Centre for Environment Fisheries & Aquaculture Science

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

Annex 3. Estimating the total economic impact, gross value added, and numbers of jobs supported by sea anglers resident in the UK in 2016 and 2017

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Executive Summary

In Europe, marine recreational fishing (MRF) can impact fish stocks, but it has also been shown to have important economic and social benefits. Economic data are needed to support the development of MRF and decisions on the allocation of fisheries resources. In this study, the total economic impact, Gross Value Added (GVA), and employment supported by sea angling in the UK in 2016 and 2017 were estimated using an Input-Output method. Expenditure on trips and major items (capital) was collected from a sample of sea anglers and raised to the total population using information from a national survey of sea angling participation. Taxes were removed, and expenditure partitioned between industrial sectors accounting for imports. Expenditure on trips and major items (capital) could be used from 250 sea anglers in 2016 and 576 in 2017, and raised to the total population giving an annual expenditure of £1.11 billion in 2016 and £1.32 billion 2017. This led to a direct impact after removal of taxes and imports of £696 million generating £326 million GVA and supporting over 7600 full time equivalent jobs (FTEs) in 2016, and £847 million direct impact, £388 million GVA and over 8900 FTEs in 2017. The total economic impact – including direct, indirect, and induced impacts - was estimated to be £1.57 billion, providing £696 million of GVA and supporting in total over 13500 FTEs in 2016 and was £1.94 billion, providing £847 million of GVA and supporting around 16300 jobs in 2017. Comparison with 2012 surveys showed similar per angler expenditure, but lower total economic impact, GVA, and employment in 2016 and 2017. This was due differences in data, methods for collection, and analytical approaches. There may still be bias in the results as it was not possible to correct for angler experience and specialisation, but given the similarity to previous studies, the results are likely to be robust. Further potential work is highlighted which could help to reduce uncertainty and broaden the utility of the data collected.

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1 Introduction

There are many approaches to estimate the economic value of an activity or sector (EFTEC, 2015; Parkkila et al., 2010) but 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; 2018; Monkman et al., 2015; Roberts et al., 2017). Different approaches are needed depending on the question being asked, and range from the non-market benefits to society to the impact that MRF has on a given economy (ICES, 2018).

From a social welfare perspective, the economic value of a good in the absence of a market price is created by the use and non-use values provided by a good or service to an economic agent (Perman et al., 2011; Tietenberg and Lewis, 2012). To capture the use and non-use value of recreational fishing and how this might change under different management scenarios, willingness-to-pay (WTP) studies are usually applied (EFTEC, 2015; Parkkila et al., 2010). WTP values are generally estimated using revealed preference or stated preference valuation methods (EFTEC, 2015; Parkkila et al., 2010). Revealed preference methods use information about observed behaviour to infer the demand for and value of MRF experiences (e.g. travel cost models - Bockstael et al., 1989; Prayaga et al., 2010). Conversely, stated preferences WTP studies quantify individual perceived values of an activity through survey responses (e.g. choice experiments - ICES, 2018; Lew and Larson, 2014, 2015).

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). 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 1675 jobs (out of 3148) and £37 million annual income (out of £70 million) which presents about 53% of the economic impact created.

In IO methods, multipliers are created based on the existing industry structure to measure the potential impact of an increase in industrial activity in one sector on the direct output of the sector, the indirect and induced effects, the employment (direct, indirect and induced), and the Gross Value Added (GVA) due to this change in industrial activity (Kowalewski, 2009). If there is an increase in final use for a particular industry output, it is assumed that there will be an increase in the output of that industry, as producers react to meet the increased use; this is the direct effect. As these producers increase their output, there will also be an increase in use of their suppliers and the supply chain, known as the indirect effect. As a result of the direct and indirect effects the level of household income throughout the economy will increase due to increased employment. A proportion of this increased income will be spent on final goods and services and this is known as the induced effect. The direct, indirect, and induced effects are summed to get the total economic impact of an activity. This approach has been used to estimate the economic impact of MRF (Armstrong et al., 2013; Hyder et al., 2017; Poudel et al., 2018; Roberts et al., 2017).

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 this spending supported nearly 19000 jobs directly and £71 million of supplier income (Drew, 2004). In south west England in 2004, it was estimated that 240900 residents and 600000 visitors were active sea-anglers and spent £165 million (Lawrence, 2005). The impact of sea angling in Scotland in 2009 was £70 million and supported 3148 jobs (Radford and Riddington, 2009). In Wales, the total annual expenditure of sea anglers was £39 million for visitors and a further £87 million for residents that supported around 1700 jobs (Monkman et al., 2015).

A study for England was done in 2012 estimating 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 IO methodology to calculate total economic impact, FTEs, and GVA (Armstrong et al., 2013; Roberts et al., 2017). Sea anglers residing in England spent £1.23 billion on the sport, equivalent to £831 million direct spend (excluding tax and imports), and supported 10400 full-time equivalent jobs and almost £360 million of GVA (Armstrong et al., 2013; Roberts et al., 2017). Taking indirect and induced effects into account, sea angling supported £2.1 billion of total spending, and a total of over 23600 jobs, and almost £978 million of GVA (Armstrong et al., 2013; Roberts et al., 2017). Further studies have been done for particular sectors (e.g. Williams and Davies, 2018) and species (e.g. Grilli et al., 2018). In addition, there are several studies of the economics of freshwater angling in the UK (Simpson and Mawle, 2010, 2005), which are not further considered in this review.

In this annex, the total economic impact, GVA, and employment supported by sea angling in the UK in 2016 and 2017 is estimated based on the IO approach. The following section describes in detail the methods and assumptions used before results are presented and discussed. Estimates of effort in terms of numbers of people going sea angling in 2016 and 2017 were taken from the Watersports Participation Survey (Annex 1) and spend per angler was collected through the sea angling diary (Annex 2).

2 Methods

The methodology used to raise and analyse the results from the survey follows 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). This is described in detail below, but further details can be found in the original references for the Sea Angling 2012 study (Armstrong et al., 2013; Roberts et al., 2017).

2.1 Expenditure

At three points in 2016 (June, September, and December) and two in 2017 (July, December), an economic survey was conducted with anglers participating in the catch diary panel (Annex 2) 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 (Table 1). 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 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). Full details of the questions asked are provided in Appendix 1. These were voluntary surveys, with 250 and 576 responses in 2016 and 2017, respectively, that could be used for the analysis. This was based on respondents fishing in the UK, and being able to combine responses with trip data and demographic information that was required for raising.

The main challenge for UK surveys was that the generation of a probability-based sample of sea anglers is very difficult for off-site approaches as there is no sea angling licence list to sample from, participation rates are around 1.6% (see Annex 1), and responses to mail and postal surveys are generally poor. As a result, it was necessary to use a self-selected sample of anglers in the diary panel and to attempt a correction for non-representativeness in the panel composition when raising the expenditure of the panel members to estimate the total for all sea anglers in the UK. To do this, data from a randomised, omnibus face-to-face survey of 12000 households across the UK in 2016 and 2017 were obtained to give estimates of the numbers of anglers and trips, and demography, types of MRF done, and frequency of fishing of the sea angling population (Annex 1). These data were combined with the diary panel estimates of expenditure to estimate the total expenditure by UK sea anglers.

Several different scenarios for post-stratification and reweighting of the panel data to improve representativeness were tested. Different combinations of age, avidity, location, and platform (type of sea angling such as shore or boat fishing) were tested, and the sensitivity of the raised expenditure estimates to these were assessed. Two age strata (18-54, 55+) and two avidity strata (less than 20; 20 or more days fished per year) were defined for 2016. For 2017, two platform strata (shore angling only, and boat only or mixed boat and shore) and two avidity strata (less than 20, 20 or more days) were used in the analyses. In addition, different levels of trimming the panel to exclude anglers with the highest and lowest expenditure were assessed to reduce the impact of single very large purchases

(e.g. boats) on the results (Armstrong et al., 2013; Roberts et al., 2017). These high cost and very low probability items can substantially inflate the variance of the estimate of mean annual expenditure per angler, making it more difficult to discern trends between years in the estimates. Trimming the three highest and lowest values was found to be a suitable balance between reducing variance and introducing bias.

The total expenditures by sea anglers in the UK were calculated separately for trip (effort) based expenditure and capital (major item/investment) expenditure (Table 1). Standard errors were estimated for each category and the trips and capital expenditure were 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

2.2 Economic impact

Total economic impact, GVA, and numbers of job supported were estimated using the IO approach. Using this approach, the total expenditure by sea anglers in the UK was partitioned between the industries impacted by the sea angling spend. To calculate the direct expenditure, taxes, and the proportion of goods that each industry imports needed to be removed. Using IO tables for the UK economy, output multipliers were calculated that allow 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. This method has been used to estimate total economic impact of sea angling (Armstrong et al., 2013; Hyder et al., 2017; Monkman et al., 2015; Roberts et al., 2017), and the general approach for this study is illustrated in Figure 1.

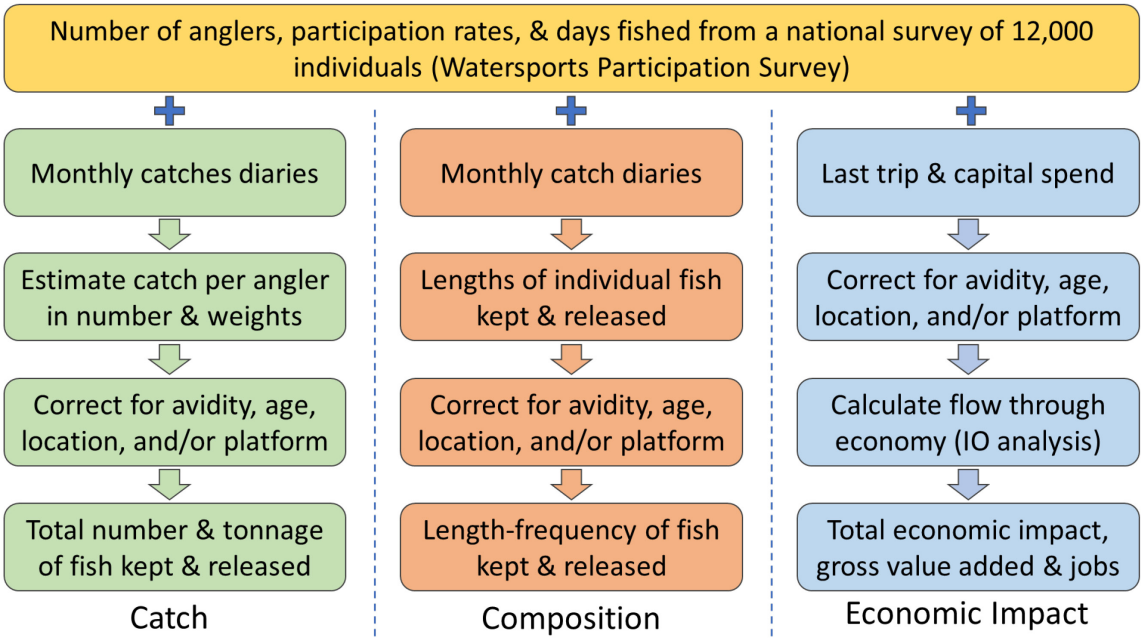

Figure 1. Approach used to estimate catch, composition, and economic impact by sea anglers in the UK.

The branches of the UK economy that were important for sea angling were defined as: agriculture, forestry, fishing; food, drink, clothing; machinery, non-electronics; coke and refined petroleum products; wholesale and retail; hotels and restaurants; transport and transport services; furniture; other manufactured goods; sporting services and amusement and recreation services; and wood, paper, publishing. Expenditure in each category was then split between industries using a similar approach to previous surveys (Armstrong et al., 2013; Roberts et al., 2017) (Table 2; Figure 2).

Taxes and imports were removed from the total expenditure by sea anglers in the UK as these do not affect the demand in each industry (Table 3; Table 4). Tax rates were applied following UK Her Majesty Revenue and Customs (HMRC) guidance[1]. For most categories, the standard value-added tax (VAT) rate of 20% was applied, except for spend categories exempt from VAT (car park, pier fees, public transport) or with multiple possible rates (boats, engines). For boats, VAT varies with a rate of 16.7% on retail sales and 0% on private sales, so a composite rate of 11% was applied (Armstrong et al., 2013; Roberts et al., 2017). A rate of 17% VAT was applied to engine parts representing the VAT margin scheme on these products (Armstrong et al., 2013; Roberts et al., 2017). The same tax rates were applied to calculate the direct expenditure in 2016 and 2017 as there were no changes in the tax regulations impacting the spending considered in this study.

[1] https://www.gov.uk/government/organisations/hm-revenue-customs

Table 2. 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

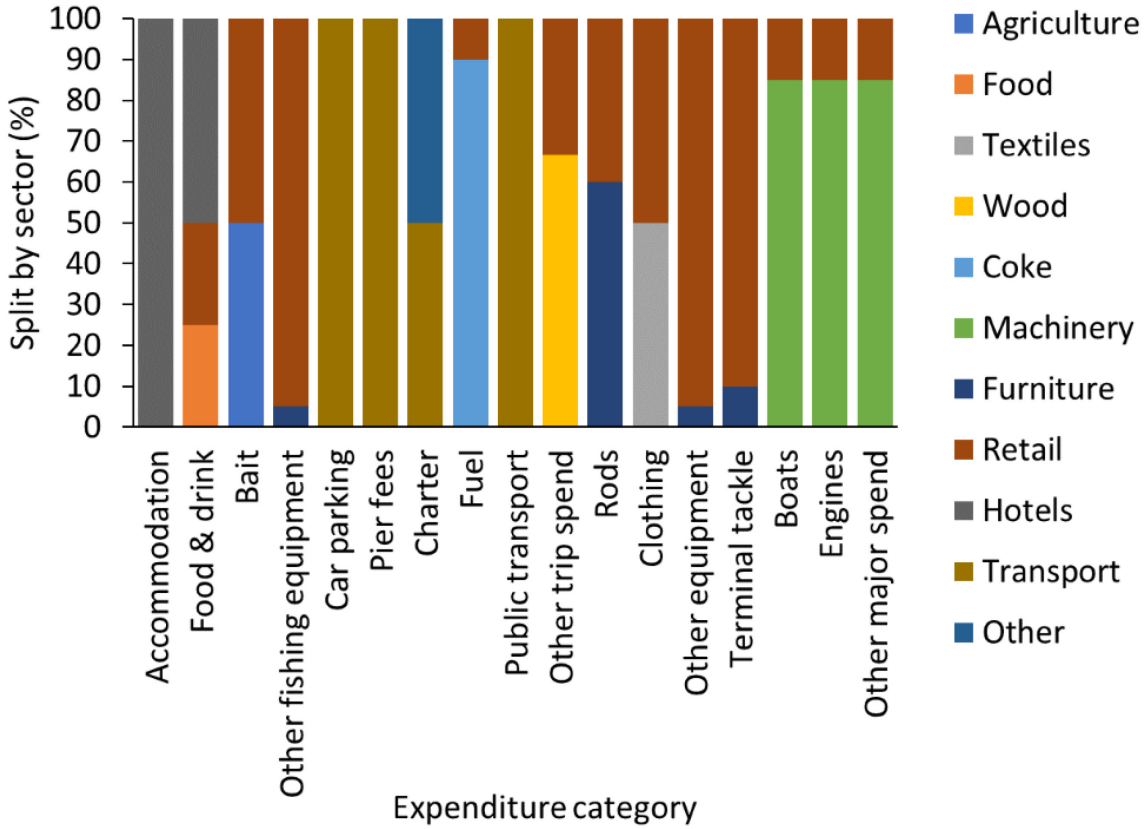

Figure 2. Partitioning of expenditure by sea anglers between industrial sectors.

Table 3. Tax applied to each level of expenditure.

Spend	Category	Fuel Tax (%)	VAT (%)
Accommodation	Trip	0	20
Food & drink	Trip	0	20
Bait	Trip	0	20
Other fishing equipment	Trip	0	20
Car parking	Trip	0	0
Pier fees	Trip	0	0
Charter	Trip	0	20
Fuel	Trip	50	20
Public transport	Trip	0	0
Other trip spend	Trip	0	20
Rods	Major item	0	20
Clothing	Major item	0	20
Other equipment	Major item	0	20
Terminal tackle	Major item	0	20
Boats	Major item	0	11
Engines	Major item	0	17
Other major spend	Major item	0	20

Table 4. Percentage of imports by sector in input-output table.

Sector	Sector number	Imports (%)
Agriculture	1	26.3
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

The sectoral supply structure of the UK economy as well as UK imports were taken from the supply and use tables (SUT) published by the Office for National Statistics (ONS)[2]. In the SUT, 105 industrial sectors are distinguished that were aggregated into the 65 NACE[3] classified industries to derive output multipliers for indirect and induced effects, GVA, and employment based on the Leontief inverse matrix of the industrial structure of the UK (Surís-Regueiro et al., 2014). The latest SUT table from ONS was only available for the year 2015, so technological efficiency and productivity was assumed to be constant between the year 2015 and 2017.

In contrast to previous studies (Armstrong et al., 2013; Roberts et al., 2017), no correction was made of the GVA for any kind of feedback loops of taxes to the UK economy. Taxes are invested in the economy in a different way to sea angling expenditure, so including feedback from taxes on GVA would add to the uncertainty in the estimates. As a result, these were excluded from the calculations. To provide estimates of the error, the expenditure ± standard error (SE) for each category were put through the IO analysis. This was likely to be an underestimate of the error as uncertainty in the IO analysis was excluded from this calculation.

2.3 Comparison between years

Total economic impact, GVA, and jobs supported were available for 2012, 2016 and 2017. Results from the years were corrected for inflation to 2017 prices using the Harmonised Consumer Price Index from EUROSTAT[4]. 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, indirect and induced, total). Errors estimates were not available for 2012 meaning that full statistical comparison was not possible, so a visual comparison was made instead.

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

[3] Statistical Classification of Economic Activities in the European Community, commonly referred to as NACE from the French term "**n**omenclature statistique des **a**ctivités économiques dans la **C**ommunauté **e**uropéenne"), is the industry standard classification system used in the European Union.

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

3 Results

3.1 Expenditure

Expenditure was raised from the economic survey to the whole population of UK sea anglers based on avidity, age, and/or platform. In 2016, younger anglers spent more in total, but less on each trip (Table 5). Boat anglers spent more than shore anglers and regular anglers more than frequent anglers in 2017 (Table 5), but this may be mediated by demographic characteristics. The total expenditure was similar between years with anglers spending £1.11 billion in 2016 and £1.32 billion 2017, with a roughly equal split between capital and trip spend and with relatively moderate standard errors (Table 6; Figure 3). Sea anglers spent most on rods, fuel (boats and car), and terminal tackle, with low expenditure on public transport, car parking, pier fee, and other equipment and trip spend (Table 7; Figure 4). Generally, expenditure on the different categories was reasonably consistent between 2016 and 2017, with the exception of pier fees and other trip spend being much higher in 2017 (Table 7; Figure 4).

Table 5. Response rates, trip spend, and major item spend for each stratum in 2016 (A) and 2017 (B). Regular fished for less than 20 days and frequent for 20 or more days each year. Boat includes both private and charter boats. Standard errors are given in brackets.

A.2016		Average Expenditure		Total Expenditure (million GBP)		
Category	Responses	Last Trip	Capital	Trip	Capital	Total
18-54 & Frequent (≥20 trips/year)	35	£70 (£8)	£1028 (£140)	£211 (£125)	£69 (£40)	£281 (£131)
18-54 & Regular (<20 trips/year)	79	£77 (£6)	£724 (£77)	£167 (£40)	£378 (£88)	£545 (£97)
55+ & Frequent (≥20 trips/year)	38	£82 (£9)	£1309 (£159)	£83 (£41)	£42 (£20)	£125 (£45)
55+ & Regular (<20 trips/year)	98	£76 (£5)	£704 (£92)	£56 (£18)	£101 (£32)	£158 (£37)
Total	250	£76 (£14)	£847 (£243)	£517 (£139)	£591 (£104)	£1108 (£173)

B.2017		Average Expenditure		Total Expenditure (million GBP)		
Category	Responses	Last Trip	Capital	Trip	Capital	Total
Regular (<20) & Boat	206	£128 (£12)	£1050 (£133)	£171 (£48)	£332 (£89)	£503 (£101)
Regular (<20) & Shore	252	£74 (£8)	£613 (£81)	£104 (£27)	£197 (£50)	£301 (£57)
Frequent (≥20) & Boat	60	£102 (£18)	£1037 (£110)	£286 (£148)	£77 (£37)	£363 (£153)
Frequent (≥20) & Shore	58	£50 (£8)	£684 (£74)	£120 (£70)	£31 (£14)	£152 (£71)
Total	576	£94 (£24)	£821 (£205)	£682 (£173)	£637 (£110)	£1318 (£205)

Table 6. Trip and capital spend in 2016 (raw and inflated to 2017 prices) and 2017. The standard error is provided in brackets.

Measure	2016	2016 inflated	2017
Last trip	£75 (£20)	£77 (£21)	£86 (£22)
Trip annual average	£675 (£181)	£693 (£186)	£901 (£229)
Capital average	£772 (£136)	£792 (£139)	£841 (£145)
Total trip (millions)	£517 (£139)	£531 (£143)	£682 (£173)
Total capital (millions)	£591 (£104)	£607 (£107)	£637 (£110)
Total spend (millions)	£1108 (£173)	£1137 (£178)	£1318 (£205)

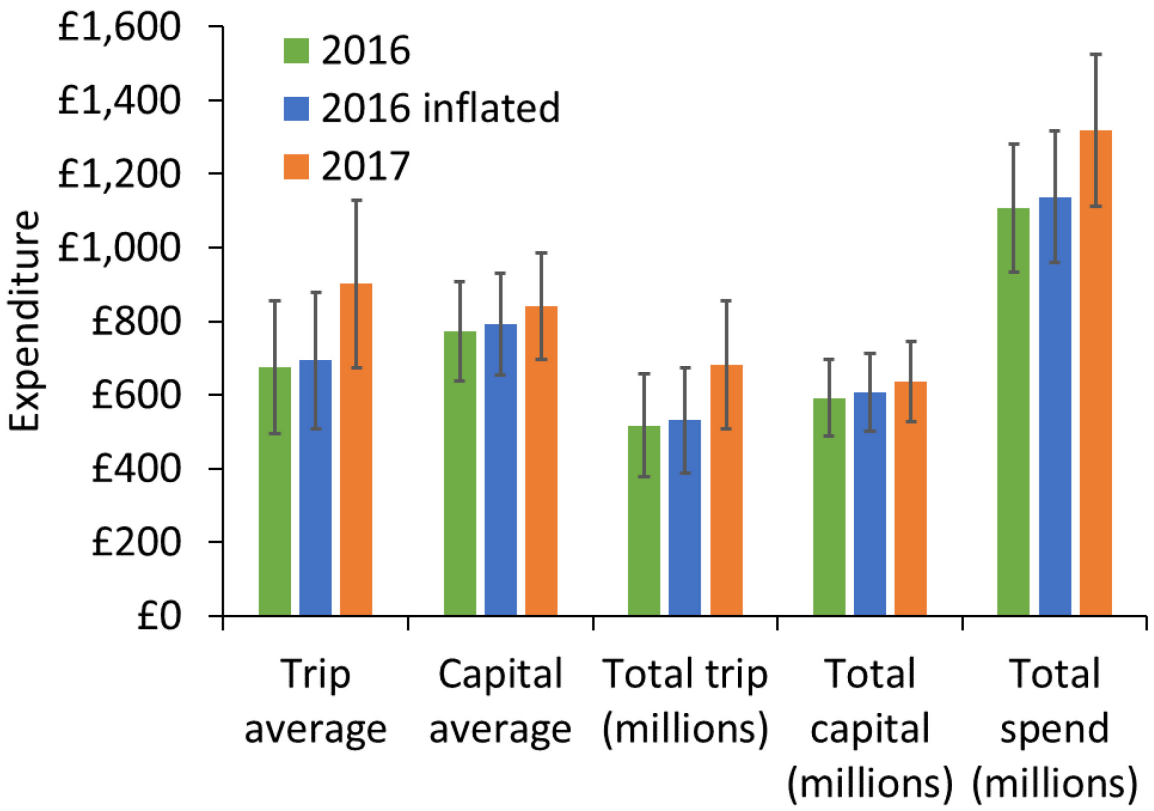

Figure 3. Trip and capital expenditure presented for each angler (average) and for the whole population (total). Error bars are standard errors.

Table 7. Trip and capital spend in 2016 (raw and inflated to 2017 prices) and 2017 in each spend category. The associated error is provided in terms of standard error (SE) and all values are in millions.

Spend category	2016	2016 inflated	2017
Accommodation	£65 (£24)	£66 (£25)	£76 (£24)
Food & drink	£92 (£21)	£95 (£22)	£87 (£17)
Bait	£70 (£21)	£72 (£21)	£82 (£22)
Other fishing equipment	£17 (£5)	£18 (£5)	£21 (£7)
Car parking	£10 (£3)	£10 (£3)	£13 (£3)
Pier fees	£6 (£2)	£6 (£2)	£44 (£29)
Charter	£59 (£15)	£60 (£15)	£72 (£21)
Fuel	£133 (£32)	£137 (£33)	£152 (£32)
Public transport	£2 (£2)	£2 (£2)	£15 (£11)
Other trip spend	£9 (£3)	£10 (£3)	£61 (£33)
Rods	£196 (£37)	£201 (£38)	£213 (£35)
Clothing	£73 (£13)	£75 (£13)	£65 (£10)
Other equipment	£38 (£8)	£39 (£8)	£38 (£7)
Terminal tackle	£146 (£24)	£150 (£25)	£131 (£19)
Boats	£44 (£13)	£45 (£13)	£98 (£28)
Engines	£77 (£18)	£79 (£19)	£83 (£20)
Other major spend	£71 (£29)	£72 (£30)	£68 (£31)
Total	£1108 (£79)	£1137 (£81)	£1318 (£94)

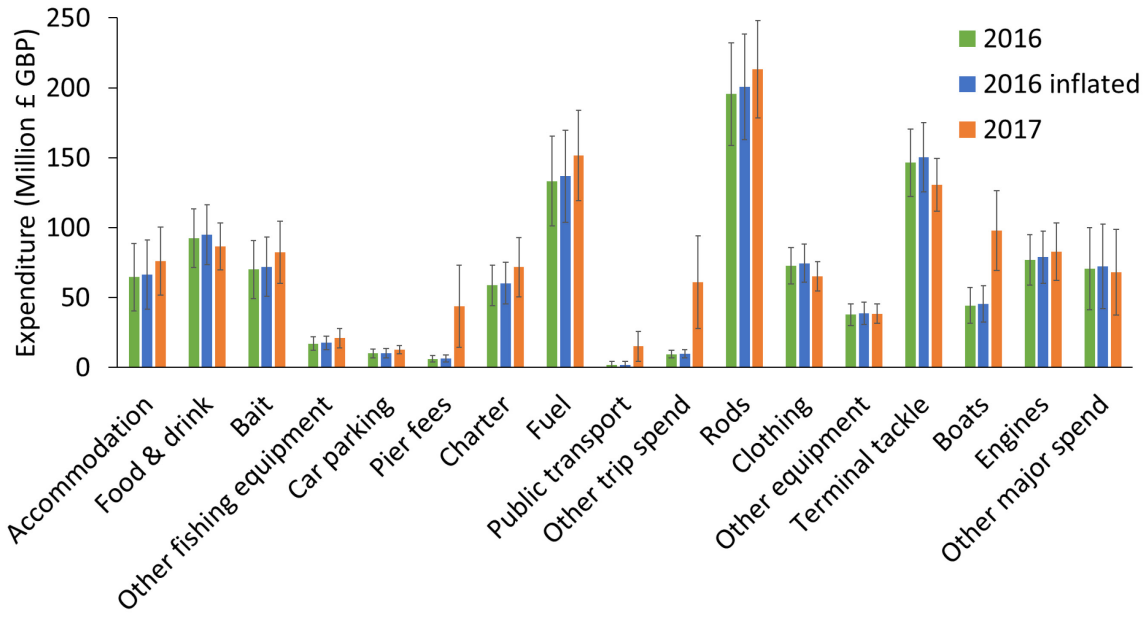

Figure 4. Total expenditure by sea anglers in 2016 (raw and inflated to 2017 prices) and 2017 split by spend category (error bars represent standard errors).

3.2 Economic Impact

After partitioning to different sectors and removing imports and taxes (Table 3; Table 4), the majority of the direct expenditure is 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 8; Figure 5). Due to the high spending in high import sectors (Table 3; Table 4), removal of imports and taxes from expenditure was one of the biggest categories representing £411 and £422 million in 2016 and 2017, respectively (Table 8; Figure 5). This led to a direct impact after removal of taxes and imports of £696 million generating £326 million GVA and supporting over 7600 full time equivalent jobs (FTEs) in 2016 (Table 9A), and £847 million direct impact, £388 million GVA and over 8900 FTEs in 2017 (Table 9B). The 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 9). In 2016, the total economic impact of sea angling was £1.57 billion and supporting around 13500 jobs (Table 9A). The total was slightly higher in 2017, with a total economic impact of sea angling was £1.94 billion and supporting around 16300 jobs (Table 9B).

Table 8. Total direct expenditure, imports, and taxes in millions provided by sea anglers in 2016 (raw and inflated to 2017 prices). The associated error is provided in terms of standard error (SE) in brackets.

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)

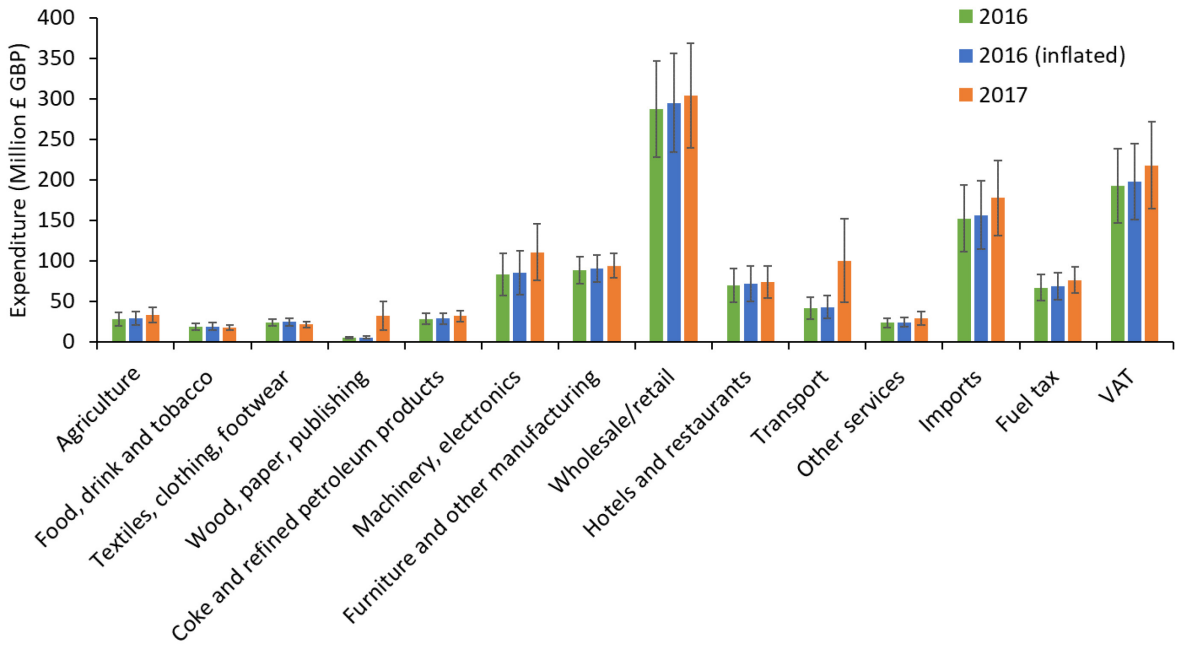

Figure 5. Total direct expenditure, imports, and taxes (fuel and VAT) partitioned between industrial sectors in 2016 (raw and inflated to 2017 prices) and 2017 (error bars represent standard errors).

Table 9. 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 (A) and 2017 (B). Numbers in brackets indicate the potential range of uncertainty associated with the estimates.

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)

3.3 Comparisons between years

Estimation of the total economic impact, GVA and jobs supported has previously been done for England in 2012 (Armstrong et al., 2013; Roberts et al., 2017) and in this study for the UK in 2016 and 2017. 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 was £2.26 billion, supporting 23600 FTE jobs and £385 million of GVA (inflated numbers taken from Armstrong et al., 2013; Roberts et al., 2017) (Table 10; Figure 6). The expenditure for each individual angler on trip and capital items in 2012, 2016 and 2017 was very similar ranging from £1485 (2016 inflated) to £1742 in 2017, as was the split between trip and capital spend (Table 10; Figure 6). There was little difference in the total expenditure ranging from £1.14 billion (2016 inflated) to £1.33 billion (2012 inflated), 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%) (Table 10; Figure 6). The largest differences were in the total economic impact, GVA, and jobs supported, with 2016 and 2017 lower than 2012 (Table 10; Figure 6). This was driven by several factors including different surveys methods, spend profile, use of a different IO multiplier, and some difference in taxes. Despite the differences with 2012, the results from 2016 and 2017 are reasonably consistent and still indicate a large impact of the sector on the economy.

Table 10. Comparison of 2012 (England only) with 2016 and 2017 (whole UK), where inflated represents values in 2017 prices so that direct comparisons can be made.

Category	2012	2016	2012 Inflated	2016 Inflated	2017
Per angler expenditure:					
Trip	£761	£675	£819	£693	£901
Capital	£633	£772	£681	£792	£841
Total	£1394	£1447	£1500	£1485	£1742
Raised expenditure:					
Total expenditure	£1233	£1108	£1326	£1137	£1318
Direct	£831	£696	£895	£715	£847
Imports	£199	£152	£214	£156	£177
Tax	£202	£259	£217	£266	£253
Economic impact (million):					
Direct	£831	£696	£895	£715	£847
Indirect & induced	£1266	£880	£1362	£904	£1089
Total	£2097	£1577	£2257	£1619	£1936
Employment (thousand):					
Direct	10392	7651	10392	7651	8919
Indirect & induced	13227	5943	13227	5943	7394
Total	23619	13594	23619	13594	16313
GVA (million):					
Direct	£357	£326	£385	£334	£388
Indirect & induced	£621	£371	£668	£381	£459
Total	£978	£697	£1053	£715	£847

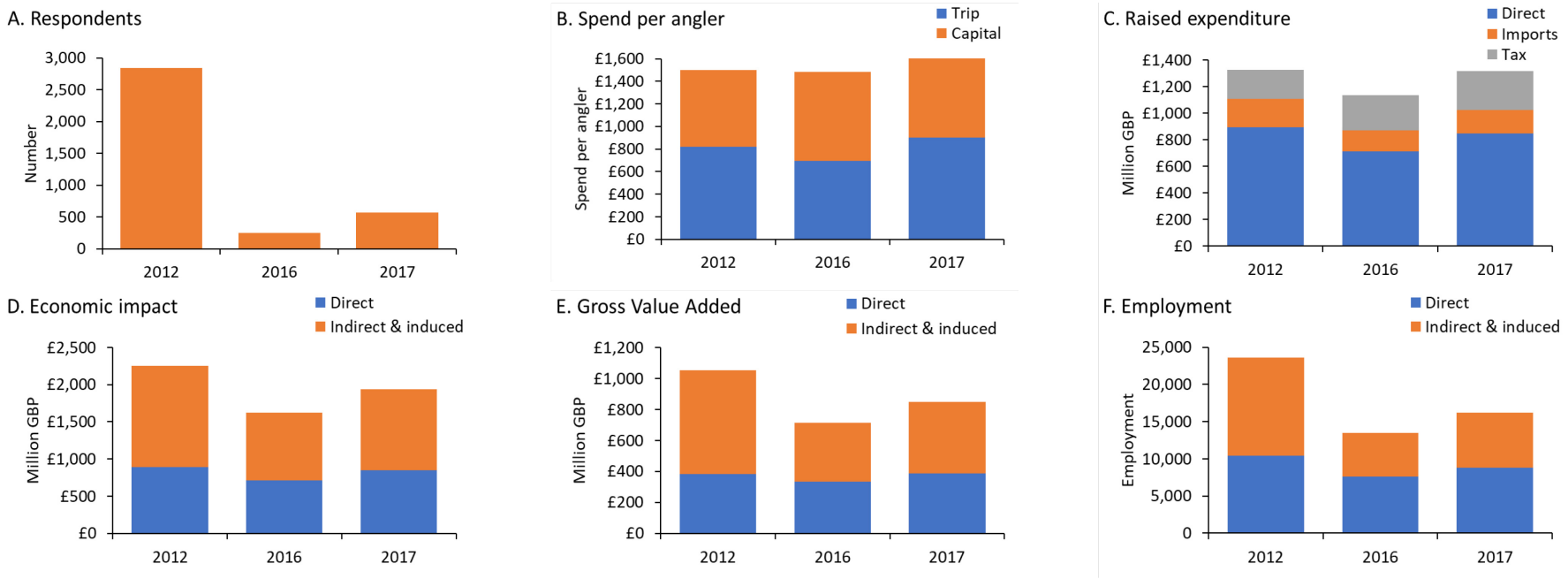

Figure 6. Comparison between the results form 2012, 2016 and 2017 for numbers of respondents (A), spend per angler (B), raised expenditure (C), economic impact (D), Gross Value Added (E), and employment (F). All values in GBP are presented in 2017 currency. Figures for 2012 are for England only, whereas 2016 and 2017 are for the whole of the UK.

4 Discussion

The total economic impact, GVA, and employment supported by sea angling in the UK in 2016 and 2017 was estimated using an IO approach. Expenditure on trips and major items (capital) could be used from 250 sea anglers in 2016 and 576 in 2016, and raised to the total population giving an annual expenditure of £1.11 billion in 2016 and £1.32 billion 2017. This led to a direct impact after removal of taxes and imports of £696 million generating £326 million GVA and supporting almost 7600 full time equivalent jobs (FTEs) in 2016, and £847 million direct impact, £388 million GVA and over 8900 FTEs in 2017. The total economic impact was estimated to be £1.57 billion, providing £326 million of GVA and supporting around 13500 jobs in 2016. It was slightly higher in 2017, with a total economic impact of sea angling was £1.94 billion, providing £388 million of GVA and supporting around 16300 jobs. UK sea anglers have the highest direct expenditure in Europe, but it is comparable with France and Norway (Hyder et al., 2018).

4.1 Validity of estimates

All approaches for collecting data on sea angling are subject to error, due to the varied and dispersed nature of the activity. The approaches for data collection are wide-ranging and each method is subject to different potential biases (ICES 2010). A variety of on-site and off-site approaches are used across Europe to provide data (ICES, 2018), but a consistent approach for Europe wide MRF surveys was considered not to be efficient or effective due to national and cultural differences (ICES, 2018). Uncertainty in the UK estimates of participation, effort and expenditure arise from two sources: measurement error (precision) and biases from issues with design, recruitment and implementation of each survey and methods used for extrapolation (Pollock et al. 1994; ICES 2010).

Measurement error was calculated for the estimates in terms of the standard errors, which reflected the variation in expenditure between individual panel members as well as sampling error in the estimates of participation from the Watersports Participation Survey (Annex 1). The relative standard error of the estimate was around 30% in most cases indicating reasonable levels of precision. In addition, lower and upper bounds of the estimates of expenditure have been used to capture some of the error in the IO methods. However, the standard error excluded errors in the IO methods, so are likely to overestimate the precision of the estimates. This could not be resolved as errors are not provided for the IO tables. Increased sampling could be done to increase the precision, but this has an associated cost.

In addition to measurement error, there are potential sources of bias including recall, avidity biases, coverage, and non-response (see ICES, 2010; Pollock et al., 1994). The diarists in the Sea Angling Diary were not a randomised probability-based sample of the population of sea anglers, and self-selection resulted in the composition of the panel differing from the overall population of sea anglers in the UK in terms of characteristics such as age, avidity, and main fishing platform. For example, those who fish rarely were less likely to be included in our surveys. In the raising expenditure in the analysis, the panel was post-stratified by characteristics such as age and avidity and reweighted to represent the composition of sea anglers interviewed in the randomised Watersports Participation Survey (Armstrong et al., 2013; Roberts et al., 2017). Although the design of the Watersports Participation Survey is in principle less biased than the diary panel, the number of sea anglers interviewed each year

is small and therefore provides an imprecise estimate of the composition of the angling population. A combination of data over several years may provide more robust data for diary panel weighting.

Due to the nature of off-site surveys, it is likely that there are other inherent biases that we are not able to correct. Participation in angling is very diverse (Arlinghaus, 2006; Arlinghaus et al., 2017; Beardmore et al., 2011; Fedler and Ditton, 1994), and angler behaviour can affect harvest rates through the consumption orientation of the angler (e.g. Beardmore et al., 2011). As a result, 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 level of expenditure. To address this, it would be necessary to either identify additional factors around specialisation or generate a small group of diarists using a randomised probability approach that could be used to correct for bias.

4.2 Comparisons with existing studies

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. It was assumed in this study that more bait was sourced from wholesale/retail sectors than specialised bait shops compared with 2012 due to changes in prices for baits, 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 Future surveys

Economic data collection can be challenging and should be targeted based on the questions that need to be addressed. To maximise the benefit generated and support the future development of sea

angling, total economic impact should continue to be estimated on a regular basis, but may not need to be done each year given the similarities in the outcomes. To ensure that bias is minimised or corrected for within analyses, additional questions on specialisation should be added to the Watersports Participation Survey (Annex 1) and the diary recruitment survey; and a small randomised probabilistic panel should be recruited to assess bias in the diary panel (this is underway in 2019).

A different approach is needed to assess the demand (function) for MRF and the changes of the demand due to competing management measures. This is more complex, requiring a mixture of stated and revealed preference methods to estimate a robust economic value and being able to models trade-offs when making choices. More research is needed before these could be deployed to support decision-makers in accounting for social, economic, and biological trade-offs in allocation of fisheries resources.

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Appendix 1: Questionnaire

2016 survey

This survey is part of the Sea Angling 2016 study. Alongside the catch data which is being collected via the online Diary Tool, we also need to understand more about what sea anglers are spending in 2016.

We will be running three of these surveys during the year to get an idea of spending across the year – this one in the spring, the next in the summer and the last one in autumn/winter.

The survey is split into three elements:

- What you spent on your most recent day's sea angling in May 2016 – including travel, accommodation, bait etc.
- What you have spent in the last six months on major items – such as reels, rods, boats.
- What might increase the amount of fishing you do

If you did not go sea angling in May, do not worry – we need to get a cross section from our sample and not everyone will be fishing every month. But we do need you to tell us about any spending on major items.

If you have not spent anything in either May or on major items, we still need to know – just enter 0 !

Remember – all information is treated confidentially and only used in aggregate. We won't tell anyone!

Thanks for this additional input into Sea Angling 2016.

1. Did you go sea angling in May 2016?

- Yes
- No

2. Your last trip in May

On your <u>most recent day sea angling in May 2016</u>, please estimate what you spent on the following items. Do not include major items (such as rods and reels) which are dealt with in a subsequent question.

Please put a numerical figure for pounds and put 0 if you spent nothing in a category. Do not use the £ sign.

2.1 Travel

- Fuel for your own private vehicle – only include that spent to go sea angling:
- Public transport:
- Other transport cost:

2.2 Accommodation and food

- Accommodation – *only* for the night before and/or the night after your day sea angling:

- Food paid for separately as part of accommodation and only if not included in the accommodation figure:
- Food, drink, snacks - excluding food bought as part of accommodation:

2.3 Fishing related costs spent on the day

- Bait:
- Terminal tackle (weights, hooks, line, lures etc.):
- Other fishing equipment bought on the trip:
- Car parking:
- Pier, harbour or launch fees:
- Charter boat and/or boat hire
- Boat fuel
- Other fishing related spending

2.4 What was the location of your last day sea angling in May?

- Region
- Place name

2.5 Was this expenditure average for a fishing trip for you, below average or above average?

- Average expenditure
- A little below average expenditure
- A lot below average expenditure
- A little above average expenditure
- A lot above average expenditure

3. Major Items Spending

In the LAST SIX MONTHS please estimate what you spent on purchasing the following MAJOR ITEMS.
Please think carefully about everything you bought and put a numerical figure for pounds. Put 0 if you spent nothing and do not use the £ sign.

- Fishing rods and reels
- Clothing specifically bought for fishing
- Other fishing equipment (e.g. rests, boxes, lighting but EXCLUDING terminal tackle)
- Terminal tackle (weights, hooks, line, lures etc.)
- Boats/kayaks (used mostly for sea fishing)
- Boat engines/equipment (inc. electronic equipment etc.)
- Any other major items

4. Amount of Fishing

4.1 If fish stocks improved so that it was likely that you caught more fish more regularly (but not necessarily bigger fish), how many <u>more trips</u> would you have undertaken in May?

- 0% - no more
- 1 - 10% more trips

- 11 - 20% more trips
- 21 - 30% more trips
- 31 - 40% more trips
- 41 - 50% more trips
- 51 - 60% more trips
- 61 - 70% more trips
- 71 - 80% more trips
- 81 - 90% more trips
- 91 - 100% more trips

4.2 If fish stocks improved so that it was likely that you caught bigger more regularly, (but not necessarily more fish) how many more trips would you have undertaken in May?

- 0% - no more
- 1 - 10% more trips
- 11 - 20% more trips
- 21 - 30% more trips
- 31 - 40% more trips
- 41 - 50% more trips
- 51 - 60% more trips
- 61 - 70% more trips
- 71 - 80% more trips
- 81 - 90% more trips
- 91 - 100% more trips

4.3 Are there any other factors that would increase the amount of fishing trips you do?

- Yes
- No

4.3(a) If yes, what would be most likely to increase the amount of fishing trips you undertook in May?

4.3(b) If this happened, how many more trips would you have undertaken in May?

- 0% - no more
- 1 - 10% more trips
- 11 - 20% more trips
- 21 - 30% more trips
- 31 - 40% more trips
- 41 - 50% more trips
- 51 - 60% more trips
- 61 - 70% more trips
- 71 - 80% more trips

- 81 - 90% more trips
- 91 - 100% more trips

2017 survey

This survey is to help estimate the economic contribution that sea angling makes to the UK economy. We want you to let us know **what you spent on the trip that you are currently entering information about**. We will repeat this process two or three times in 2017.

1. On the trip you are entering now, can you please say what you spent on the following items. Do not include major items (such as rods and reels) which are dealt with in a subsequent question.
Please put a numerical figure for pounds and put 0 if you spent nothing in a category. Do not use the £ sign.

1.1 Travel

- Fuel for your own private vehicle – only include that spent to go sea angling:
- Public transport
- Other transport cost

1.2 Accommodation and food

- Accommodation – only for the night before and/or the night after your day sea angling
- Food paid for separately as part of accommodation and only if not included in the accommodation figure
- Food, drink, snacks - excluding food bought as part of accommodation

1.3 Fishing related costs spent on the day

- Bait
- Terminal tackle (weights, hooks, line, lures etc.)
- Other fishing equipment bought on the trip
- Car parking
- Pier, harbour or launch fees
- Charter boat and/or boat hire
- Boat fuel
- Other fishing related spending

2. Major Items Spending
In the LAST SIX MONTHS (i.e. to date in 2017) please estimate what you spent on purchasing the following MAJOR ITEMS.
Please think carefully about everything you bought and put a numerical figure for pounds. Put 0 if you spent nothing and do not use the £ sign.

- Fishing rods and reels
- Clothing specifically bought for fishing
- Other fishing equipment (e.g. rests, boxes, lighting but EXCLUDING terminal tackle)
- Terminal tackle (weights, hooks, line, lures etc.)
- Boats/kayaks (used mostly for sea fishing)
- Boat engines/equipment (including electronic equipment etc.)
- Any other major items

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About us

We are the Government's marine and freshwater science experts. We help keep our seas, oceans and rivers healthy and productive and our seafood safe and sustainable by providing data and advice to the UK Government and our overseas partners.

We are passionate about what we do because our work helps tackle the serious global problems of climate change, marine litter, over-fishing and pollution in support of the UK's commitments to a better future (for example the UN Sustainable Development Goals and Defra's 25 year Environment Plan).

We work in partnership with our colleagues in Defra and across UK government, and with international governments, business, maritime and fishing industry, non-governmental organisations, research institutes, universities, civil society and schools to collate and share knowledge.

Together we can understand and value our seas to secure a sustainable blue future for us all, and help create a greater place for living.

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Innovative, world-class science is central to our mission. Our scientists use a breadth of surveying, mapping and sampling technologies to collect and analyse data that are reliable and valuable. We use our state-of-the-art Research Vessel Cefas Endeavour, autonomous marine vehicles, remotely piloted aircraft and utilise satellites to monitor and assess the health of our waters.

In our laboratories in Lowestoft and Weymouth we:
- safeguard human and animal health
- enable food security
- support marine economies.

This is supported by monitoring risks and disease in water and seafood; using our data in advanced computer models to advise on how best to manage fish stocks and seafood farming; to reduce the environmental impact of man-made developments; and to respond to serious emergencies such as fish disease outbreaks, and to respond to oil or chemical spills, and radioactivity leaks.

Overseas, our scientists currently work in Commonwealth countries, United Kingdom Overseas Territories, South East Asia and the Middle East.

Our customer base and partnerships are broad, spanning Government, public and private sectors, academia, non-governmental organisations (NGOs), at home and internationally.

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