutting-edge technique used in political science to extrapolate bias, self-selecting, polling data to the population. Hence, the use of this approach to extrapolate

our survey data aids us in dealing with several of the survey's issues, such as a self-selecting panel.

To assess the bias in the Sea Angling Diary panel composition, a small validation panel was recruited of 120 sea anglers from three English regions using a postal survey of 50 000 houses (Hyder *et al.*, 2021). The demographic and avidity profile of the validation panel was more like the diary panel than the overall population of sea anglers from the WPS. An explanation is that older and more avid anglers were more likely to volunteer to keep a catch diary. It is possible that the approach used to recruit diarists has limited impact, instead driven by the types of anglers that are willing to keep a diary (Hyder *et al.*, 2021).

Total catch estimates were higher than the in the English 2012 onsite survey. It is likely that a combination of survey bias, sampling error, or changes in fish abundance generated the differences. The consistent difference between the approaches indicated that it is likely due to the methods, both of which are uncertain and subject to bias. As a result, a side-by-side comparison between diary and onsite approaches should be done in future to validate the diary approach. Additional studies have been done to assess the potential for bias in the SAD, including a probabilistic approach for 3 regions.

DESIGN				
AREA	**QUESTION**	**ANSWER**	**OFFSITE POPULATION SURVEY OF EFFORT (WPS)**	**OFFSITE SEA ANGLING CATCH DIARY (SAD)**
Target population	Have all components of the target population been identified?	WPS: Yes SAD: Yes	*Yes. The Watersport Participation Survey (WPS) is a face-to-face survey of 12 000 households, with probabilistic sampling stratified by location. This is raised to the population based on demographics from the UK census*	*Yes. The Sea Angling Diary (SAD) focuses on the rod and line angling, although some catches by other gears are recorded but excluded from analysis*
	Is there a component of the target fishery that is not covered by the survey and if so, what was it?	WPS: No SAD: No	*Non-UK fishers are not covered, but sea angling tourism in the UK by non-residents is thought to be minimal, so exclusion has little impact on estimates.*	*Non-UK fishers are not covered, but sea angling tourism in the UK by non-residents is thought to be minimal, so exclusion has little impact on estimates.* *Sea angling only is considered, as effort from other gears quantified in WPS was limited. Exclusion is likely to have little impact on estimates.*
	Are there elements of the target population that are not accessible, and if so, what are they (e.g. private access points or unlisted telephone numbers)?	WPS: No SAD: No	*Location based sampling, so all households can be accessed.*	*Any sea angler can sign up to keep a diary, so is available to all elements of the target population resident in the UK.*
Sampling frame	What is the sample frame(s) and the associated PSU?	WPS: Yes SAD: Yes	*Frame is a list of UK households stratified by region, postcode, demographic profile, etc. PSU is a UK household.*	*Self-selecting survey, but sampling frame is substance's angler database. PSU is an angler.*
	Does the sampling frame adequately cover the target population?	WPS: Yes SAD: Partial	*Yes, all UK households considered, and probabilistic sampling allows all regions and demography to be covered.*	*Convenience sample of diarists that are self-selecting. The diary panel contains older, more avid and experienced anglers, with occasional anglers less well-represented compared with the sea angling population.*

				The demographic and avidity profile of the validation panel was more similar to the diary panel than the overall population of sea anglers from the WPS. An explanation is that older and more avid anglers were more likely to volunteer to keep a catch diary. It is possible that the approach used to recruit diarists has limited impact, instead driven by the types of anglers that are willing to keep a diary. *Differences between the sea angling population (WPS) and SAD are corrected for in the raising procedure.*
	Are there elements of the sample frame that have been deliberately excluded, and if so and what were they (e.g. quiet season)?	WPS: Yes SAD: Yes	*Non-UK fishers, all non-angling fishing methods*	*Non-UK fishers, all non-angling fishing methods*
Stratification	Are the strata well defined, known in advance (spatial/temporal)?	WPS: Yes SAD: Partial	*UK demographic well quantified by the UK census.*	*Information on the UK sea angling population is generated by the WPS. This allows us to understand the potential strata to include in the diary panel, and geographic sampling targets.*
	Is there adequate sampling within each stratum (e.g. days surveyed during weekend/summer)?	WPS: Yes SAD: No	*However, it would be beneficial to have a larger sample size to reduce errors in the raising and provide regional level information.*	*Small sample sizes for low avidity anglers and in some regions. Attempts made to increase the number of low avidity diarists, but this has not been possible as they do not tend to enter data even after agreeing to keep a diary.*
Selection	Is sampling probability based (e.g. stratified random, PPS - Proportional to Population Size)?	WPS: Yes SAD: No	*UK census used to provide sampling probabilities*	*Convenience sample and self-selecting diary. Attempts to quantify and correct for bias in analysis.*
	Has the survey been designed to achieve target precision in an analytically optimal fashion?	WPS: No SAD: No	*No prior data to inform sample size determination.*	*No prior data to inform sample size determination.*
	Have issues associated with ethics/ permits and privacy been addressed?	WPS: Yes SAD: Yes	*Ethical approval granted and GDPR followed.*	*Ethical approval granted and GDPR followed.*

IMPLEMENTATION (FILL OUT IF THE SURVEY HAS STARTED)				
AREA	**QUESTION**	**ANSWER**	**OFFSITE POPULATION SURVEY OF EFFORT (WPS)**	**OFFSITE SEA ANGLING CATCH DIARY (SAD)**
Selection	Has the survey followed the sampling design?	WPS: Yes SAD: Yes	*Yes. The face-to-face survey follows the design.*	*The survey uses a convenience sample, so has followed the agreed approach.*
	Have sampling protocols been documented and followed at each stage (selection of individuals, times, boats, biological samples)?	WPS: Yes SAD: Yes	*The sampling protocol has been documented and followed. A full description of the sampling approach can be found in the 2016–2017 survey report.*	*The sampling protocol has been documented and followed. A full description of the sampling approach can be found in the survey reports.*

	Have contingency protocols been specified to deal with issues such as incomplete interviews of un-surveyable weather and were they required?	WPS: Yes SAD: NA	*Refusal at door leads to surveyor moving to the house next door. As sampling is post-code based there are many houses to choose from to maintain a representative sample.*	*NA*
	Has there been any major departure from the survey design (frequent refusal to take observers on board a charter vessel)?	WPS: No SAD: No	*No.*	*No.*
	Is there a language barrier (tourist fishery)?	WPS: Partial SAD: Partial	*Unknown how this is dealt with in the WPS.*	*Survey covers Wales but app currently not translated to Welsh. However, Welsh language options are available for the sign-up surveys.*
	Have the planned number of sampling events and/or interviews taken place and have the completion rates been documented?	WPS: Yes SAD: Yes	*Yes, the planned number of sampling events have taken place.*	*Yes - the completion rates for the diary programme are documented.*
Nonresponse	What were the following non-response rates were relevant? • Screening – blocked contact • Screening – no reply • Screening – language problem • Panel survey – not contactable • Creel survey – refusal • Creel survey – language problem • Other	WPS: Yes SAD: Yes	*Face-to-face survey have non-response and refusals. However, there is a protocol in place for addressing these issues.*	*Panel survey – not contactable when information requested. Removed from analysis.*
Recall	What is the recall period and is it appropriate to the questions asked?	WPS: Yes SAD: Yes	*Recall on if they have been angling in the last 12 months and how many days. This may lead to some bias, but waves were not possible with budget.*	*Recall is limited as encourage to enter data during the trip. Paper diaries are provided for those not wanting to enter data during sessions that can be transcribed to the online system or app later.*
Effort	How is effort defined (unit, fishing mode, target species, location) and related to CPUE measures?	WPS: Yes SAD: Yes	*UK household is PSU*	*Angler is PSU*
	Was the measure of effort clearly communicated to the fisher (i.e. time spent with gear in the water)?	WPS: NA SAD: Yes	*NA*	*Diarist submits catches on a trip level, but we use the catches at a diarist level. Details of the length of time spent fishing is specified in the guidance for diarists.*
	Is it possible to record incorrect fishing areas?	WPS: No SAD: Yes	*NA*	*Yes, but minimized through several different mechanisms. GPS data from phone can be used,*

				diarist asked to mark location on a map, and enter a location name.
Catch	Is the retained catch verified by surveyors (e.g. all filleted, don't show)?	WPS: NA SAD: No	*NA*	*No as offsite diary, but data validation occurs. Data entered diary checked prior to submission (e.g. over certain lengths), strange species, and catches checked as well.*
	Is species identification and naming reliable?	WPS: NA SAD: Yes	*NA*	*ID guide provided to panel to aide species identification. Where there are issues, species may be grouped together (e.g. grey mullets)*
	Is there a clear division between fish kept and fish released?	WPS: NA SAD: Yes	*NA*	*Yes. Diarists enter the numbers, lengths and fate of all fish caught.*
	Is it possible that an individual will have also reported the catch of those fishing with them?	WPS: NA SAD: Yes	*NA*	*Yes, but large catches are identified during the data validation phase and checked with diarists.*
	Is there a digit preference in the reports (catch numbers and/or length frequencies)?	WPS: Yes SAD: Yes	*There is rounding in the numbers of days fished, but not for the number of anglers.*	*There is rounding bias for numbers and sizes of fish.*

ANALYSIS and REPORTING (fill out if the survey is complete)

AREA	QUESTION	ANSWER	OFFSITE POPULATION SURVEY OF EFFORT (WPS)	OFFSITE SEA ANGLING CATCH DIARY (SAD)
General	Does the estimation procedure follow the survey design?	WPS: Yes SAD: Partial	*Yes. Weights are applied to each of the respondents based on demographic information from the UK census and location. Multi-level regression and post-stratification used to model the participation and effort of anglers based on 5 years of survey data.*	*Multi-level regression and post-stratification used to raise survey. This is used to correct for biases in the composition of the diary panel.*
	Has imputation been used to account for missing observations and, if so, is the procedure documented?	WPS: No SAD: No	*No imputation used.*	*No imputation has been done.*
	Has there been weighting to correct for nonresponses/avidity bias	WPS: No SAD: Partial	*No. Non-response is not accounted for in the analysis. However,*	*Model considers avidity as a predictive variable for how much a person catches*
	Has the precision of estimates been calculated and, if yes, how have they been calculated and where are they documented?	WPS: Yes SAD: Yes	*Yes – Bayesian model allows credibility interval calculation*	*Yes – Bayesian model allows credibility interval calculation*
	Were estimates estimated with acceptable precision.	WPS: Yes SAD: No	*Yes*	*Multispecies survey, so some species have low precision, some have very high precision*

WGRFS ASSESSMENT OF SURVEY

The UK sea angling survey generates estimation of participation, effort and catches. The survey is well constructed, but there are some issues around the convenience sample used to generate the diary panel. However, this was necessary as there is no list of sea anglers (e.g. license) and response rates to postal and telephone surveys are low. A postal survey of 3 regions generated very similar demographics to the convenience sample suggesting that that the approach used to recruit diarists has limited impact, instead driven by the types of anglers that are willing

to keep a diary. A second issue is with the non-response of some of the diarists and missing data. Statistical approaches have been developed to try to address the potential biases, which perform better than simple post-stratification. However, the outcomes are still higher than pervious onsite surveys, so further work is needed to validate the catch levels (e.g. onsite surveys).

WGRFS concludes the UK survey programme is well designed, appropriate analysis has been done to account for bias in the diary approach, and the outputs can be used for decision-making with appropriate caveats and sensitivity testing. Further work is needed to assess potential bias in the levels of catches driven by the diary approach that should include running a parallel onsite survey.