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Participation, catches and economic impact of sea anglers resident in the UK in 2016 & 2017

Final report of the Sea Angling 2016 and 2017 project

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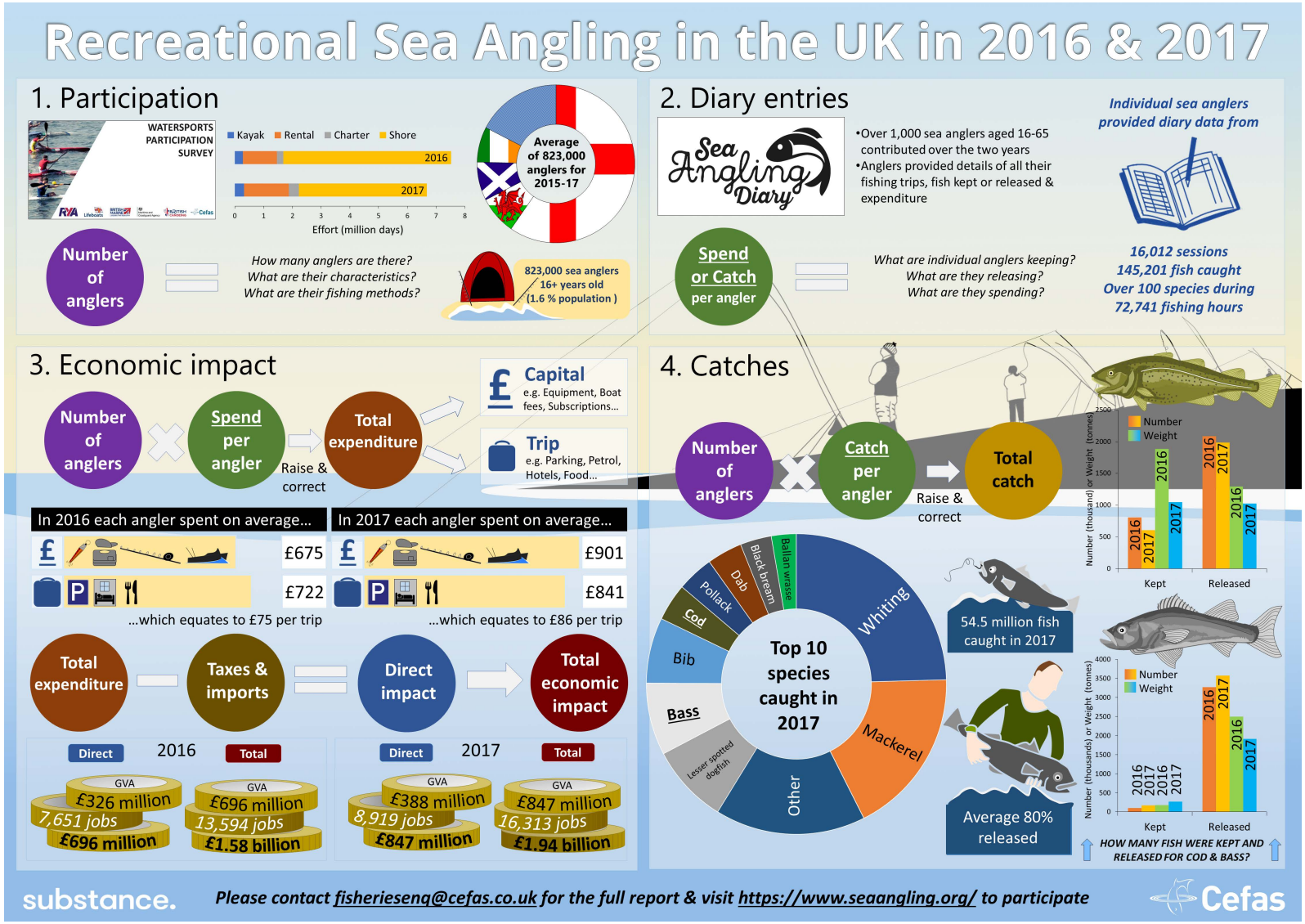
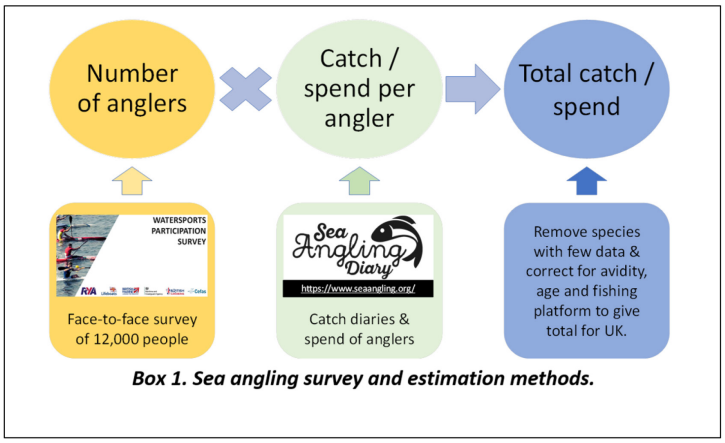
Graphical summary



Executive Summary



Box 1. Sea angling survey and estimation methods.

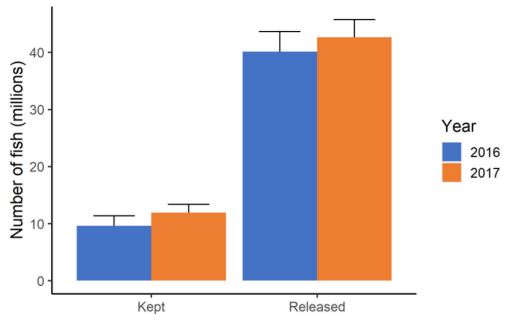
Sea angling is a popular activity in the UK that has social and economic benefits, and catches can be significant. Data on participation, catch and economic value of sea angling are needed by government and stakeholders to support well-informed decisions and sustainable management of fisheries. As part of our statutory monitoring obligations to Europe, the UK must report annual catches of recreational sea fishing. Following from "Sea Angling 2012" survey in England, a revised monitoring programme with new methods was tested in 2015 and expanded in 2016 and 2017 to estimate numbers of UK sea anglers, how often they fish, what they catch and how much they spend on their sport (Box 1).

To obtain these estimates, the outputs from two separate survey methods were combined. Firstly, an existing survey of 12000 UK residents (Watersports Participation Survey - WPS) was extended to estimate fishing effort in terms of how many people went recreational sea fishing, and the number of days on which they fished from the shore or from different types of boats. On average, 823000 UK residents aged 16 years or older went sea angling in the years 2015 -2017, representing a participation rate of 1.6%, and in total they fished on 7.0 million days (Box 2). Numbers of sea anglers were greatest in England, and within England were largest in the South West. The participation rates and days fished for Wales, Scotland and Northern Ireland were uncertain due to small numbers of sea anglers interviewed in these regions.

Measure	Number of sea anglers	%	Days
UK	823	1.6	7.0
England	607	1.4	4.6
Wales	72	2.8	0.8
Scotland	81	1.8	0.7
Northern Ireland	67	4.4	0.9

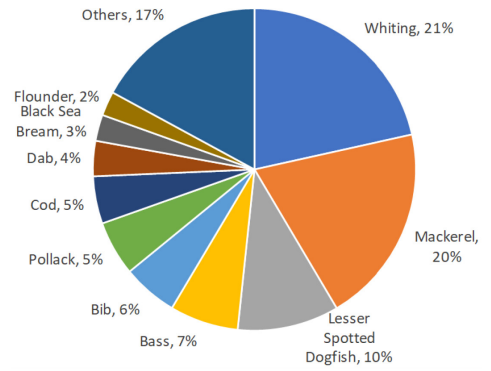
Box 2. Average number of participants of 16+ years (thousands), participation rate (%) & days fished (millions) by UK sea anglers from 2015-17.

The second of the two annual surveys was designed to estimate the average catch per day by sea anglers each year. A nationwide panel of sea anglers was recruited to complete a diary recording all their marine recreational angling activities, catches and spend during the year (www.seaangling.org). A total of 476 diarists in 2016 and 1 495 in 2017 signed up, but not all provided the minimum of six months of data needed for them to be included in the analysis. In 2016, 292 anglers meeting this threshold caught 45874 fish from 3824 day-sessions, and 639 anglers caught 76510 fish from 7353 sessions in 2017.



Box 3. Total numbers of fish caught in all surveys kept and released by UK sea anglers.

The outputs from the WPS survey and diary panel were combined to estimate total UK catches, after



Box 4. Fish species caught in 2017.

correcting for differences in frequency of fishing (avidity), age, and type of fishing (shore, boat) between the diary sample and the UK WPS sample. In total, 100 different fish species were caught by sea anglers in the UK in 2016 and 2017. Sufficient data were available to provide raised estimates of total UK numbers caught for 68 individual species and tonnage for 32 species. For the 68 species raised, the total number of fish kept and released for the whole UK was 49.7 million in 2016 and 54.5 million in 2017 (Box 3) with release rates of 80%. The species composition of the catch was similar in 2016 and 2017, and the four most common species were whiting, mackerel, dogfish, and bass (Box 4).

At intervals in the year, diarists provided data on expenditure on capital (major) items and a breakdown of spend on their most recent sea angling day trip, allowing estimation of the total economic impact and jobs supported by sea angling in the UK. The total expenditure estimate per adult anglers 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. These were slightly lower than the estimates for England in 2012 probably due a combination of differences in allocation between industries, taxes, and survey method.

Measure	2012	2016	2017
Expenditure per angler:			
• **Trip (£)**	£633	£675	£901
• **Capital (£)**	£761	£772	£841
• **Total (£)**	£1394	£1447	£1742
Total expenditure (£M)	£1233	£1108	£1318
Direct impact:			
• **Expenditure (£M)**	£831	£696	£847
• **Jobs (thousands)**	10.4	7.7	8.9
• **GVA (£M)**	£357	£326	£388
Total economic impact:			
• **Expenditure (£M)**	£2097	£1577	£1936
• **Jobs (thousands)**	23.6	13.6	16.3

Box 5. Economic impact of sea angling (£M is million pounds; 2012 England & 2016-17 UK).

Catch estimates for England from the 2016 and 2017 surveys were higher across many species than from the Sea Angling 2012 survey programme, particularly for released fish. It was not possible to use an on-site approach in 2016-17 due to resource constraints. Instead an angler diary panel was implemented that was both resource efficient and has been used to provide robust catch estimates in other countries. As the 2012 data are for only one year and used different survey methods, it has not been possible to determine the extent to which the increased catch estimates are due to survey bias, random sampling error, or changes in fish abundance. It is likely that a combination of these factors generated the differences. Although a method was applied to reweight the panel to be more representative of the population in terms of avidity, age or predominant sea angling method, some bias may remain if sea anglers who complete a diary are on average more experienced or skilled than the general population, and this might affect their catches and expenditure. Further work is underway in 2019 to assess the level of bias including a validation survey and correcting for fishing experience and skill.

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1 Introduction

1.1 Overview of marine recreational fisheries

Marine recreational fisheries (MRF) has been defined as: "*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*" (ICES, 2013). In Europe, MRF has been shown to be important economically and socially, and can also have an impact on fish stocks (Hyder et al., 2017; 2018; Radford et al., 2018; Lewin et al., 2019). As MRF is exploiting a scarce fish resource alongside commercial fisheries, market failure in form of the "tragedy of the commons" is possible (Gordon, 1954; Hardin, 1968). This occurs if access to marine fish is not restricted when the stock is being overexploited. Information on the social, economic, and biological impact of MRF is needed to underpin balanced management, but is often lacking, so data collection programs have been introduced to provide evidence for decision makers (Hyder et al., 2014; 2017; 2018).

Participation in MRF is highly variable between countries in Europe varying between 0.2% in Germany to 33% in Norway (Hyder et al., 2018). Many factors have been shown to influence participation rates (e.g. population size, population density – e.g. Arlinghaus et al., 2015; Edwards, 1989; Heberlein et al., 2002), but it is likely that complex interactions between factors drive differences in participation rates between countries. Individual motivations for participation in MRF are very diverse, including relaxation, experiencing nature, exercise, personal consumption, and socialising (Arlinghaus, 2006; Armstrong et al., 2013; Beardmore et al., 2011; Fedler and Ditton, 1994). For example, angler behaviour can affect harvest rates through the importance to the angler of catching fish to eat (e.g. Aas & Vittersø, 2000; Beardmore et al., 2011). In fact, MRF can also an important source of food in some countries (Cooke et al., 2018).

Expenditure on MRF in Europe is significant and has been estimated to be €5.9 billion each year (Hyder et al., 2018), creating a total economic impact of €10.5 billion and supporting almost 100000 jobs (Hyder et al., 2017). In addition, there are many social benefits including environmental improvement, experiencing nature, spending time with friend and family, and health and wellbeing (McManus et al., 2011; Armstrong et al., 2013; Griffith et al., 2017). Although most individual fisher's catches are small, the combined catches of a million fishers on all their fishing trips in a year can be large enough to have a significant impact on some fish stocks (Armstrong et al., 2013; Cooke and Cowx 2004; Hyder et al., 2017; 2018; Lewin et al. 2006; 2019; Radford et al., 2018), and potentially have other environmental impacts such as lead loss and introduction of non-native species (Lewin et al., 2006; 2019). In Europe, recreational removals (harvest plus fish that die after release) for some species can represent between 2-43% of the total catch (Hyder et al., 2017; 2018; Radford et al., 2018). Along with fish kept for eating, this includes fish that are released but die due to injuries or stress (Kerns et al., 2012), with high released rates found in Europe (Ferter et al., 2013). Despite these catches, MRF is rarely included in stock assessment in Europe which may impact on sustainable management of fisheries (Hyder et al., 2014; 2017; 2018).

The benefits and impacts of recreational fishing must be documented alongside similar data from commercial fisheries to help local and national policy makers make balanced and well-informed

decisions (Hyder et al., 2018). This information also helps angling and commercial fishing organisations, and other non-governmental bodies, to develop their own policies and provide best practice advice.

1.2 Sea angling across the UK

Sea angling is the capture of resources for leisure or personal consumption, by line only, and is the most common method of marine recreational fishing in the UK. There are no complete lists of marine recreational fishers nor licensing schemes in the UK, so an independent study is required to estimate participation, effort, and catches (see ICES, 2010; Jones and Pollack, 2013; Pollack et al. 1994). A number of studies have included an estimation of the numbers of sea anglers and participation rates in the individual countries of the UK (e.g. Armstrong et al., 2013; Drew, 2004; McMinn, 2013; Radford and Riddington, 2009; Simpson and Mawle, 2005, 2010), including omnibus surveys using face-to-face methods. In 2003, an omnibus survey in England and Wales estimated there were 1.1 million sea anglers equating to a participation rate of 5% for over 16-year olds (Drew, 2004). Surveys to assess public attitudes to angling in England and Wales found that 2 million (5%) and 1.9 million (4%) of individuals aged 12 years or over in 2005 and 2010 respectively, had been sea angling in the past year (Simpson and Mawle, 2005; 2010). The most recent information on MRF participation and effort in Great Britain (England, Wales and Scotland) was carried out in 2012 using an omnibus survey of over 12000 households which estimated that 2.2% or 1.08 million people of 16 years or older had been sea angling in the past year, with 884000 from England, 125000 from Scotland, and 76000 from Wales (Armstrong et al., 2013). Other surveys showed that in 2009, there were an estimated 125188 sea anglers of 18+ years in Scotland (Radford and Riddington, 2009) and 64800 sea anglers of 18+ years (3.6% participation) in Northern Ireland in 2012 (McMinn, 2013).

Several studies have been done in the UK to assess the economic value and impact of sea angling (Armstrong et al., 2013; Drew, 2004; Lawrence, 2005; Monkman et al., 2015; Radford and Riddington, 2009; Roberts et al., 2017). In 2003, the expenditure by sea anglers resident in England and Wales was estimated at £538 million per year based on 12.7 million angler days of activity, and with this spending supporting nearly 19000 jobs directly and £71 millions of supplier income (Drew, 2004). In south west England in 2004, it was estimated that 240900 residents and 600000 visitors were active sea anglers spending a total of £165 million (Lawrence, 2005). The impact of sea angling in Scotland in 2009 was estimated at £70 million, supporting 3148 jobs (Radford and Riddington, 2009). In Wales, the total annual expenditure of sea anglers was estimated as £39 million for visitors and a further £87 million for residents, supporting around 1700 jobs (Monkman et al., 2015). The most comprehensive study for England was done in 2012 estimating an economic impact using a household survey of effort (numbers of anglers) and an online and face-to-face survey of expenditure (spend per angler) in combination with an Input-Output (IO) methodology to calculate total economic impact, Full Time Equivalents (FTEs), and Gross Value Added (GVA) (Armstrong et al., 2013; Roberts et al., 2017). It was found that sea anglers residing in England spent £1.23 billion on the sport, equivalent to £831 million in direct spend, and supported 10400 full-time equivalent jobs with almost £360 million of GVA. Taking indirect and induced effects into account, it was estimated that sea angling supported £2.1 billion in total spending, GVA of £978 million, and a total of over 23600 jobs (Armstrong et al., 2013; Roberts et al., 2017).

Total economic impact studies are not generally used to assess the impact of a change in policy. This is because complete cessation of sea angling would only to lead to a partial loss of the total economic impact generated as most anglers would redistribute their spend to other recreational activities. For example, Radford and Riddington (2009) estimated that a total cessation of sea angling would lead to a net loss of 1,675 jobs (out of 3,148) and £37 million annual income (out of £70 million) which presents about 53% of the economic impact created. In 2012, sea angling in England represented about 6% of the UK GVA created by the recreational sector based on leisure industry values from the nominal and regional GVA tables published by the Office for National Statistics[1]. Hence, this sector had a relatively large economic impact compared to its participation rate of 2.2.% in 2012 (Armstrong et al., 2013). As a result, spending on other recreational activities may not offset the economic loss completely, but this depends on how the spend is redistributed. However, it is difficult to use this approach to assess the impact of policy, with stated or revealed preference approaches usually used for this purpose (EFTEC 2015).

1.3 Why do we need sea angling data?

Sea angling data are needed to support local, national, and regional management of fish stocks, environmental protection, marine spatial planning, and development of the blue economy (ICES, 2015). Information is needed at local scales (e.g. UK Inshore Fisheries and Conservation Authorities), national scales (e.g. government departments), and international scales (e.g. the International Council for the Exploration of the Seas, ICES and the European Commission and its Scientific, Technical and Economic Committee on Fisheries) to inform marine management and policy. Data are also needed by the angling community for development of their own policies (ICES, 2017). It is a statutory requirement under the EU Data Collection Framework (DCF) for the UK to report recreational catches and releases of cod, sea bass, pollack, elasmobranchs, eels, salmon, and highly migratory species (the EU Data Collection Framework (Council Regulation (EC) No 199/2008) and the Multi-Annual Programme (Council Regulation (EU) 2017/1004)). There is also the requirement to report all catches of recovery plan species by boats flying the UK flag under the Control Regulations, which includes recreational charter boats (EU, 2009).

Europe has lagged behind some countries such as the USA and Australia in collecting and making use of data on recreational sea fishing (e.g. NOAA, 2015; Ryan et al. 2016). There is a paucity of catch estimates making it difficult to include recreational fisheries when assessing the conservation status of marine fish stocks and advising on future catches to achieve goals for sustainability (Hyder et al., 2014; 2017; 2018). As a result, it has therefore been largely ignored in stock assessments in Europe (Hyder et al., 2014; 2017; 2018). Marine recreational fishing has been included in stock assessments for European sea bass, western Baltic cod, Baltic sea trout, and Atlantic salmon in the Baltic, leading to recreational fisheries management measures including bag limits and closed seasons (e.g. sea bass, western Baltic cod). A decline in a stock and reduction in fishing opportunities for both commercial and recreational fishing brings these sectors into conflict and makes allocation between them a

[1] Online available: https://www.ons.gov.uk/economy/grossvalueaddedgva/datalist?filter=datasets (published 19 December 2019).

challenge (Williams et al., 2018). Therefore, accurate data are needed to enable robust assessments and management decisions.

1.4 Survey methods

1.4.1 Catches

To estimate total annual catches and releases by sea anglers for a country or sea area, it is typically necessary to carry out independent surveys of MRF effort and catch per unit effort, along with biological information on the lengths and weights of catches (ICES, 2010; Jones and Pollack, 2013; Pollack et al. 1996). On-site (e.g. creel, aerial, camera) or off-site (e.g. household) approaches are used to estimate the effort (e.g. numbers of anglers, trips, boats). The effort can be partitioned among groups that have different characteristics (e.g. age, avidity, platform, mode). Catch per unit effort (CPUE) can also be collected using on-site (e.g. access point, roving creel) or off-site (e.g. diary, recall) approaches. Characteristics of the respondents are usually recorded to correct for differences between the sample and population (e.g. age, avidity, platform, mode). The approaches for data collection vary and there is no single preferred method, as each is subject to different potential biases (ICES, 2010; Jones and Pollack, 2013; Pollack et al. 1996). Bias in sea angling surveys can arise at the design stage, for example insufficient spatial coverage or use of non-random sample selection methods. During implementation, additional biases can arise such as non-response, prestige bias (exaggeration), recall errors, and rounding up or down of numbers.

Different methods can be used to reduce these biases as much as possible. Catch and effort surveys used are often selected based on a detailed evaluation of logistics, staffing and resources needed, available budget, likely response of anglers, potential for bias, and the types and quality of information needed by end users. Logbook (or diary) surveys involving recruitment of a representative panel of fishers are a popular method of collecting marine recreational fishing data in Europe and potentially worldwide, due to the low cost per sample (Bellanger and Levrel, 2017) and the ability to collect detailed catch, demographics, and effort data. However, this only provides information on resident fishers, so is not suitable where there are large tourist fisheries, unless data for tourists are available from surveys in their own countries, or on-site sampling is possible to quantify the number of tourist anglers. The survey approaches used can impact on the outcome as there are different challenges and biases. In fact, comparisons between on-site creel and off-site diary panel surveys in New Zealand showed that the results from off-site diary were between 2 and 50% higher for the harvested component of the five most commonly caught species with the largest differences for less commonly caught species (Hartill et al., 2015).

1.4.2 Economics

Most studies of recreational fisheries focus on either the economic value from a social welfare perspective (e.g. Toivonen et al., 2004) or the macro-economic impact of the activity (Armstrong et al., 2013; Hyder et al., 2017; Monkman et al., 2015; Roberts et al., 2017). There are many approaches to estimate the economic value of an activity or sector (e.g. EFTEC, 2015; Parkkila et al., 2010). These vary according to the questions being asked and range from the non-market benefits to society (such as willingness to pay surveys) to the impact that marine recreational fishing has on a given economy (ICES, 2018).

Economic impact identifies, from a macro-economic perspective, the monetary funds a particular project or industry brings to the area where it is located (EFTEC, 2015). Hence, this approach calculates the impact of the demand for MRF on the regional or national economy. This is done using Input-Output (IO) models, which is a quantitative static approach to represent the interdependencies between multiple economic sectors (EFTEC, 2015; Parkkila et al., 2010). The IO method measures the potential impact of an increase in activity in one sector on the total economy through the direct output of the sector, indirect and induced effects, employment, and GVA due to this change in activity (Kowalewski, 2009). The direct effect relates to the increased production output, indirect effects capture the increase in production in the other sectors, and the induced effect is where more employment is generated which allows households to increase their income and spending. The direct, indirect and induced effects are summed to get the total economic impact of an activity. This approach has been commonly used to estimate the economic impact of marine recreational fishing (Armstrong et al., 2013; Hyder et al., 2017; Poudel et al., 2018; Roberts et al., 2017).

1.5 This study

This study estimated participation, effort, catch, and economic impact of sea anglers resident in the UK in 2016 and 2017. To achieve this, the outputs from two separate surveys were combined. Firstly, an existing nationwide survey of UK residents (the Watersports Participation Survey - WPS) was used to estimate fishing effort in terms of how many people go recreational sea fishing, and how often they use different methods. Secondly, a nationwide panel of sea anglers was recruited to complete a diary recording all their marine recreational angling activities and catches during the year, from which the average catch per unit effort was calculated[2]. The diary results were then raised to the total UK population using information from the WPS. To minimise bias in the estimates, differences in avidity, age, and fishing platform between the diary sample and UK population were corrected in the analysis. This report describes the methodology, participation, catch and economic results, and discusses the implications for future surveys. As the methods are complex, full methodologies and results for each survey are provided in the four Annexes (WPS, diary, economic impact, and catch).

[2] https://www.seaangling.org/

2 Methods

The overall aim of the analysis was to estimate the numbers and tonnages of fish kept and released by adult sea anglers resident in the UK by species, along with the associated estimates of precision. Two datasets formed the basis of the analysis:

- Watersports Participation Survey (WPS): a face-to-face omnibus survey of 12000 randomly selected households within strata across the UK that provides a population level estimate of the numbers, profile, and activity of sea anglers in the UK (see Annex 1 for a full description).
- Sea angling diary: a year-long online catch diary tool that provides a record of the catches from a self-selecting panel of sea anglers (see Annex 2 for a full description) and regular surveys of expenditure.

The estimates of the number of anglers (effort) from the WPS (Annex 1) were combined with catches by individual anglers (catch per unit effort) from the sea angling diary survey (Annex 2) (Figure 1). To minimise bias in the estimates, differences in avidity, age and fishing platform between the diary sample and UK population were corrected for. This type of two-stage survey is done for most sea angling surveys (see Jones and Pollock, 2013; Pollock et al., 1994 for a general review) to account for differences in the composition of the sample and population.

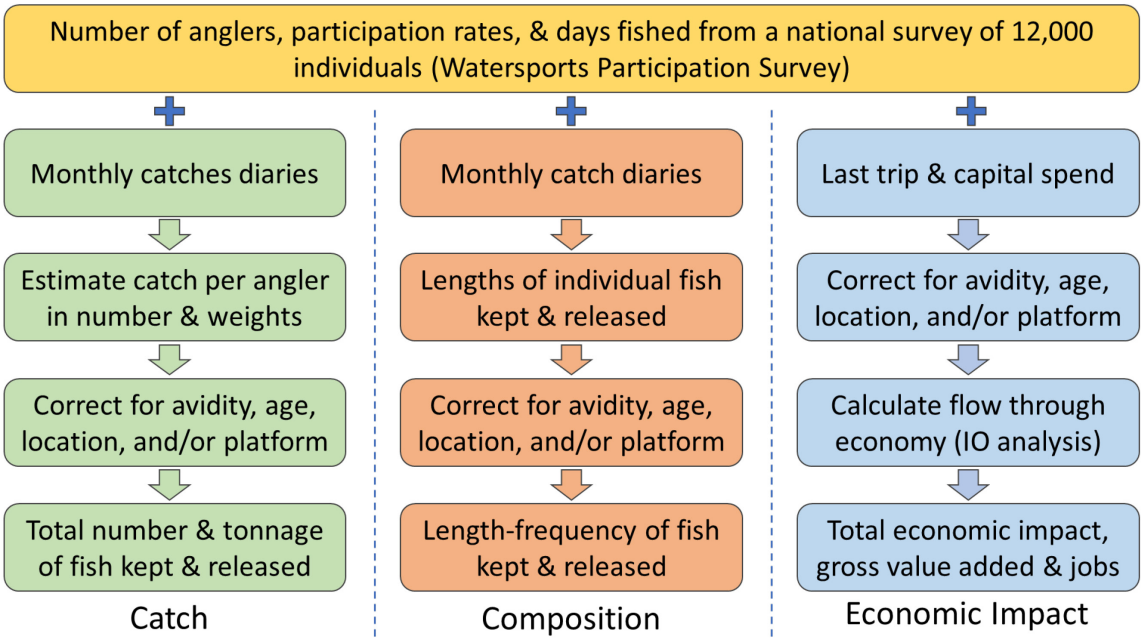

Figure 1 Overview of sampling methodology, raising the diary records of catch and spend to the national estimates, using the participation rates from the WPS.

2.1 Participation, numbers, and effort

The WPS was delivered by the market research consultancy Arkenford (now part of The Nursery Research & Planning Ltd[3]). The survey includes a face-to-face omnibus survey of 12000 UK households

[3] https://the-nursery.net/

to estimate participation and trends in watersport activities. Questions were added to the omnibus survey in 2015, 2016, and 2017 on sea angling to generate information on effort (numbers of anglers and days fished) that could be used to calculate catches and releases by sea anglers in the UK. The sample frame, sample points and interview methodology are described in detail in Annex 1.

The sampling frame was created from the 2011 Census small area statistics and the Postcode Address File (PAF). This was used to identify non-overlapping areas of similar population sizes within a single Government Office Region (GOR) that then became the sample points in the sampling frame. Each year, 605 sample points were identified across the UK, with 600 south of the Caledonian Canal. Sampling points north of the Caledonian Canal differed in size from those south of the canal and from each other, in order to ensure that the Scottish Highlands and Islands were adequately covered The addresses selected for sampling at each selected sampling point were issued to achieve an adult sample of 13, 15, or 17 in London and 15, 17, or 19 elsewhere per sampling point, depending on the questionnaire length.

All respondents were 16 years or older and each was asked if they had taken part in any of 32 different watersport activities. For marine recreational fisheries, the following categories were defined: sea angling from a kayak; sea angling from a private or rental boat; sea angling from a charter boat; sea angling from the shore; and recreational sea fishing (using pots, traps, nets, spears). From 2015 onwards, if the respondent answered yes to any of these categories, they were then asked how many days that they had been fishing in the UK in the last year. Responses were weighted based on the interviewee's location, age, sex, and social grade. A breakdown of demographics published by the Office of National Statistics (ONS) were used to raise the weighted samples (questionnaire responses) to the entire population of the UK over the age of sixteen. Participation rates, numbers, and days fished in 2016 and 2017 were calculated for the UK and compared with previous surveys.

2.2 Catches

2.2.1 Catch diaries

Recruitment of diarists in 2016 and 2017 involved the identification of a sample of people who fish for recreation in the sea and who were willing to keep catch diaries. Recruitment varied between years, but was done by contacting an existing database of around 17000 anglers by email, through angling clubs, internet fora, adverts in published media, social media, and flyers in tackle shops. The diarist panel was self-selecting rather than random, so has potential for bias due under- or over-representation of anglers in terms of avidity, fishing methods, age or region or other factors that affect catches. Regional sampling targets for recruitment of diarists were set to ensure a distribution of diarists across the UK that matched the distribution of sea anglers from previous population surveys. Phase one for both surveys was conducted during the autumn/winter months to obtain the initial sample of 600 and 1000 in 2016 and 2017, respectively, to begin in January, and then from July 2017 on a 'rolling' basis to add numbers to the diary panel.

Diarists were given a fish identification booklet, tape measure, and waterproof notebook to record details of location, methods, and catches on each session. An explanation of the recording requirements (including location, duration, method, and catches) and access to the online diary

system[4] to record catches each month. Diarist recorded whether they had fished each month, and details of each session (location, duration) including catch (species, size, fate). The data was anonymised, so that individual anglers could not be identified and no entries could be linked to an individual. Each fishing location recorded was jittered to protect individual marks. All personal data was removed from the database before data analysis. Significant effort was put into following up with diarists to ensure that data were completed each month, but there were still issues with missing data. Sizes could be provided as length or weight, so weights were calculated for each species using known length-weight relationships (Silva et al., 2013).

2.2.2 Catch by UK sea anglers

The numbers and tonnages of fish of each species kept and released were calculated from the number of UK sea anglers (effort) from the WPS in each year multiplied by the average annual catch of each species by panel members (catch per unit effort) from the sea angling diary survey to give total catches for the UK population (see Jones and Pollock, 2013; Pollock et al., 1994 for a general review). No estimates were provided where there were fewer than four diarists or 15 records for an individual species as these were considered too uncertain to provide robust estimates. In addition, tonnages were not calculated for species with fewer than five diarists or 50 individual fish reported. Only diarists that provided six or more months of data were included and the highest and lowest three catches were removed (trimmed) to reduce this impact of single large catches. There was potential bias because the diarists were self-selecting rather than random, so the data from the panel were post-stratified and reweighted to reduce the effects of bias. The sensitivity of the results to number of months of data each year and trimming was tested. Different strata for reweighting were tested including avidity, fishing methods, and region, and precision of the total catch estimates was evaluated. Balancing the numbers of respondents (WPS and diary) and metrics led to selection of different post-stratification in 2016 (3 avidity and 2 platform) and 2017 (3 avidity and 2 age). The numbers of fish kept and released (total and catch per angler) and release rates were compared in 2012 (Armstrong et al., 2013), 2016 and 2017 (this study). The catch composition by numbers caught was assessed for 2016 and 2017 for the UK and composition within England compared to 2012 (Armstrong et al., 2013).

2.3 Economic impact

At three points in 2016 (June, September, and December) and two in 2017 (July, December), an economic survey was conducted with anglers who were part of the catch diary in order to obtain estimates of annual expenditure on sea angling. Multiple surveys were done to reduce recall bias by asking about recent expenditure and to generate information in different seasons of the year. Through an online tool, diarists provided expenditure on capital (major) items in the last six months and a breakdown of spend on their most recent trip in the preceding month. Trip expenditure included: transport, accommodation (only for the night of and/or night after day sea angling), food and drink, bait, tackle, other fishing equipment bought for the trip, car parking, pier/harbour/launch fees, charter or private boat hire and boat fuel (Table 1). All respondents were asked to provide their expenditure on capital or 'major items' over the preceding six months (in June and December in 2016 and both

[4] https://www.seaangling.org/

surveys in 2017). Major item categories included: fishing rods/reels, clothing, other fishing equipment (excluding terminal tackle), boats/kayaks used mainly for sea fishing, and any other major items relating to sea angling (Table 1). These were voluntary surveys, with 250 and 576 responses in 2016 and 2017, respectively.

The methodology used to estimate total economic impact, jobs, and GVA (Figure 1) followed a similar approach to that used in previous surveys of economic impact of sea angling (Armstrong et al., 2013; Hyder et al., 2017; Monkman et al., 2015; Roberts et al., 2017). The results of the WPS and the spend diaries were used to estimate the total expenditure by UK sea anglers. The three highest and lowest values were trimmed, and two age groups (18-54, 55 or more), two avidity groups (less than 20, 20 or more) and two platform types (boat, shore) defined the sampling strata for each year in the analysis.

The total expenditures by sea anglers in the UK was calculated for each individual category of trip (effort based) and capital (major item/investment) expenditure (based on the categories in Table 1). Taxes and imports were removed (taken from Office for National Statistics (ONS)[5]) from the total expenditure by sea anglers in the UK as these do not affect the demand in each industry (Table 2) and expenditure split between industries (Table 3). 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.

Table 1. Categories of trip and major item expenditure provided by individual anglers. Trip relates to the last trip and major item captures large purchases.

Trip	Capital
• Accommodation • Food & drink • Bait • Terminal tackle (trip) • Other fishing equipment • Car parking • Pier fees • Charter • Fuel (boat & own vehicle) • Public transport • Other trip spend	• Rods • Clothing • Other equipment • Terminal tackle (capital) • Boats • Engines • Other major spend

[5]https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/inputoutputsupplyandusetables

Table 2. Percentage of imports by sector in Input-Output table.

Sector	Sector number	Imports (%)
Agriculture	1	26.6
Food, drink and tobacco	3	20.0
Textiles, clothing, footwear	4	29.0
Wood, paper, publishing	5	0.2
Coke and refined petroleum products	6	24.8
Machinery, electronics	10	38.0
Furniture and other manufacturing	11	27.0
Wholesale/retail	14	0.4
Hotels and restaurants	15	6.0
Transport	16	0.0
Other services	21	0.0

Total economic impact, GVA, and number of jobs supported were estimated using the Input-Output (IO) approach. In this approach, the total expenditure by sea anglers in the UK is partitioned between the industrial branches identified as impacted by the sea angling activity (Table 1, following Armstrong et al., 2013; Roberts et al., 2017). To calculate the total direct expenditure, taxes and the proportion of goods that each industry imports need to be removed from each spend category. The sectoral supply structure of the UK economy which was used for calculating Leontief output multipliers and UK imports, were taken from the supply and use tables (SUT) published by the ONS UK[6]. Leontief output multipliers (type II) were calculated, which allowed estimation of the indirect and induced impact of the direct spending, the numbers of jobs supported, and the GVA created by the contribution of sea angling to the UK economy (Figure 1). To provide estimates of the error, the standard error for each expenditure category were included in the IO analysis. This is likely to be an underestimate of the error as uncertainty in the IO analysis is excluded from this calculation.

Total economic impact, GVA, and jobs supported were calculated for 2016 and 2017. Results from 2016 were corrected for inflation to 2017 prices using the Harmonised Consumer Price Index from EUROSTAT[7]. Comparisons were made between angler expenditure (capital, trip, total), population expenditure (spend, direct, imports, tax), economic impact (direct, indirect and induced, total), employment (direct, indirect and induced, total), and GVA (direct). A visual comparison was made to 2012 results, as lack of error estimates for 2012 prevented a statistical comparison.

[6] https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/inputoutputsupplyandusetables

[7] https://ec.europa.eu/eurostat/web/hicp

Table 3. Allocating spend by anglers between industries for input-output analyses. Percentage of spend category that flows into an industrial sector.

Spend Category	Agriculture	Food, drink and tobacco	Textiles, clothing, footwear	Wood, paper, publishing	Coke and refined petroleum products	Machinery, electronics	Furniture and other manufacturing	Wholesale / retail	Hotels and restaurants	Transport	Other services	Total
Accommodation									100			100
Food & drink		25						25	50			100
Bait	50							50				100
Other fishing equipment							5	95				100
Car parking										100		100
Pier fees										100		100
Charter										50	50	100
Fuel					90			10				100
Public transport										100		100
Other trip spend				67				33				100
Rods							60	40				100
Clothing			50					50				100
Other equipment							5	95				100
Terminal tackle							10	90				100
Boats						85		15				100
Engines						85		15				100
Other major spend						85		15				100

3 Results

3.1 Participation, numbers, and effort

It was estimated from the WPS that 874000 16+ year olds in the UK went sea angling in the 2016, and 902000 in 2017, representing an average participation rate of 1.6% in each year (Table 4). Numbers of sea anglers were greatest in England, but participation rates were highest in Northern Ireland and the South West of England (Table 4). The majority of sea anglers were between 25 and 64 years old and there were similar participation rates across age groups apart from a lower rate for those over 65 years old (Figure 2). Most sea anglers were male, but the percentage of males was lower than in most other surveys at 80% (Figure 2). Sea anglers were mainly from socio-economic groups B, C1 and C2, with a lower portion from A and E (Figure 2). Participation rates were reasonably consistent except for a lower rate for group E (Figure 2). Due to the relatively low numbers of anglers responding, these results are likely to be very uncertain.

Table 4. Sea angler numbers, participation rates, days fished by platform, and days fished by an individual in 2012, and 2015-17. The numbers for 2012 were from surveys of Great Britain (Armstrong et al., 2013) and Northern Ireland (McMinn, 2013). UK indicates resident in the UK. In 2016, some postcodes were missing making assigning location impossible for around 6,000 sea anglers, but were assigned to England for this analysis. Average is the mean of the 2015-17 results. Standard errors are given in brackets.

Measure	2012	2015 (UK)	2016 (UK)	2017 (UK)	Average
A. Numbers (thousands)					
Total sea angling UK	1,145	694 (99)	874 (128)	902 (149)	823
England	884	525 (87)	601 (101)	677 (103)	603
Wales	76	46 (24)	99 (49)	69 (33)	72
Scotland	125	75 (31)	88 (46)	81 (40)	81
Northern Ireland	65*	47 (24)	80 (37)	75 (38)	67
Total non-angling methods	---	104	131	242	159
B. Participation (%)					
Total sea angling UK	2.2	1.4	1.7	1.7	1.6
England	2.2	1.3	1.4	1.5	1.4
Wales	3.1	1.9	3.8	2.6	2.8
Scotland	2.4	1.8	2.0	1.7	1.8
Northern Ireland	3.6*	3.2	5.2	4.8	4.4
Total non-angling methods	---	0.2	0.2	0.5	0.3
C. Effort (million days)					
Total sea angling UK	4.8	6.7	7.5	6.7	7.0
Kayak	---	0.2	0.3	0.3	0.3
Private	0.5	1.3	1.2	1.6	1.3
Charter	0.4	0.2	0.2	0.3	0.3
Shore	3.9	5.0	5.8	4.5	5.1
Total non-angling methods	---	0.2	0.6	0.6	
D. Effort (days/angler)					
Total sea angling UK	4.2	9.7	8.6	7.4	8.5

*Northern Ireland numbers are from McMinn (2013).

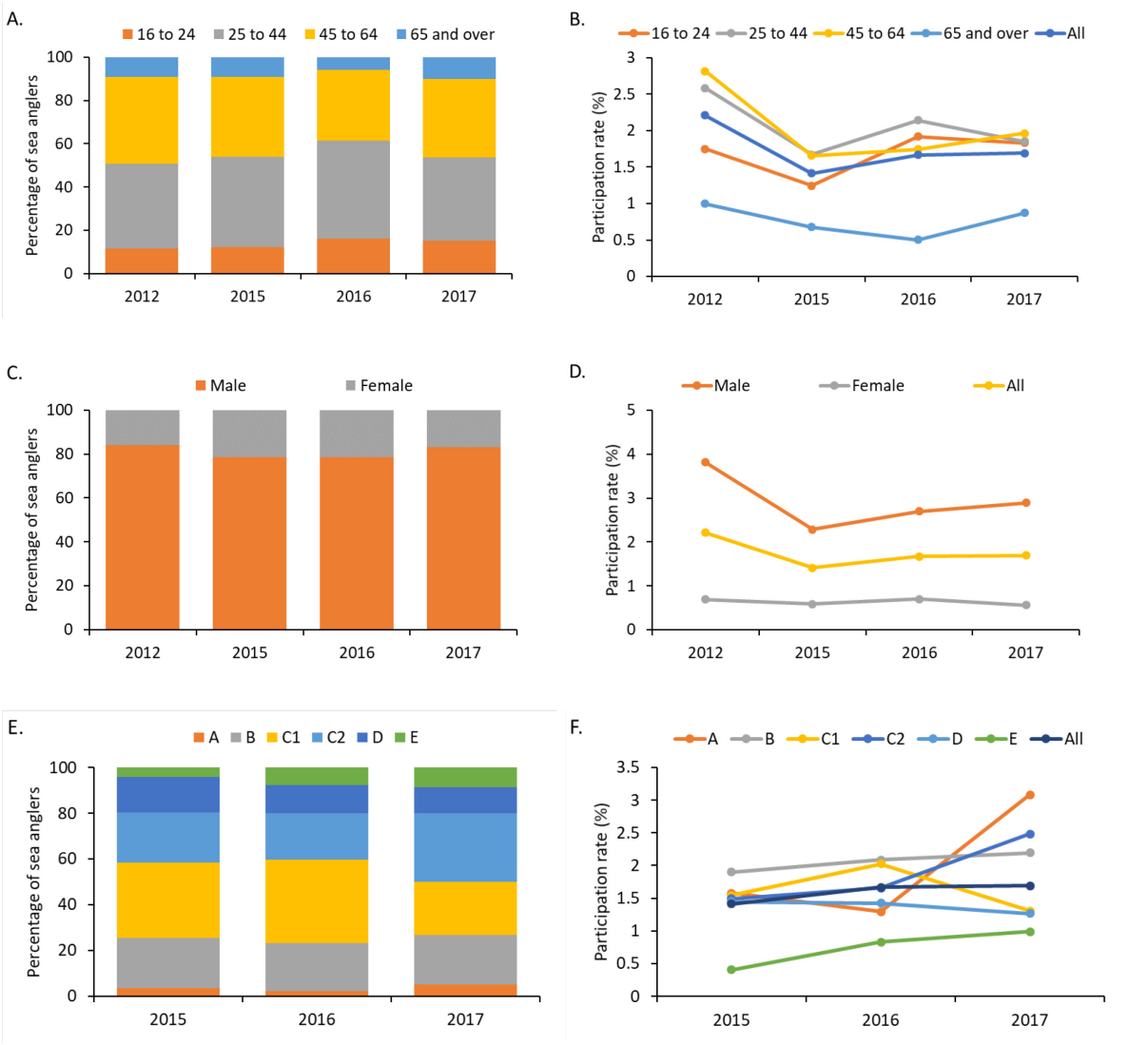

Figure 2. The percentage (panels A, C, E) and participation rates (B, D, F) of sea anglers by age (A&B), gender (C&D) and socio-economic group (E&F).

3.2 Catches

3.2.1 Catch Diaries

A summary of the fishing activity recorded in 2016 and 2017 is provided in Table 5. While there were more diarists in 2017 (both initial sign ups who had signed up before the start of 2017, and final numbers who had joined by the end of 2017), there were more sessions per diarist in 2016, and the fishing sessions were longer on average, resulting in more hours per diarist. However, because there were more diarists overall, by the end of 2017 there were nearly twice as many fishing hours recorded as in 2016 (47462 and 25279 respectively). In total 106 species plus 'others' were recorded over the two years, with 100 fish species caught by sea anglers in the UK.

Table 5. Summary of the fishing activity of the diarists in each year.

Item	2016	2017 initial	2017 final
Total diarists in study	476	932	1,495
Total diarists fishing in year	348	677	878
Total sessions recorded	5410	9663	10602
Average number of sessions per diarist in the study	11.4	10.4	7.1
Average number of sessions per diarists who fished	15.5	14.3	12.1
Average session length	4.7	4.4	4.5
Total fishing hours recorded	25279	42527	47462
Average number of hours per diarist in the study	53.1	45.6	31.7
Average number of hours per diarists who has fished	74.6	62.8	54.1

Most of those who agreed to complete the diaries were resident in England, followed by Wales, Scotland, and Northern Ireland (Table 6). Nearly twice as many diarists signed up in 2017 compared with 2016, and even more signed up during 2017, giving a total of 1495 diarists by the end of 2017. Of the diarists who signed up to the survey, not all entered data with 432 and 1216 diarists providing data in 2016 and 2017, respectively (Table 6).

Table 6. Number of diarists signed up and entering data from different home locations.

Location	2016		2017 initial		2017 final	
	Signed up	Data	Signed up	Data	Signed up	Data
East Midlands	17	14	34	30	58	44
East of England	43	39	85	79	141	120
London	12	10	20	17	38	28
North East	26	23	55	49	79	66
North West	49	38	75	67	108	91
South East	84	80	173	161	304	235
South West	92	90	222	206	343	274
West Midlands	18	16	30	30	44	39
Yorkshire & Humber	32	28	38	38	62	55
England Total	373	338	732	677	1177	952
Northern Ireland	25	23	31	30	66	50
Scotland	34	31	73	71	103	92
Wales	44	40	85	83	125	110
Republic of Ireland	0	0	2	0	10	1
Other	0	0	7	6	11	9
France	0	0	2	2	3	2
Grand Total	476*	432	932	869	1495	1216

*Note that some of the initial diarists that signed up dropped out and requested removal of their data accounting for the difference between the initial number of 507 and the 476 given in this table

3.2.2 Catch by UK sea anglers

In order to correct for biases in the self-selected diary results using post-stratification and reweighting, different combinations of post-stratifying by age, avidity, location, and platforms were tested, and the sensitivity of the raised catches assessed. In addition, different levels of trimming (removal of the equal numbers of diarists with the largest and smallest catches) were assessed to reduce the impact of single very large catches on the results. (Armstrong et al., 2013; Roberts et al., 2017). Finally, the sensitivity of the number of months of data each year was tested. Six months or more data was needed

for a diarist to be included in the analysis, leaving 292 diarists catching 45874 from 3842 sessions in 2016 and 639 catching 76510 fish from 7353 sessions in 2017.

The final analysis configuration was as follows: trimming the three anglers with highest and lowest catches; post stratification in 2016 using "strata 12" which included three avidity strata (<5, 5-19 and 20+ trips per year) and two angling platforms (anglers fishing from shore only, anglers fishing from boat only or mixed boat and shore); post-stratification in 2017 using "strata 15" which included two age strata (18-54, 55+ years) and the same three avidity strata as for 2016. The final estimation procedure is presented in Figure 3. Numbers could not be estimated 20 from 82 species in 2016 and 27 from 95 species excluded due to insufficient diarists or records to provide robust estimates (Table 7). Tonnages were estimated for 20 and 32 species and 4 groups (all fish, elasmobranchs, sharks, skates and rays) in 2016 and 2017, respectively. Details of the method is provided in Annex 4.

The total number of fish kept and released were fewer in 2016 (49.7 million) than 2017 (54.5 million), but release rates were similar and were in the region of 80%. English sea anglers kept and released the largest total numbers of fish (Figure 4), mainly due to the larger number of anglers resident in England. Catches per angler were similar in 2016 and 2017, but total numbers of kept and released varied for Wales and Northern Ireland, which is probably due to the small number of diarists and respondents in the WPS. Differences in tonnages kept and released between the years were largely explained by differences in the average fish weights. Catches were higher in 2016 and 2017 than in 2012 with higher numbers kept and released, but the difference was much greater for the released component. The release rates were higher in 2016 and 2017 than 2012.

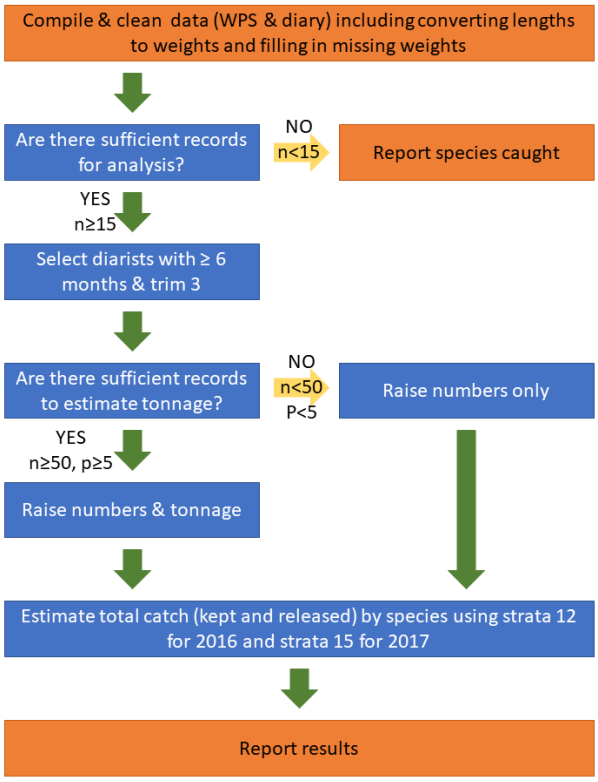

Figure 3. Schematic demonstrating the final estimation procedure for each species and/or group. Stratification methods were strata 12 in 2016 (three avidity strata (<5, 5-19 and 20+ trips per year) and two angling platforms (anglers fishing from shore only, anglers fishing from boat only or mixed boat and shore)) and strata 15 in 2017 (two age strata (18-54, 55+ years) and the same three avidity strata as for 2016).

Table 7. Species excluded from the analysis in 2016 and 2017 because there were fewer than 15 recorded entries in the diary of they were caught by fewer than 4 diarists.

2016	2017
Anchovy	Black-mouthed Dogfish
Black-mouthed Dogfish	Blue Whiting
Bull Rout (short spined sea scorpion)	Bull Rout (short spined sea scorpion)
Common Skate	Four-bearded Rockling
Connemera Sucker (Clingfish)	Giant Goby
Greater Weever Fish	Greater Pipefish
Lemon Sole	John Dory
Leopard-spotted Goby	Lemon Sole
Lesser Sandeel	Leopard-spotted Goby
Monkfish (Anglerfish)	Long Rough Dab (American Plaice)
Porbeagle Shark	Megrim (Cornish Sole, Whiffy)
Red Mullet (Striped Mullet)	Norway Pout
Red Sea Bream	Pandora Sea Bream
Rock cook Wrasse	Pilchard
Rock Goby	Red Mullet (Striped Mullet)
Sand Goby	Red Sea Bream
Shad (twaite)	Salmon (North Atlantic Salmon)
Smelt (Small-scaled)	Sand Sole
Sprat (skipper)	Shad (twaite)
Vivaporous Blenny (eelpout)	Smelt (Small-scaled)
	Spanish Mackerel
	Starry Ray (Thorny Skate)
	Stingray (Common Stingray)
	Topknot
	Triggerfish
	Vivaporous Blenny (eelpout)
	White Sea Bream

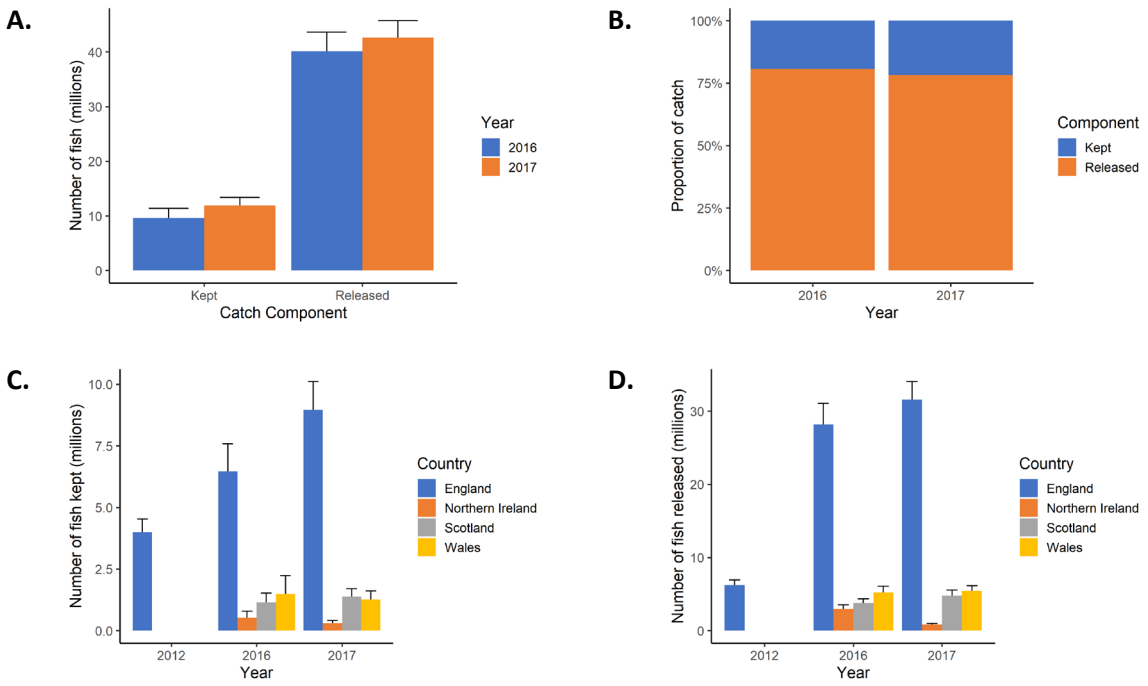

Figure 4. Numbers of fish kept and released (A) and release proportions (B) for the whole UK in 2016 and 2017 (A&B); and numbers of fish kept (C) and released (D) for individual countries within the UK in 2012, 2016 and 2017. The error bars represent standard errors.

In total, 100 fish species were caught by sea anglers in the UK in 2016 and 2017 varying from small unusual species (e.g. tompot blenny), common angling species (e.g. cod, bass, dab, whiting and mackerel) to large pelagic fish (e.g. blue shark). The composition of species in the catch was similar between 2016 and 2017 with the same top four most common species being whiting, mackerel, dogfish and bass (Figure 5). The next four most common species were cod, pollack, dab and bib, but appeared in a different in order in the two years (Figure 5). The composition of catches was similar for England in 2012 was similar to 2016 and 2017 although there were differences in the order.

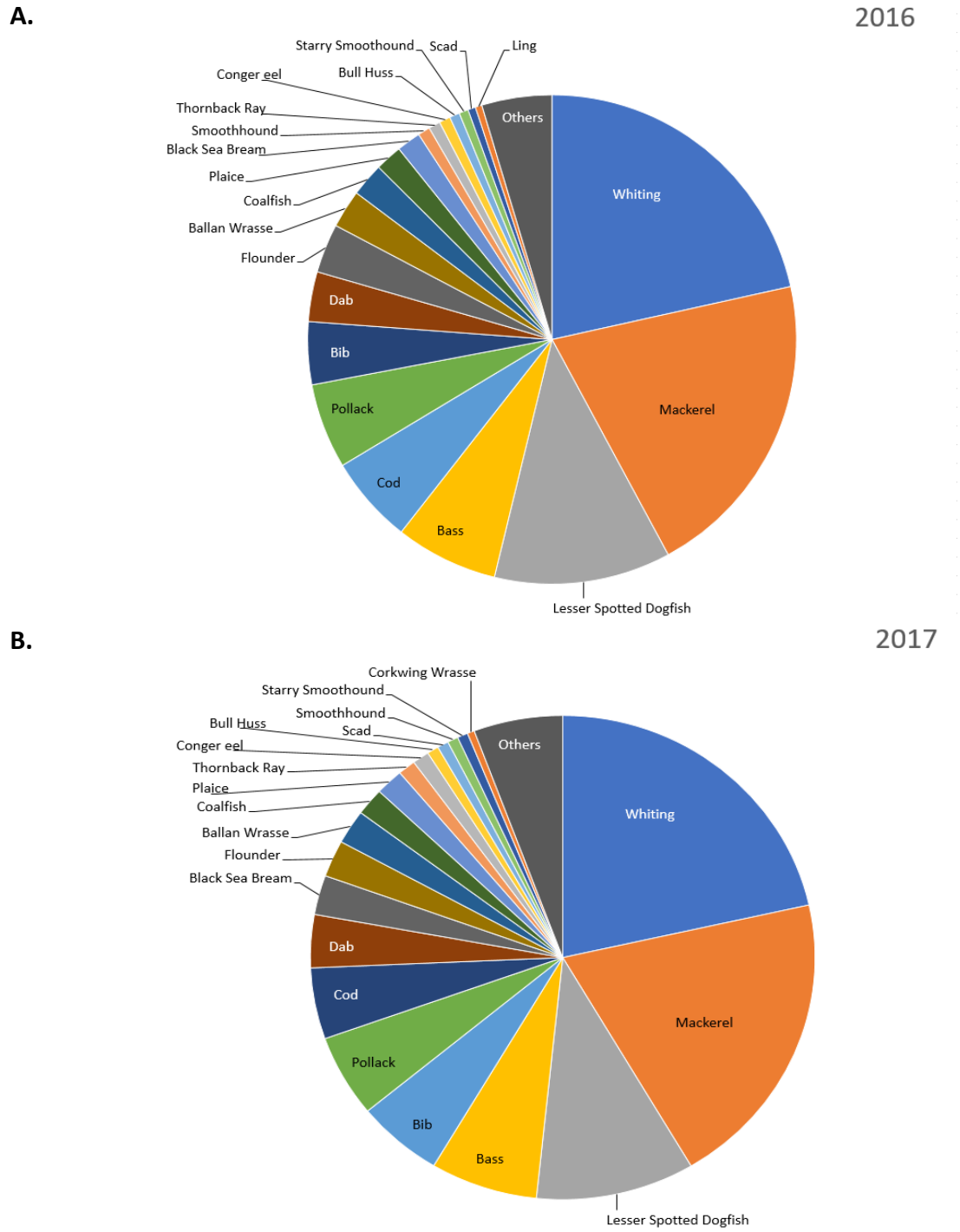

Figure 5. Catch composition by number for the UK in 2016 (A) and 2017 (B) with the top 20 most commonly caught fish displayed.

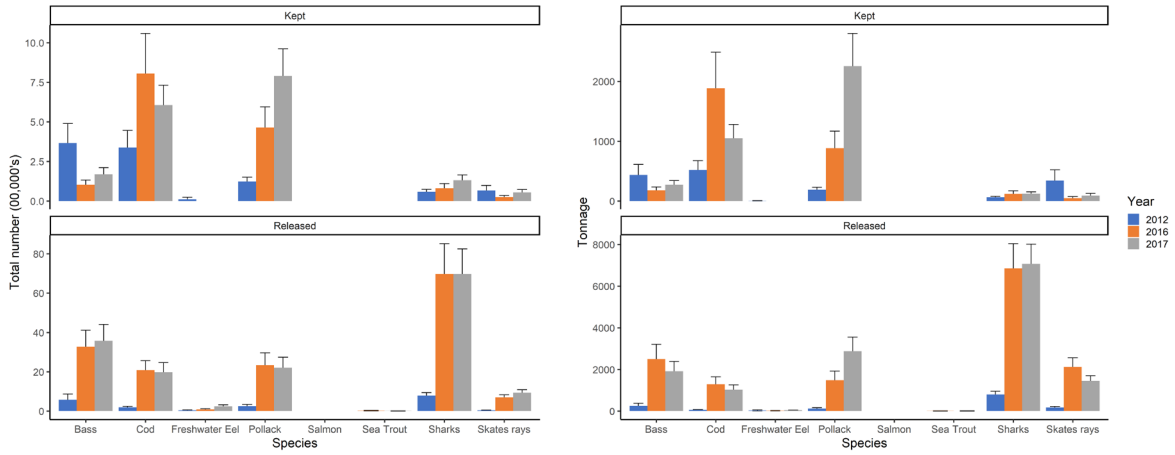

Figure 6. Numbers and tonnage of data collection framework species kept and released by sea anglers resident the UK in 2012, 2016 and 2017. The results for 2012 are for England only and error bar are standard errors.

For EU Data Collection Framework species (sea bass, cod, eel, pollack, salmon, sea trout, elasmobranchs and highly mobile ICCAT species (e.g. Atlantic Bluefin Tuna)), catches were similar in 2016 and 2017, apart from pollack and cod where the numbers and tonnage kept varied (Figure 6). There were minimal catches of eel, sea trout and salmon, but significant catches of sea bass, cod and pollack. The kept and released components of the catch were generally higher than in 2012, especially for the released component, with the exception of sea bass, which had bag limits and closed seasons in place from 2015 onwards.

3.3 Economic impact

There were 250 and 576 respondents to the economic surveys in 2016 and 2017, respectively (Table 8; Figure 7A). The average per trip expenditure was £75 in 2016 and £86 in 2017, with over £750 spent each year on capital items (Table 8; Figure 7B). Stratification approaches varied between years and was determined using a similar approach for catch and included trimming of three values (Section 2.2). The total expenditure was similar between years with anglers of 18 years or older spending £1.11 billion in 2016 and £1.32 billion 2017, with a roughly equal split between capital and trip spend (Table 8). After partitioning to different sectors and removing imports and taxes (Table 2; Table 3), the majority of the direct expenditure was in the wholesale/retail (mainly tackle and rods) in both years, followed by machinery/electronics (mainly boats and engines), furniture and other manufacturing (mainly rods), and hotels and restaurants (Table 9).

After removing imports and taxes, scaling up to the whole UK population left a direct expenditure of £696 in 2016 and £847 million in 2017 as an input to the IO analysis, with the majority acting on the retail and wholesale sectors (Table 10). In 2016, the total economic impact of sea angling was £1.58 billion, providing £326 million of GVA (direct) and supporting around 13,600 jobs (Table 10). The total was slightly higher in 2017, with a total economic impact of sea angling was £1.94 billion, providing £388 million of GVA (direct) and supporting around 16,300 jobs (Table 10).

Table 8. Response rates, last trip spend, and annual major item spend for 2016 and 2017. Raised total expenditure split into trip and capital. Standard errors are given in brackets.

		Average Expenditure		Total Expenditure (million GBP)		
Year	Responses	Last Trip	Capital	Trip	Capital	Total
2016	250	£75 (£20)	£772 (£136)	£517 (£139)	£591 (£104)	£1108 (£173)
2017	576	£86 (£22)	£841 (£145)	£682 (£173)	£637 (£110)	£1318 (£205)

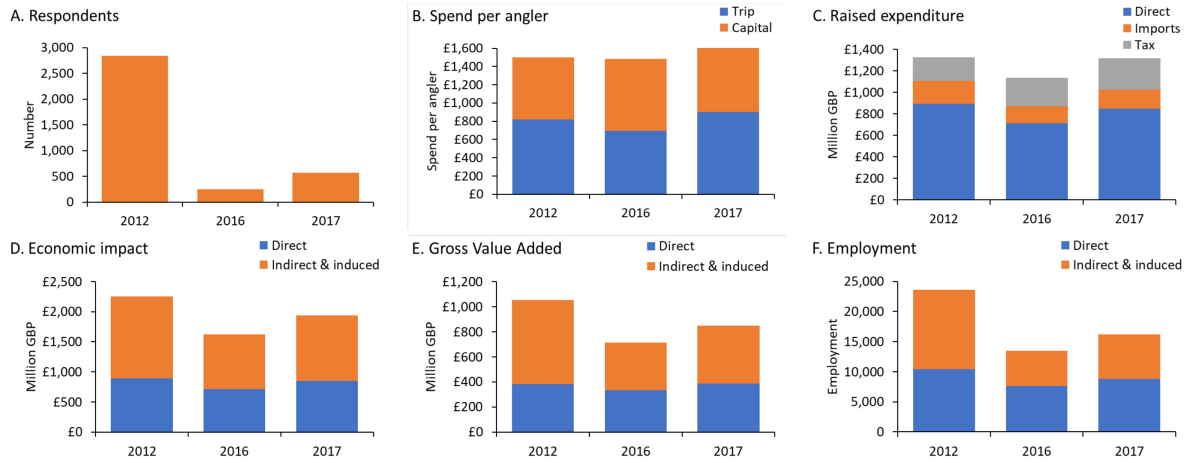

Figure 7. Comparison between the results from 2012, 2016 and 2017 for numbers of respondents (A), spend per angler (B), raised expenditure (C), economic impact (D), Gross Value Added (E) and employment (F). All values in GBP are presented in 2017 value. Figures for 2012 are for England only, 2016 and 2017 are for the whole of the UK.

Table 9. Total direct expenditure, imports, and taxes in millions provided by sea anglers in 2016 (raw and inflated to 2017 prices).

Industry	2016	2016 inflated	2017
Agriculture	£28 (£20-£37)	£29 (£20-£38)	£33 (£24-£42)
Food, drink and tobacco	£18 (£14-£23)	£19 (£15-£23)	£17 (£14-£21)
Textiles, clothing, footwear	£24 (£19-£28)	£24 (£20-£29)	£21 (£18-£25)
Wood, paper, publishing	£5 (£4-£6)	£5 (£4-£7)	£32 (£15-£50)
Coke and refined petroleum products	£28 (£21-£35)	£29 (£22-£36)	£32 (£25-£39)
Machinery, electronics	£83 (£57-£109)	£85 (£59-£112)	£110 (£75-£145)
Furniture and other manufacturing	£88 (£72-£104)	£90 (£74-£107)	£94 (£79-£109)
Wholesale/retail	£287 (£228-£346)	£295 (£234-£356)	£304 (£240-£369)
Hotels and restaurants	£70 (£49-£91)	£72 (£50-£93)	£74 (£54-£94)
Transport	£42 (£28-£55)	£43 (£29-£57)	£100 (£49-£152)
Other services	£23 (£18-£29)	£24 (£18-£30)	£29 (£20-£37)
Imports	£152 (£111-£193)	£156 (£114-£198)	£177 (£131-£224)
Fuel tax	£67 (£51-£83)	£68 (£52-£85)	£76 (£60-£92)
VAT	£193 (£147-£238)	£198 (£151-£245)	£218 (£164-£271)
Total	£1108 (£838-£1378)	£1137 (£861-£1414)	£1318 (£968-£1669)

Estimation of the total economic impact, GVA and jobs supported has been done for England in 2012 (Armstrong et al., 2013; Roberts et al., 2017) and for the UK in 2016 and 2017 in this study. The Harmonised Consumer Price Index was used to inflate the results from 2012 and 2016 to 2017 prices, so that a comparison could be made. In 2012, total economic impact of sea angling in England by anglers of 16 years or older was £2.1 billion, supporting 23,600 FTE jobs and £978 million of GVA (Armstrong et al., 2013; Roberts et al., 2017) (Figure 7C-F). The annual expenditure for each individual angler on trip and capital items each year was very similar ranging from £1,447 to £1,742, as was the split between trip and capital spend. There was little difference in the total expenditure ranging from £1.11 to £1.31 billion, but the direct expenditure was lower for 2016 and 2017 due to higher levels of tax and imports in 2016 (37%) and 2017 (36%) than in 2012 (33%) (Figure 7C-F). The largest differences were in the total economic impact, GVA, and jobs supported, with 2016 and 2017 lower than 2012 (Figure 7C-F). This was driven by several factors including spend profiles, ages, use of a different IO multiplier, and differences in taxes. Despite the differences with 2012, the results from 2016 and 2017 are reasonably consistent.

Table 10. Total economic impact (million GBP), employment, and Gross Value Added (GVA) create indifferent industrial sectors by direct, indirect and induced (Ind) expenditure by sea anglers in the UK in 2016 and 2017. Errors are provided in brackets.

A.2016	Spending/output £m			Employment (FTEs)			Gross Value Added		
Sectors	Direct	Ind.	Total	Direct	Ind.	Total	Direct	Ind.	Total
Agriculture, Forestry, fishing	£28 (£20-£37)	£49 (£35-£64)	£78 (£55-£100)	£249 (£175-£322)	£307 (£216-£397)	£555 (£392-£719)	£9 (£6-£11)	£20 (£14-£25)	£28 (£20-£37)
Food, drink, clothing	£42 (£34-£51)	£73 (£58-£88)	£115 (£92-£138)	£224 (£179-£269)	£469 (£375-£563)	£693 (£554-£832)	£13 (£10-£15)	£29 (£23-£35)	£42 (£34-£51)
Machinery, electronics, transport equipment	£83 (£57-£109)	£146 (£100-£192)	£229 (£157-£300)	£432 (£297-£566)	£836 (£575-£1097)	£1267 (£872-£1663)	£27 (£18-£35)	£56 (£39-£74)	£83 (£57-£109)
Other manufacturing, energy, construction	£121 (£96-£146)	£164 (£130-£198)	£285 (£226-£344)	£535 (£423-£647)	£913 (£724-£1101)	£1448 (£1147-£1748)	£51 (£41-£61)	£70 (£55-£85)	£121 (£96-£146)
Wholesale, retail, transport, accommodation and other services	£422 (£322-£522)	£448 (£341-£555)	£870 (£664-£1077)	£6211 (£4721-£7703)	£3419 (£2600-£4240)	£9630 (£7321-£11944)	£227 (£174-£279)	£195 (£149-£242)	£422 (£322-£522)
Total	£696 (£530-£863)	£880 (£665-£1097)	£1577 (£1194-£1960)	£7651 (£5795-£9508)	£5943 (£4490-£7398)	£13594 (£10286-£16906)	£326 (£249-£402)	£371 (£280-£462)	£696 (£530-£863)

B.2017	Spending/output £m			Employment (FTEs)			Gross Value Added		
Sectors	Direct	Ind.	Total	Direct	Ind.	Total	Direct	Ind.	Total
Agriculture, Forestry, fishing	£33 (£24-£42)	£58 (£42-£74)	£91 (£67-£116)	£292 (£214-£371)	£360 (£263-£458)	£653 (£477-£829)	£10 (£7-£13)	£23 (£17-£29)	£33 (£24-£42)
Food, drink, clothing	£39 (£32-£45)	£67 (£55-£78)	£105 (£87-£124)	£205 (£169-£241)	£429 (£353-£504)	£634 (£523-£745)	£12 (£10-£14)	£27 (£22-£32)	£39 (£32-£45)
Machinery, electronics, transport equipment	£110 (£75-£145)	£194 (£133-£255)	£304 (£208-£401)	£574 (£392-£755)	£1111 (£759-£1462)	£1684 (£1151-£2218)	£35 (£24-£46)	£75 (£51-£99)	£110 (£75-£145)
Other manufacturing, energy, construction	£158 (£118-£198)	£226 (£165-£287)	£384 (£283-£485)	£722 (£531-£913)	£1280 (£926-£1634)	£2002 (£1456-£2548)	£64 (£49-£78)	£94 (£69-£119)	£158 (£118-£198)
Wholesale, retail, transport, accommodation and other services	£507 (£363-£651)	£544 (£386-£702)	£1051 (£749-£1353)	£7126 (£5225-£9026)	£4214 (£2964-£5464)	£11340 (£8190-£14490)	£268 (£194-£342)	£239 (£169-£310)	£507 (£363-£651)
Total	£847 (£613-£1082)	£1089 (£781-£1396)	£1936 (£1393-£2478)	£8919 (£6531-£11307)	£7394 (£5266-£9522)	£16313 (£11797-£20829)	£388 (£284-£493)	£459 (£329-£589)	£847 (£613-£1082)

4 Discussion

4.1 Current survey

4.1.1 Participation, numbers, and effort

From 2015 to 2017, the numbers and participation rates in sea angling have remained relatively consistent over time according to the WPS. However, the small annual numbers of survey respondents that had been sea angling each year limits the precision of the participation estimates and the ability to post-stratify and reweight the diary panel to make it more representative of the population in terms of demography, avidity or other characteristics that affect angling catches. Increasing the level of sampling in the WPS would increase the precision for individual regions and demographic categories, but is unlikely to be implemented due to the additional cost given that questions on sea angling are only a small part of the survey. An alternative approach being considered is to combine WPS estimates over a series of years on either side of a diary panel year to increase the sample size available for post-stratification. This would provide more robust results depending on the extent of any trends over time in variables of interest.

As the first online angling diary of its kind in the UK, recruitment for the Sea Angling 2016 diary panel was slower than in 2017, and the survey initially attracted the more avid anglers and those aged between 34 and 64. Recruitment for the 2017 panel was both more intensive and spread over a longer time period, and so reached more people. Recruitment methods were adapted to address some imbalances in the 2016 sample, particularly the over-representation of older and more avid anglers, and geographic imbalance. An additional approach targeting anglers face-to-face in the summer months of 2017 increased the recruitment of less avid anglers. More effort was also spent on recruiting sea anglers resident in Wales, Northern Ireland, and Scotland, to provide more robust estimates for these countries.

As the sea angling surveys continue in future years, and the sample size increases, the aim is to continue to improve the balance of diarists across the avidity, region and age categories, and reduce potential biases in the results. New ways of recruiting diarists to the panel will be needed as a large number of diarists are lost each year due to survey fatigue. Additional support from the angling community is needed to increase participation. Completion rates were a challenge, with many diarists not providing full data sets. New approaches are being developed to reduce the reporting burden and make it as simple as possible to report catches, which will decrease drop out rates. These include alternate contact methods (e.g. texts) and direct data entry (e.g. Smartphone Apps). Finally, further functionality is being built into the system that will encourage anglers to provide data, such as adapting the current system to include catch sharing.

4.1.2 Catches and releases

Total annual catches by sea anglers resident in the UK in 2016 and 2017 were estimated by multiplying the mean annual catch of each species per angler in the diary panel by the total numbers of people who went sea angling in those years estimated by the UK-wide WPS. Despite analytical approaches being well understood for angling surveys (Jones and Pollock, 2013; Pollock et al., 1994), there are still challenges during the analysis of results that need to be resolved. For example, for rarer species, the

numbers of anglers reporting catches, and the numbers and sizes of fish they have caught, are often insufficient to allow robust estimation of raised nation-wide catch numbers or catch weight. In this study, quantitative estimates of catch numbers were only provided for species with at least four diarists reporting 15 catch records, and catch weights were provided only if more than five people recorded over 50 individual fish lengths. This was considered reasonable after testing a range of thresholds, but requires further evaluation as more years of data are collected.

Sufficient data were available to provide raised estimates of total UK numbers caught for 68 individual species and tonnage for 32 species over the two years. The total number of fish kept or released was 49.7 million in 2016 and 54.5 million in 2017, with a release rate of around 80%. Release rates varied widely across species. The majority of catches were by English sea anglers, due to the large proportion of UK sea anglers resident in England. For species specified in the DCF for mandatory recording of recreational catches, catches were minimal for diadromous species, but comparatively high for cod, bass, and pollack. The distribution of catches between UK countries and ICES sea areas were as expected with more sea bass being caught by English anglers in the South West and a relatively even spatial distribution for cod. Released fish were smaller on average than kept fish.

4.1.3 Economic impact

The total economic impact of sea angling in 2016 was estimated to be £1.58 billion, providing £326 million of GVA (direct) and supporting around 13,600 jobs. Estimates were slightly higher in 2017, with a total economic impact of sea angling of £1.94 billion, providing £388 million of GVA (direct) and supporting around 16,300 jobs. Based on the Sea Angling 2012 surveys, UK sea anglers have the largest estimates of direct expenditure in Europe and are comparable with France and Norway (Hyder et al., 2018). A reasonable precision was attained for estimates of expenditure in 2016 and 2017, with relative standard errors (standard error divided by the estimate for a variable) around 30% in most cases. In addition, lower and upper bounds on the estimates of expenditure have been used to capture some of the error in the IO methods. However, this does not capture the errors in the IO methodology completely, so is likely to overestimate the precision of the estimates. This is not easy to resolve as errors are not provided for the supply and use tables. Increased sampling would increase the precision, but this has an associated cost, so this should be considered based on the use of the data. As with the catch estimates, other potential sources of bias including recall, avidity, coverage, and non-response which may influence the results (see Pollock et al., 1994; ICES, 2010).

4.1.4 Potential bias

All approaches for collecting data on sea angling are subject to error, due to the varied and dispersed nature of the activity. There will be uncertainty in the UK estimates of participation, effort, and expenditure. This arises from two sources: measurement error (precision) and biases from issues with design and implementation of each survey and methods used for extrapolation (Pollock et al. 1994; ICES 2010; Jones and Pollack, 2013). Whilst diary surveys have been shown to represent good value for money and are used in many countries (Bellanger and Levrel, 2017), they are subject to a larger set of biases than on-site approaches (Jones and Pollack, 2013).

Ideally, a diary panel should be a picked at random from a population of sea anglers to ensure it is as representative as possible. This is very difficult as there is no complete list of sea anglers in the UK (e.g. a fishing licence or other registration system). Randomised telephone or postal surveys can be

used for estimating fishing effort as well as recruiting people to the diary panel, but can have low response rates. It was therefore decided to use a self-selected sample of volunteers from a list of sea anglers who had participated in a range of previous surveys and from respondents to various media campaigns. The composition of the final panels in 2016 and 2017 differed from the respondents to the WPS surveys, particularly in relation to avidity, which was lower on average in the WPS. Different approaches were tried to increase participation by those who fish rarely including face-to-face recruitment, but this remained a challenge.

Several different methods for post-stratification were tested to reweight the diary panel to reflect the population in terms of avidity, age, or sea angling method. However, this does not fully remove bias, which must be taken into consideration when the data are used. Many factors have been shown to influence catch rates of anglers, such as motivations for participation (Arlinghaus, 2006; Beardmore et al., 2011; Fedler and Ditton, 1994). For example, fishers motivated by catching fish to eat will have lower release rates than those who fish for sport (Beardmore et al., 2011). If anglers who are more motivated or skilled are more likely to volunteer for surveys, this would increase the potential for over-estimating the average catch rates in the population based on catch diaries as these characteristics are not currently recorded in the WPS and the diary panel. Understanding any residual bias that has not been corrected in the current survey would highlight how best to use this survey to support decision making. Additional data collection has been added to the 2019 survey to collect data to assess the level of residual bias.

4.2 Comparison with previous surveys

An extensive sea angling survey programme was conducted across England in 2012 (Armstrong et al., 2013), and provided estimates of participation, catches and expenditure that can be directly compared with the results of the 2016 and 2017 surveys using data for England only. The 2012 and 2016 onwards surveys both used similar-designed nationwide population surveys to estimate fishing effort. The main difference was the use of on-site surveys in 2012 to collect catch data directly from anglers whilst fishing or landing their boats. The on-site method used in the 2012 study reduces several sources of bias present in the present study for the kept component of the catch, such as rounding, prestige bias and species misidentification, due to the presence of a trained observer. Attempts were made in 2016 and 2017 to reduce these errors by providing a notebook, measuring tape, and species identification guide. On-site surveys have many issues including the need to recall numbers and sizes of fish released before the interview and partial trip data for shore anglers interviewed whilst fishing. A correction was made to account for partial trip data in 2012, but the method may have had some bias. Biased recall of releases if an observer was not present may have partially accounted for the greater release rates observed in the 2016-17 studies. The estimated participation rate during 2012 was slightly higher than in the later surveys (2.2% for Great Britain in 2012 compared with 1.7% for the UK in 2016 and 2017), though the demographic split was similar. However, there is uncertainty in the number of people participating in recreational sea angling from the WPS and the 2012 ONS survey, so was unlikely to represent an actual change in participation rates.

4.2.1 Catches and releases

Catches estimated from the surveys in 2016 and 2017 were consistently higher in England than from the on-site survey of England in 2012, particularly for released fish, despite the overall composition of

catches being similar (Armstrong et al., 2013). It is unlikely for this to be only a result of random sampling error in estimates of catch rates obtained from the on-site and diary surveys, as the differences were observed over many species. Three potential reasons for these differences are: 1) the true total catches of many species increased substantially between 2012 and 2016; 2) annual fishing effort or numbers of anglers (needed for raising catch rate estimates of all species to total annual catches), were under- or overestimated due to random sampling error in the nationwide population surveys; and 3) there were different types and extent of bias associated with the design and implementation of the on-site surveys in 2012 and the diary surveys in later years. As the 2012 data are for only one year and used different survey methods, it has not been possible to determine the extent to which the increased catch estimates are due to survey bias, random sampling error or changes in fish abundance. It is likely that a combination of these factors generated the differences.

Biases inherent in the design in the implementation of the surveys are a possible source of the difference in catch estimates between years. Several important sources of bias in the 2012 surveys are recognised – these include recall of shore and boat fishing effort by ONS survey respondents; recall of data on released fish by anglers interviewed on-site or by charter skippers; areas of coast excluded from the sampling frame; extrapolation of daily shore catches for anglers interviewed part way through their trip; length-of-stay bias due to shore anglers fishing for longer periods of the day being more likely to be interviewed (a method was developed to try and correct for this); restriction of on-shore sampling to dawn to dusk only, and refusals by some charter skippers to participate. In 2016-17, a self-selected diary panel was used, and bias was corrected when estimating catch and expenditure for all sea anglers in the UK. It is likely that sea anglers that complete a diary may be more experienced or specialised than the general population, and this might affect their catches and expenditure. Those who fish rarely are less likely to be included in our surveys. Different approaches were tested to reweight the panel to be more representative of the population in terms of avidity, age, or sea angling platform. The different potential bias structures created by the different survey instruments make the results from the two surveys difficult to compare.

It was possible that catches have changed significantly over the period, as sea angling catches will fluctuate in response to changes in fish abundance. For example, time series from Germany have shown large variation in catch rates between years (Strehlow et al., 2012). Whilst it is expected that that catches vary between years, the differences in the present studies between 2012 and 2016 or 2017 were larger over a wide range of species than the differences between 2016 and 2017, indicating that this was unlikely to account for all this difference. In addition, angling surveys elsewhere show how different survey techniques can lead to greatly varying results. Differences between two and 50% have been found between harvest estimates from on-site and off-site surveys in New Zealand, with the largest differences for the rarest species (Hartill et al., 2015). The main causes were underestimates of effort at boat ramps and non-reporting of zero catches (Hartill et al., 2015). This only included the harvested component which was most similar in this study, and no comparisons exist of the released component. To assess this robustly would need side-by-side on-site (creel) and off-site (diary) surveys in the same year, so should be considered in future.

4.2.2 Economic impact

Despite using different methods, comparison with 2012 surveys showed similar per angler expenditure, but lower total economic impact, GVA and employment in 2016 and 2017 (Armstrong et

al., 2013; Roberts et al., 2017). The economics surveys for Sea Angling 2012 covered only England, compared with the whole of the UK in 2016 and 2017. Similar results were found in this study to a 2003 survey of England and Wales that found a direct expenditure of £737 million when raised to 2017 prices, but more jobs were supported in 2003 (Drew, 2004). There are a number of potential reasons for the observed differences, relating to the underlying data, methods for collection, difference in the industrial structure at the time of the study, and the analysis approach. A higher number of anglers and participation rate was found in 2012 (2.2% for Great Britain only) than 2016 or 2017 (1.6% for the United Kingdom). This led to slightly lower levels of expenditure despite similar levels of spend for each angler. There are also differences in the levels of taxes between 2012 and the period analysed in this study (2016, 2017) due to changes in the tax regulations, import fractions, and spending patterns of the respondents between expenditure categories. Respondents in 2016 and 2017 reported less spending on accommodation and more for fuel, leading to higher levels of taxes. In addition, due to changes in prices for baits, it was assumed in this study that more bait was sourced from wholesale/retail sectors than specialised bait shops compared with 2012, hence a different approach for partitioning the bait spending was applied. The fraction of imports was adapted based on the proportion of imports in the whole sector inputs. This led to lower levels of direct expenditure in 2016 (£696 million) and 2017 (£847 million) than 2012 (£895 million).

A different supply and use table was used for 2016 and 2017 than in 2012, in order to be applicable to the whole UK and to use more recent national data. This resulted in different output multipliers for the total economic impact, GVA, and employment. In contrast to 2012, inflation was not included in the impact of the spending as the same year was considered in the analysis for spending and economic impact of the spending. Finally, the calculation of the indirect/induced impact of the spending was restricted to the sectors which are assumed to receive direct spending. Despite all these differences, the expenditure results are similar in 2003, 2012, 2016 and 2017.

4.3 Further work

This report provides information from the first two years of the diary surveys, and further recruitment in coming years is expected to increase the sample size and representation of different avidity groups and regions of the UK. More years of catch data will allow trends in catches to be seen, and any responses to management measures identified. To monitor changes in marine recreational fishing and to support future development of sea angling, diary panels should continue to be used to collect data on UK activity. These could be supplemented by on-site surveys or other methods, to add further information and to reach a different sample of anglers. There are a number of key areas of further work needed to develop the current approach and understand how best to use the data to support decision making. Some of which are already underway, but others would require further funding to progress. These are described below under the themes of data collection and analysis, improving the precision of estimates, understanding bias, and additional data requirements for decision making.

Increasing the size of the diary panel and the completion rates by diarists are key to improving data collection. New approaches are needed to recruit new diarists, as a significant number are lost each year due to survey fatigue. This will become more challenging each year as more anglers have already been part of the panel. Support from the angling community would be useful to increase participation, alongside the ability to publicise to new lists of anglers (e.g. freshwater angling licence holders). In addition, many diarists do not enter data for all months restricting the number of diarists that can be

used in the analysis. Improving the experience of diarists through the development of the diary system is likely to increase completion rates and improve data quality. A number of significant improvements have been made to increase the utility of the system to sea anglers including app-based data entry and the ability to share catches. Technology can be used to increase the accuracy of the results, such as mobile phone apps which are used to record data in real-time (Venturelli et al., 2017), reducing the recall bias which exists when fishers enter data after a fishing session has finished. Other valuable information can also be collected from apps such as location and duration automatically, reducing the time demands on survey participants. Further development to the app-based data entry is needed to fully realise the potential of this approach. Once the data have been collected, there are a number of different statistical analyses that could be done. The traditional analytical approach for these surveys that uses post-stratification is complex and inefficient. An alternate approach that could be tested in future is to use statistical models.

Improving the precision of the estimates can be done through increasing the sample sizes in the WPS and the diary panel (see above). The limited number of sea anglers interviewed in the WPS restrict the numbers of strata that can be used in raising and generate a significant proportion of the overall error. There are two potential solutions: combine data from a number of years or increase the WPS sample size. Combining years of the WPS is reasonable as participation rates are unlikely to vary much over a short period, so this will be tested in the analysis of future surveys. However, a large bespoke survey would be the most robust way of increasing precision, but this would require significant additional resource to implement.

Given the differences between the catch estimated in this survey (especially the released component) and results from the on-site survey in 2012, it would be useful to understand the potential biases in each of the surveys. Understanding the residual bias that has not been corrected in the current survey would demonstrate how best to use the data to support decision making. There are a number of approaches for this that vary in cost. Firstly, questions about skill and experience have been added to the WPS in 2019 that can be used to understand the drivers for catch rate and included in the raising to correct for bias. Secondly, a small probability-based survey has been implemented in 2019 involving randomised mailshot to recruit diarists. Differences in catches between the random sample and the existing diary panel will be used to assess and correct for bias due to self-selection. The most robust way to understand the level of bias would be to do a side-by-side comparison between on-site (diary) and off-site (creel) in the same year that includes both the retained and release components of the catch. A similar approach is used in other parts of the world (e.g. Western Australia), where diary surveys are run annually with an on-site creel survey done every five years for comparison. This approach will generate times series needed for stock assessment, so regular (annual) consistent data collection is required to capture trends in sea angling catches (Hyder et al., 2017; 2018).

To maximise the benefit generated by sea angling and support its future development and policy, additional data are required on economic and social benefits. Economic data collection can be challenging and should be targeted based on the questions that need to be addressed. A different approach is needed to assess the demand for sea angling and the changes in the demand due to competing management measures. This is much more complex, requiring a mixture of stated and revealed preference methods to estimate a robust economic value and to model trade-offs when making choices. More research is also needed to develop methods that account for social, economic, and biological trade-offs in the allocation of fisheries resources to support decision-making.

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[8] http://www.cefas.co.uk
[9] http://www.substance.net

6 References

Aas, Ø., Vittersø, J. 2000. Re-examining the consumptiveness concept: Some suggestions from a confirmatory factor analysis, Human Dimensions of Wildlife, 5:4.

Arlinghaus, R., 2006. On the Apparently Striking Disconnect between Motivation and Satisfaction in Recreational Fishing: The Case of Catch Orientation of German Anglers. N. Am. J. Fish. Manag. 26, 592–605.

Arlinghaus, R., Tillner, R., & Bork, M., 2015. Explaining participation rates in recreational fishing across industrialised countries. Fish. Manag. Ecol. 22, 45–55.

Armstrong, M., Brown, A., Hargreaves, J., Hyder, K., Munday, M., Proctor, S., Roberts, A., Roche, N., Williamson, K., 2013. Sea Angling 2012 – a survey of recreational sea angling activity and economic value in England. Defra, London, UK. 16pp.

Beardmore, B., Haider, W., Hunt, L.M., Arlinghaus, R., 2011. The Importance of Trip Context for Determining Primary Angler Motivations: Are More Specialized Anglers More Catch-Oriented than Previously Believed? N. Am. J. Fish. Manag. 31, 861–879.

Bellanger, M., Levrel, H., 2017. A cost-effectiveness analysis of alternative survey methods used for the monitoring of marine recreational fishing in France. Ocean Coast. Manag. 138, 19–28.

Cooke, S.J., Cowx, I.G., 2004. The role of recreational fishing in global fish crises. BioScience 54, 857–859.

Cooke, S.J., Twardek, W.M., Lennox, R.J., Zolderdo, A.J., Bower, S.D., Gutowsky, L.F.G., Danylchuk, A.J., Arlinghaus, R., Beard, D., 2018. The nexus of fun and nutrition: Recreational fishing is also about food. Fish. 19, 201–224.

Drew, 2004. Research into the economic contribution of sea angling. Drew Associates Ltd, London, UK. 71pp.

Edwards, S.F., 1989. Forecasts of In-state Participation in Marine Recreational Fishing. Trans. Am. Fish. Soc. 118, 564–572.

EFTEC, 2015. Comparing Industry Sector Values, With a Case Study of Commercial Fishing and Recreational Sea Angling. EFTEC, London, UK. 67pp.

EU, 2009. Council Regulation (EC) No. 1224/ 2009 of 20 November 2009 Establishing a Community control system for ensuring compliance with the rules of the Common Fisheries Policy, amending Regulations (EC) No. 847/96, (EC) No 2371/2002, (EC) No. 811/2004, (EC) No. Off. J. Eur. Union L343, 1–50.

Fedler, A.J., Ditton, R.B., 1994. Understanding Angler Motivations in Fisheries Management. Fisheries 19, 6–13.

Ferter, K., Weltersbach, M. S., Strehlow, H. V., Volstad, J. H., Alos, J., Arlinghaus, R., Armstrong, M., Dorow, M., de Graaf, M., van der Hammen, T., Hyder, K., Levrel, H., Paulrud, A., Radtke, K.,

Rocklin, D., Sparrevohn, C.R., Veiga, P., 2013. Unexpectedly high catch-and-release rates in European marine recreational fisheries: implications for science and management. ICES J. Mar. Sci. 70, 1319–1329.

Gordon, H.S. 1954. The Economic Theory of a Common-Property Resource: J. Polit. Econ. 62, 124–142.

Griffiths, S.P., Bryant, J., Raymond, H.F., & Newcombe, P.A., 2017. Quantifying subjective human dimensions of recreational fishing: does good health come to those who bait? Fish. 18, 171–184.

Hardin, G. 1968. The Tragedy of the Commons. Science, 162, 1243–1248.

Hartill, B.W., Edwards, C.T.T., Jacobson, L., 2015. Comparison of recreational harvest estimates provided by onsite and offsite surveys: detecting bias and corroborating estimates. Can. J. Fish. Aquat. Sci. 72, 1379–1389.

Heberlein, T.A., Ericsson, G., Wollscheid, K.U., 2002. Correlates of hunting participation in Europe and North America. Z. Jagdwiss. 48, 320–326.

Hyder, K., Armstrong, M., Ferter, K., Strehlow, H.V., 2014. Recreational sea fishing – the high value forgotten catch. ICES INSIGHT 51, 8–15.

Hyder, K., Radford, Z., Prellezo, R., Weltersbach, M.S., Lewin, W.-C., Zarauz, L., Ferter, K., Ruiz, J., Townhill, B., Mugerza, E., Strehlow, H. V, 2017. Research for PECH Committee - Marine recreational and semi-subsistence fishing - its value and its impact on fish stocks. European Parliament, Policy Department for Structural and Cohesion Policies, Brussels, 134pp.

Hyder, K., Weltersbach, M.S., Armstrong, M., Ferter, K., Townhill, B., Ahvonen, A., Arlinghaus, R., Baikov, A., Bellanger, M., Birzaks, J., Borch, T., Cambie, G., de Graaf, M., Diogo, H.M.C., Dziemian, Ł., Gordoa, A., Grzebielec, R., Hartill, B., Kagervall, A., Kapiris, K., Karlsson, M., Kleiven, A.R., Lejk, A.M., Levrel, H., Lovell, S., Lyle, J., Moilanen, P., Monkman, G., Morales-Nin, B., Mugerza, E., Martinez, R., O'Reilly, P., Olesen, H.J., Papadopoulos, A., Pita, P., Radford, Z., Radtke, K., Roche, W., Rocklin, D., Ruiz, J., Scougal, C., Silvestri, R., Skov, C., Steinback, S., Sundelöf, A., Svagzdys, A., Turnbull, D., van der Hammen, T., van Voorhees, D., van Winsen, F., Verleye, T., Veiga, P., Vølstad, J.-H., Zarauz, L., Zolubas, T., Strehlow, H. V, 2018. Recreational sea fishing in Europe in a global context-Participation rates, fishing effort, expenditure, and implications for monitoring and assessment. Fish Fish. 19, 225–243.

ICES, 2010. Report of the Planning Group on Recreational Fisheries (PGRFS). ICES CM 2010/ACOM:34. ICES, Copenhagen, Denmark. 162pp.

ICES, 2013. Report of the Working Group on Recreational Fisheries Surveys (WGRFS). ICES CM 2013/ACOM:23. ICES, Copenhagen, Denmark. 45pp.

ICES, 2015. Report of the Working Group on Recreational Fisheries Surveys (WGRFS). ICES CM 2015\SSGIEOM:10. ICES, Copenhagen, Denmark. 111pp.

ICES, 2017. ICES WGRFS Report 2017. Report of the Working Group on Recreational Fisheries Surveys (WGRFS). ICES CM 2017/EOSG:20. ICES, Copenhagen, Denmark. 113pp.

ICES, 2018. Report from the Working Group on Recreational Fisheries Surveys (WGRFS). ICESCM 2018/EOSG:19. ICES, Copenhagen, Denmark. 109pp.

Jones, M., Pollock, K.H., 2013. Recreational Angler Survey Methods: Estimation of Effort, Harvest, and Released Catch. In: Zale, A.V., Parrish, D.L., Sutton, T.M. (Eds.), Fisheries Techniques. American Fisheries Society, Bethesda, Md., American Fisheries Society, Bethesda, Md., pp. 883–919.

Kerns, J.A., Allen, M.S., Harris, J.E., 2012. Importance of assessing population-level impact of catch-and-release mortality. Fisheries 37, 502–503.

Kowalewski, J., 2009. Methodology of the input-output analysis, HWWI Research Paper No 1-25. HWWI Institute of International Economics, Hamburg, Germany. 35pp.

Lawrence, K.S., 2005. Assessing the value of recreational sea angling in South West England. Fish. Manag. Ecol. 12, 369–375.

Lewin, W.C., Arlinghaus, R., Mehner, T., 2006. Documented and potential biological impacts of recreational fishing: Insights for management and conservation. Rev. Fish. Sci. Aquac. 14, 305–367.

Lewin, W.-C., Weltersbach, M.S., Ferter, K., Hyder, K., Mugerza, E., Prellezo, R., Zarauz, L., Strehlow, H.V., 2019. Potential Environmental Impacts of Recreational Fishing on Marine Fish Stocks and Ecosystems. Rev. Fish. Sci. Aquac. 27, 287–330.

McManus, A., Storey, J., White, J., 2011. Identifying the health and well-being benefits of recreational fishing Identifying the health and well-being benefits of recreational fishing (FRDC Project Number: 2011/217). Fisheries Research and Development Corporation and the Centre of Excellence for Science, Seafood and Health; Curtin Health Innovation Research Institute; Curtin University, Australia. 64pp.

McMinn, C., 2013. Report on the Survey of Recreational Sea Angling in Northern Ireland. AFBI Fisheries and Aquatic Ecosystems Branch, Belfast, Northern Ireland. 60pp.

Monkman, G., Cambie, G., Hyder, K., Armstrong, M., Roberts, A., Kaiser, M.J., 2015. Socioeconomic and Spatial Review of Recreational Sea Angling in Wales. Fisheries and Conservation Report No. 52, Bangor University, Wales. 176pp.

NOAA, 2015. National Saltwater Recreational Fisheries Policy, NOAA's National Marine Fisheries Service, Silver Spring, USA, 8 pp.

Pollock, K.H., Jones, C.M., Brown, T.L., 1994. Angler surveys and their application to fisheries management. American Fisheries Society, Special Publication 25, Bethesda, Maryland.

Poudel, J., Munn, I.A., Henderson, J.E., 2018. An input-output analysis of recreational fishing expenditures (2006 & 2011) across the southern United States. Int. J. Environ. Stud. 75, 650–672.

Radford, A., Riddington, G., 2009. Economic Impact of Recreational Sea Angling in Scotland. Scottish Government, Edinburgh, UK. 259pp.

Radford, Z., Hyder, K., Zarauz, L., Mugerza, E., Ferter, K., Prellezo, R., Strehlow, H.V., Townhill, B., Lewin, W.-C., Weltersbach, M.S., 2018. The impact of marine recreational fishing on key fish stocks in European waters. PLoS One 13, e0201666.

Roberts, A., Munday, M., Roche, N., Brown, A., Armstrong, M., Hargreaves, J., Pilgrim-Morrison, S., Williamson, K., Hyder, K., 2017. Assessing the contribution of recreational sea angling to the English economy. Mar. Policy 83, 146–152.

Ryan, K.L., Trinnie, F.I., Jones, R., Hart, A.M., Wise, B.S., 2016. Recreational fisheries data requirements for monitoring catch shares. Fisheries Management and Ecology 23, 218–233.

Silva, J.F., Ellis, J.R., Ayers, R.A., 2013. Length-weight relationships of marine fish collected from around the British Isles. Cefas Science Series Technical Report 150. Lowestoft, UK. 109 pp.

Simpson, D., Mawle, G.W., 2005. Public Attitudes to Angling 2005. A survey of attitudes and participation in England & Wales. Environment Agency, Bristol, UK. 62pp.

Simpson, D., Mawle, G.W., 2010. Public Attitudes to Angling 2010. A survey of attitudes and participation in England & Wales. Environment Agency, Bristol, UK. 67pp.

Strehlow, H. V., Schultz, N., Zimmermann, C., Hammer, C., 2012. Cod catches taken by the German recreational fishery in the western Baltic Sea, 2005-2010: implications for stock assessment and management. ICES J. Mar. Sci. 69, 1769–1780.

Toivonen, A.-L., Roth, E., Navrud, S., Gudbergsson, G., Appelblad, H., Bengtsson, B., Tuunainen, P., 2004. The economic value of recreational fisheries in Nordic countries. Fish. Manag. Ecol. 11, 1–14.

Venturelli, P.A., Hyder, K., Skov, C., 2017. Angler apps as a source of recreational fisheries data: opportunities, challenges and proposed standards. Fish Fish. 18, 578–595.

Williams, C., Carpenter, G., Clark, R., O'Leary, B.C., 2018. Who gets to fish for sea bass? Using social, economic, and environmental criteria to determine access to the English sea bass fishery. Mar. Pol. 95, 199-208.

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