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Mapping recreational sea anglers in English waters (MMO1163): Non-technical Summary

MMO1163: Mapping recreational sea anglers in English waters: Non-technical summary

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Report prepared by: Substance and Cefas,

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Information about this publication and further copies are available from:

Marine Management Organisation
Lancaster House
Hampshire Court
Newcastle upon Tyne
NE4 7YH

Tel: 0300 123 1032
Email: info@marinemanagement.org.uk
Website: www.gov.uk/mmo

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Abbreviations

Abbrev.	Phrase
EU	European Union
FK	Fisher knowledge
GES	Good Environmental Status
ICES	The International Council for the Exploration of the Sea
IFCA	Inshore Fisheries and Conservation Authority or Authorities according to context
MCAA	Marine and Coastal Access Act 2009
MCZ	Marine Conservation Zones
MEDIN	Marine Environmental Data and Information Network
MMO	Marine Management Organisation
MPLA	Marine plan area
MPS	Marine Policy Statement
MSP	Marine spatial plan, marine spatial planning (alt. maritime spatial planning) according to context
OTR	Open-text reference
OTS	Open text sample
pMPA	Proposed marine protected area
RSA	Recreational sea angling or Recreational Sea Angling according to context
RSAs	Recreational Sea Anglers
RSF	Recreational sea fishing
SD	Standard deviation
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office

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1. Introduction

1.1. Non-technical summary

This is a non-technical summary for Marine Management Organisation (MMO) commissioned report MMO1163 (Mapping recreational sea anglers in English waters). This summary covers the key elements of the full technical report to provide context of, and the methods for the creation of maps of recreational sea angling intensity in England. This report also highlights important project findings and challenges.

1.2. Background

Sea fishing is a popular recreational activity, with significant economic and social benefits. In Europe annually, 8.67 million individuals' go fishing for a total of 77.6 million days and spend 5.89 billion euros annually. Recreational fishing is worth 10.5 billion euro and supports around 100,000 jobs (Hyder et al., 2018). Around one million people or 2% of the population of Great Britain fish in the sea each year (Armstrong et al., 2013).

However, marine recreational fisheries can also have a significant impact on fish stocks, accounting for 2-43% of all fish caught (Radford et al., 2018). For example, 25% of sea bass removals in England in 2012 was estimated to be by recreational sea angling (RSA) (Armstrong et al., 2013).

The importance of marine recreational fisheries as a source of fish mortality has led to requirements to report RSA catches. In the United Kingdom (UK), there is regular data collection within the Sea Angling Diary Project (www.seaangling.org). The programme explores where people are sea angling, what they are catching and financial expenditure across the UK.

There are significant challenges in monitoring recreational fisheries. Fishing occurs from many different platforms including from shore, kayak, personal boat and charter vessels. A range of fishing gear is used and the activity occurs widely around most of the UK coast. Recreational sea fishing occurs year round but changes with the seasons for example in species caught or areas favoured.

The marine environment is being used by many different and often competing sectors, including energy generation, marine leisure activities, commercial and recreational fishing etc. and the demands are expected to grow. Understanding and managing these multiple uses through governance mechanisms like marine spatial planning (MSP) is now seen as essential in many areas.

In the UK, marine spatial planning seeks to: (i) manage human activity to protect sensitive ecosystems; (ii) achieve a sustainable marine economy; (iii) ensure a strong, healthy and just society; and (iv) live within environmental limits. The Marine and Coastal Access Act (2009) requires all users of the marine environment to be considered in management decisions and in the creation and ongoing management of Marine Conservation Zones (MCZs).

Regular sea angling data collection in England has focussed on provision of catches, activity and economic impact at a regional level to provide data for fisheries management. As a result, data is not at the resolution needed to support marine spatial planning (Monkman et al., 2015b; Monkman et al., 2018c). There are few studies of the interactions between marine planning and RSA. As a result, there is a need for a greater understanding of the distribution of sea angling activity in England, particular it varies around the coast and throughout the year to inform for marine spatial planning purposes.

1.3. Marine Spatial Planning Policy Context

The Marine and Coastal Access Act (2009) provides the legal basis for a plan-led system for the UK marine environment (Defra, 2009). The purpose of marine planning is to help achieve sustainable development in the marine area. In July 2014, the European Parliament and the Council established a framework for maritime spatial planning to create consistency in maritime spatial planning in Europe (European Commission, 2014). While each European (EU) country will be free to plan its own maritime activities, local, regional and national planning in shared seas would be made more compatible through a set of minimum common requirements.

All four UK administrations adopted the UK Marine Policy Statement in March 2011. On adoption of the Marine Policy Statement, the Marine and Coastal Access Act placed a duty on the UK Government to implement marine strategy plans for England (HM Government, 2009b). The marine strategy plan requires:

- Assessment of the marine environment, maintaining objectives to deliver Good Environmental Status (GES) and a framework for continued assessments in delivering GES.
- Documenting monitoring programmes required to chart progress for all indicators and targets.
- Defining the work programmes required to achieve GES.
- Delivery on the marine strategy to ensure that the Marine Management Organisation (MMO) can integrate economic, social and environmental considerations to meet legislative requirements in continuing to deliver GES in English waters.

1.4. Sea Angling Definition and Geographic Scope

RSA is a subset of activity within the broader category of recreational sea fishing. The International Council for the Exploration of the Sea (ICES) definition of recreational sea fishing is ‘the capture or attempted capture of living aquatic resources mainly for leisure and / or personal consumption, and covers active fishing methods including line, spear, and hand–gathering and passive fishing methods including nets, traps, pots, and set–lines’ (ICES, 2013). Legal definitions exclude subsistence fishing and fishing where the catch is sold or otherwise traded on export, domestic or black markets (Food and Agriculture Organization of the United Nations., 2008; Pawson et al., 2008) in the UK recreational sea fishing is usually synonymous with angling(Pawson et al. 2008). Angling pertains to fishing with lines, and within the UK this is almost entirely by lien with rod and reel. The extent of non-angling recreational sea fishing was outside the scope of this project.

Within England, sea angling is usually done from three platforms: (i) shore; (ii) private boats; and (iii) charter boats. Sea angling also occurs on manually powered vessels, with kayak angling in particular becoming more popular in recent years (personal observation). There is no significant for-hire sector in fishing at sea, where anglers hire a boat without a skipper. Separating the three platforms (shore, boat, and charter) is common worldwide in marine recreational fisheries assessments representing different challenges in collecting data, variation in fisheries, and different economics among platforms.

This report only considers sea angling in England, defined as "any fishing for marine species primarily using rod and line or hand-held line where the purpose is recreation and not for the sale or trade of the catch" (Armstrong et al. 2013) from the shore, charter boats and private afloat platforms. The methods employed here could identify kayak angling, but data were too sparse to draw meaningful conclusions.

1.5. Aims and Objectives

The aim of this project was to: Identify relevant data (angling literature, surveys, and local/fisher knowledge) and apply repeatable methods to produce high-resolution maps of angling activity useful for marine spatial planning.

To achieve this, the main objectives were to:

- Compile public sources of sea angling activity to provide robust data on spatial and temporal distributions along with changes in activity.
- Validate this using stakeholder knowledge.
- Produce a thoroughly documented and well-formed data set from which reported results were derived.

This work aims to produce data on the distribution of recreational sea angling by location and time of year. The data must be fit to support and guide marine authorisation and enforcement decisions made by the MMO in MSP and related marine management decisions. This includes balancing the interests of recreational sea angling with other uses and manage impacts on the marine environment.

This was a desktop exercise and thus limited by the extent of pre-existing data. The project also identified knowledge gaps in relation to recreational sea angling activity so the Marine Management Organisation and Inshore Fisheries and Conservation Authorities can prioritise further evidence gathering.

Activities undertaken to meet the project aims included:

- a review of current information to map the distribution of recreational sea angling activity for shore, private boat and charter boat platforms.
- (within the limits of pre-existing data), map activity across England at a resolution suitable for marine spatial planning.
- qualify the distribution of recreational sea angling in space and time by species.

- validate maps and data with stakeholders
- describe the data limitations and appropriate use.
- discuss possible approaches to eliminate knowledge gaps.

This report makes extensive use of text and data mining techniques to collect public data on recreational sea angling. The method uses automation to extract meaningful data from large volumes of public open text data including text published online (e.g. blogs, forums and social networks forums) and in traditional print. Text and data mining has been effective in producing qualitative information on the distribution of angling previously (e.g. Monkman et al., 2018a, 2018b, Giovos et al., 2018). These sources are called fisher knowledge and this has become recognised as an important source of fisheries data (Johannes et al., 2000; Richardson et al., 2006; Hind, 2014, 2015). This process was preceded by a consultation exercise with sea angling and marine stakeholder organisations and individuals, who provided both local knowledge and identification of datasets. Interim results were also subject to validation by stakeholders.

The main outputs from the research are 12 map layers (for example charter boats, seasonal, species etc) and accompanying data and descriptions which will be available on the MMO's digital service Explore Marine Plans. There is also a technical report that accompanies this summary.

2. Methods

2.1. Overview

This project performed a desk-based analysis of existing fisher knowledge to develop map(s) of the sites sea anglers use across England across the year and the value of different species to anglers. The methods used follow those of previously validated research work undertaken in collaboration with Bangor University and Cefas (Monkman et al., 2018a, 2018b) to describe sea angling activity in Wales (Monkman et al., 2015a). For full details please refer to the Technical report.

The method involves data mining public fisher's knowledge to extract meaningful and data from open text. These data can then be used to produce maps to provide relative indicators of the value of species and fishing areas across the seasons.

In the UK fishery, afloat activity (from a vessel rather than land) is underrepresented in public fisher's knowledge, so additional information on activity (online and published) was reviewed or generated including mapping the extent of on-the-water mooring boat storage facilities, which facilitate rapid launching to angling grounds.

In summary the method involved the following stages, illustrated in Figure 1 below:

1. Project inception: This meeting confirmed scope, definitions and objectives with MMO and stakeholders; confirmed timelines and deliverables; and identified initial stakeholder consultees.

2. Literature and data review: Searches and reviews were made to identify and summarise academic literature relating to sea angling activity, locations and species; data sources such as sea angling websites, forums and social media pages, with links recorded for the data scraping exercise[1]; and additional data from stakeholder and statutory organisations, notably the IFCAs.

3. Initial stakeholder consultation: An initial exercise was undertaken with sea angling stakeholder organisations and individuals, using of semi-structured interviews (as well as one group presentation) to inform them of the project, identify other data sources and secure agreement for assistance in the validation exercise.

4. Instrument design and data mining: These were informed by the preceding stages and consisted of designing the analysis and technical approach, creating a gazetteer (list of location names), creating a species list, and reviewing data sources. This identified some gaps, filled, where possible, with further data review (such as additional regional data sources and a census of afloat platform facilities). This element also included the acquisition of sea angling magazine archives and sea angling books.

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[1] Data scraping is a technique in which a computer program extracts data from human-readable output coming from another program.

5. Data analysis: This included the implementation of a scraping code, open text analysis and both manual and automated assessment of data source value and reliability to assign confidence in each source.

6. Interim results: Interim results produced some draft outputs with map layers and data about individual sites for use in the validation.

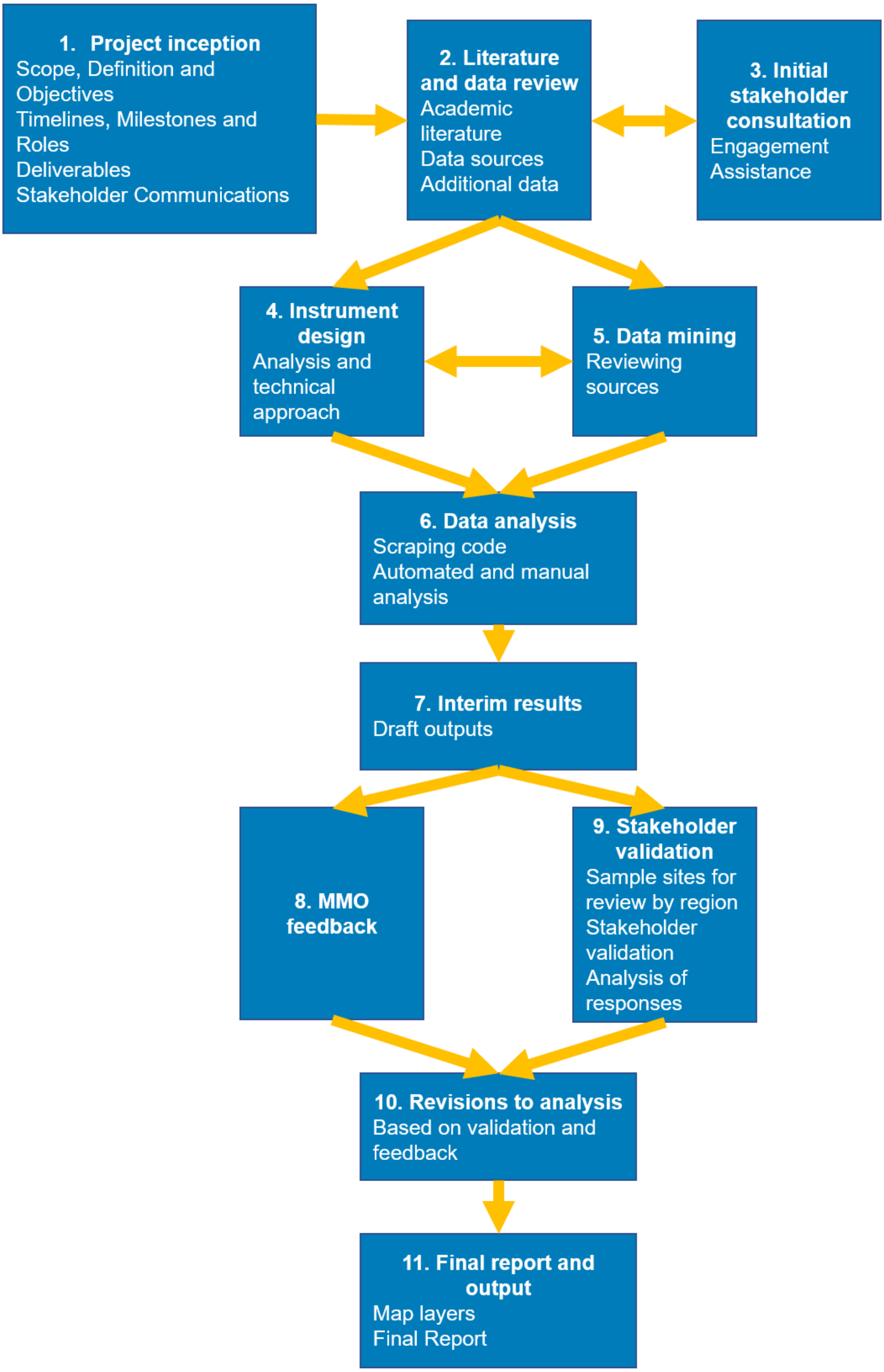
7. Stakeholder validation: This was undertaken with both angling stakeholders (individuals and representatives of sea angler organisations) and IFCAs, facilitated by the Association of IFCAs. It involved providing reviewers with samples of sites and data about them, with a proforma feedback spreadsheet where they could indicate agreement or otherwise.

8. MMO feedback: MMO also provided feedback on the maps and data produced to help inform production of final outputs.

9. Revisions: A number of revisions were made based on the validation as well as adjustments to the final data layers and maps.

10. Final report and final outputs: A Final Report was produced alongside spatial data layers of sea angling activity.

Figure 1. Summary of tasks, highlighting interactions and flow of data and knowledge.



2.2. Spatial Extent

Research covered all 11 marine plan areas in England. The offshore limits of the plan areas are defined by that of the outer limit of the Exclusive Economic Zone and England's territorial waters. Inshore, plan areas extend to the mean high water spring tide[2].

2.3. Species List

The species list was collated from: (i) historical data held by the project team; (ii) data manually transcribed from authoritative websites; and (iii) stakeholder contributions. During consultation, stakeholders contributed additional names. The final list contains 163 species which have been recorded in English waters.

Table 1. Common names referred to colloquial species aliases. Processing was case sensitive and unusual spelling for the colloquial names is common.

Common Name	Colloquial Name
Rockling (Unspecified)	Rockling
	Slug
Goby (Unspecified)	Goby
Blenny (Unspecified)	Blenny
Sole (Unspecified)	Sole
Weeverfish (Unspecified)	Weaver
	Weever
Gurnard (Unspecified)	Goudies
	Gurnard
Mullet (Unspecified)	Mullet
	Grey mullet
Pipefish (Unspecified)	Pipefish
Eel (Unspecified)	Eel
Bream (Unspecified)	Bream
Sea Scorpion (Unspecified)	Scorpion fish
	Sculpin
Wrasse (Unspecified)	Wrasse
Sea Scorpion (Unspecified)	Sea scorpion
	Sea scorp
	Seascorp

[2]Marine plan areas available at https://data.gov.uk/dataset/ceecc6a3-297b-4a72-b2ca-d430324b546f/marine-management-organisation-marine-plan-areas

	Rock sculpin
	Pig fish
	Millers thumb
	Father lasher
	Granny fish
	Bull rout
	Bullhead
	Clobberhead
	Clockamunjy
	Cockamunjy
	Devil fish
	Devilfish
	Devil's fish
	Snotty bully
Flatfish (Unspecified)	Flat fish
	Flatfish
	Flattie
	Flatty
Skate/Ray (Unspecified)	Skate
	Ray
	Raymond
	Raymondo

2.4. Compiling the List of Named Locations

The gazetteer of location names was compiled from the sources listed in Table 2. Sources were ranked according to their quality as indicated in the table. The gazetteer was expanded by replacing words in place names with common substitutions. For example, a beach may be called *beach*, *sand* or *sands,* e.g. North Beach would be expanded to include *North Sand* and *North Sands*.

Table 2. List of sources from which the shore and afloat gazetteers (named locations with geospatial coordinates) were compiled; afloat, source contributed to the afloat gazetteer; shore, source contributed to the shore gazetteer.

Source Name	Rank	Used	Description
Local Knowledge	1	Shore	Colloquial names derived from data mining and stakeholder contributions.

UKHO Constructs	2	Shore	UKHO shoreline constructs layers, provided by the MMO. Provides names of piers, harbours etc.
UKHO Marine Use	3	Shore	UKHO Marine Use layer, provided by the MMO. Provides names of piers, harbours etc.
OS Open Names Gazetteer	4	Shore, Afloat	“A comprehensive dataset of place name, road numbers and postcode”. Filtered to retain place names only. https://www.ordnancesurvey.co.uk/business-government/products/open-map-names
UKHO SeaCover	5	Shore, Afloat	Polygons of named sea features. Provided by the MMO.
UKHO Gazetteer	6	Shore, Afloat	UKHO gazetteer of named sea features, point data.
MEDIN	7	Shore, Afloat	UK marine gazetteer of sea features. Public data.
Geonames.org.uk	8	Shore, Afloat	Creative commons licensed set of point data of named features compiled from multiple sources. https://www.geonames.org/about.html
Geograph.org.uk	9	Shore, Afloat	https://www.geograph.org.uk/. Public, crowd-sourced named locations for the UK.
Substituted names	10	Shore	Substitutions, as previously described.

2.5. Shore

The study recruited stakeholders across all IFCA regions both during stakeholder engagement and once interim analysis was complete. The Association of IFCAs assisted with the engagement of IFCA staff in each IFCA region to review a sample of results; and Substance and the Angling Trust recruited individual sea anglers to also review sample data. The three outputs which were validated included:

i) ***sites*** (i.e. whether the reported sites are used for the purposes of recreational sea angling).

ii) ***site activity ranking/value*****,** (i.e. whether the provided activity ranking of high, medium or low was correct: output data: *overall*).

iii) ***species ranking/value*** (a list of three species associated with each site in a) winter/spring and b) summer/autumn, ranked as high, medium or low with regards to its association with the site compared with the region as a whole: output: *species*).

2.6. Charter Boats

Data mining of open-text references was used to provide spatial and seasonal indicators of relative activity, ground preferences and species preferences. The data mining methods shared the same approach as the shore methods. The exception was that data were insufficient to provide high resolution maps of where angling takes place.

The list of ground types was derived by review of the register and of fisher's knowledge. Ground types are described in Table 3. Open text samples were scanned for terms associated with these ground types, species and temporal indicators, and tagged accordingly.

Table 3. List of ground types.

Ground Type	Description
Estuary	All fishing occurs within the bounds of an estuary. This will almost always refer to large estuarine systems, e.g. River Mersey.
General ground	Fishing over other grounds, typically associated with anchoring.
Deep open water (Pelagic sharks)	Mainly large pelagic shark species, porbeagle, blue, thresher and mako.
Rough	Includes hard, high-rugosity substrates i.e. reefs, rock pinnacles and similar seabed structures.
Sandbanks	Significant sandbank structures, usually deposited by the interaction of conflicting current streams.
Wrecks	Wrecks where some portion of the structure is raised above the seabed.

2.7. Afloat Platforms

There is little spatial information on afloat platforms available in open text published by anglers. Nevertheless, three additional sources were available (IFCA sightings, StakMap and the pMPA survey of Kenter et. al, 2013) which required some basic processing and filtering (see the technical report for details).

To assist the mapping of afloat platforms, launch and storage facilities were investigated and mapped. This included moorings, marinas and harbour facilities that provide quick launching and protection from the worst weather. Slipway locations were collated and cross-validated using two primary sources; Google Earth satellite imagery (Google 2013) and boatlaunch.co.uk (Campbell 2015). A point-in-time estimate of the relative recreational angling boat numbers stored in moorings, marinas and harbours across England was estimated from visual counts of angling boats located in on-water boat storage facilities, using satellite imagery.

3. Results

Twelve data layer outputs were created by this project and will be available for public access at data.gov.uk and https://www.gov.uk/guidance/explore-marine-plans:

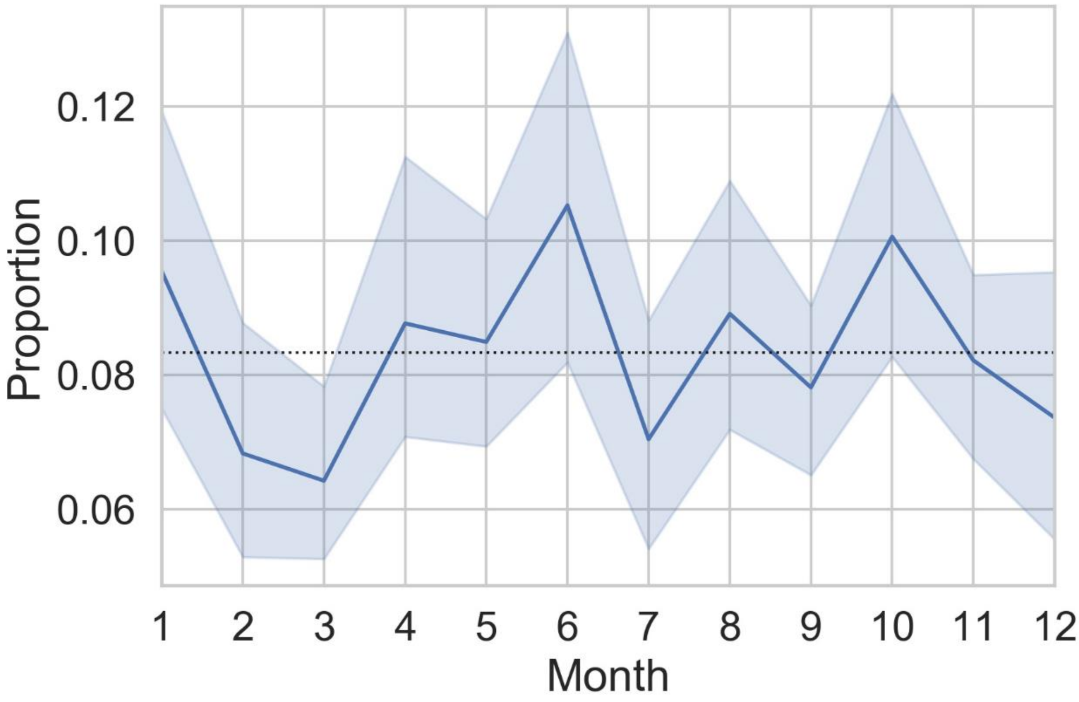
cb	Register of charter boats
cb_grounds	Proxy indicator of the grounds favoured by charter boats
cb_pivot_dst_pts	Total angler trip days per year for charter boats stratified by the operating distance license
cb_reports_all	All occurrences where species co-occurred with charter boat names
cb_spp_pvt_sans_dist_pts	Proxy indicator of species captured by charter boats
overall	Proxy indicator of relative shore marine angling activity
raw (shore)	Disaggregated data of all records of fish species names found to co-occur with named spatial location(s) and a temporal reference
raw (afloat)	Deaggregated data of each species co-occurrence with named spatial location and a temporal indicator (predominantly trip reports).
seasonal	Proxy indicator of relative shore marine angling activity
species	Proxy indicator of relative shore marine angling activity, aggregated by species and season (Winter: October to March; Summer: April to September)
species_full_join	Same as species but includes all possible stratification combinations
ugc_afloat	Angling trips divided by the polygon area in square kilometres

3.1. Shore

A total of 471 sources were identified and evaluated, of these, 60 contributed to the gazetteer of place names and 55 unique sources were used for spatial mapping. A total of 379,808 distinct open text samples s were extracted, of which 125,736 had text matches with named locations from the shore locations gazetteer.

When overall activity is considered by month, there is variability in angling activity throughout the year, as shown in Figure 2. Peaks of activity occur in June and October, as well as several other months showing above average activity (April, May, August). There is also reduced observed activity in February and March. Seasonality is discussed in detail in section 3.1 of the full technical report.

Figure 2. Relative angling activity as indicated by species frequencies extracted from open text. The dotted line is the mean expected activity level. The month range is January (Month 1) to December (Month 12).



The top three ranked species across all marine plan areas were cod, whiting and sea bass. Cod and sea bass also featured in the top five ranked species for each plan area, with the exception of the North East Inshore (Figure 3). Ray species, flatfish species and whiting also had high values for the majority of the marine plan areas (Figure 3).

Figure 3. Top five valued species by Marine Plan Area (MPLA).

3.2. Charter Boats

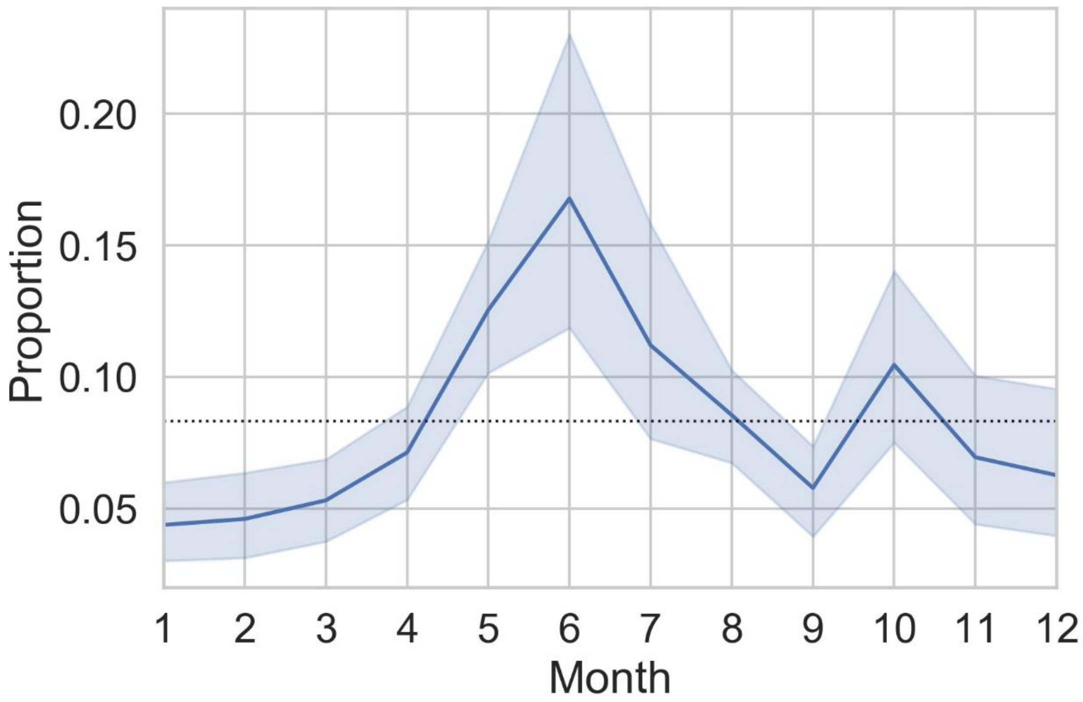
In total, 364 vessels were identified as operating from 91 ports and launch facilities across England. This figure will be subject to some error because it was impractical to validate the status of each vessel by direct contact. However, it compares closely to the 399 vessels identified for the Sea Angling 2012 research (Hargreaves et al., 2013). Details on trip numbers—used to describe ground and species preferences—were derived from data mining. The open-text references s from 38 different fishers knowledge sources were mined, with a total of 49,424 separate open-text samples contributing to this data set.

Estimated maximum angler trip days per annum were 733,766 ±12,034, with the South Inshore marine plan area having the numerical maximum number of charter boat operators (170, 47%). The spatial layer *cb_pivot_dst_pts* shows a by-port breakdown of maximum angler trip days per annum.

Results were produced for overall trips by season, trips by grounds, grounds by season and trips by species.

In terms of overall number of trips, these are at a maximum in summer and a minimum in winter (summer, 61%; winter, 39%). Figure 4 shows the proportional activity by month (mean; December, 0.063 ±0.068; January, 0.044 ±0.037; February, 0.046 ±0.039). There is an increase in activity through spring to a peak in June (0.17 ±0.13). This pattern supports anecdotal evidence from charter skippers in research conducted by Substance for MMO in 2012 (Hargreaves et al., 2013) in which skippers frequently reported that they will stop operations during late winter and early spring to perform maintenance work.

Figure 4. Relative by-month angling activity for charter boats, as indicated by species frequencies extracted from open text. The dotted line is the mean expected activity level (mean i.e.1⁄12 of total activity). The month range is January to December. Confidence intervals are displayed as the blue shaded area around the charter boat frequency line (blue thick line).



General ground fishing was the most popular type of fishing ground type across England, with 1,841 (34%) of maximum trip days per annum (trips yr-1). This was followed by angling over wrecks 1721 ±374. Fishing in deep open water (for example, for large pelagic sharks) was the least often reported “ground”, with 144 ± 23 trips yr-1.

In terms of species, the top three ranked species across all marine plan areas for charter boats were cod, skates and rays, and whiting (Figure 5). Cod and skates and rays featured in the top five valued species for every inshore marine plan area, with plaice also featuring in three areas (Figure 5). Of note is the relatively high importance of breams (dominated by black bream) in the South, with the value for the inshore South marine plan area being 360% higher than the mean for all areas (probably due to it being a key species for charter boats in the area). Surprisingly, plaice was a highly ranked target species in the North West throughout the year, being 248% higher than the mean. This high ranking for plaice in charter boat catch reports for the region was checked manually and found to be representative. Sea bass featured prominently in the South East plan area.

Figure 5. Top five species by angler value for charter boats. Data extracted from fisher knowledge for charter boats. Marine Plan Area (MPLA) is determined by the charter boat home port and not known angling grounds.

3.3. Afloat Platforms

In contrast to charter boats, fisher's knowledge sources were particularly data-poor for private boat and kayak afloat platforms. Of all open text samples for which a spatiotemporal and species value designation could be made, only 154 (0.2%) were assigned as from a kayak and 905 (1.4%) from afloat platforms (predominantly private boat).

3.4. Launch and Storage Facilities

Slipways in England can be under public ownership by the local authority or other governmental organisation or privately owned. During the summer months local authorities will frequently collect fees from people wishing to launch boats. Such facilities are also used by kayak anglers who can usually use these at no charge. Private facilities may be associated with holiday accommodation (e.g. caravan sites), clubs and other private landowners. Access to these slipways will usually be associated with a fee. Assisted launching/recovery services may also be provided, particularly where slipway access does not extend to the low water mark or is not constructed of a hard building core.

Across England 528 slipways were identified and these are detailed in Annex Z in the full technical report. The greatest densities are seen in the South and South West Inshore marine plan area and lowest density in the North East Inshore marine plan area.

A total of 550 on-water facilities were identified, with a point-in-time total estimate of boats that could be used for sea angling (95% confidence intervals) of 12,946 [10,543, 15,349]. Viewing sampled facilities shows that 88% of sampled facilities had 50 or fewer recreational sea angling-centric boats. The southerly marine plan areas hosted the largest facilities.

Of the 550 facilities, 236 (43%) were in permanent structures (e.g. harbours and pontoons) and 314 (57%) were buoyed moorings. The South West Inshore marine plan area had the highest number of recorded facilities (175, 32%), and East Inshore had the fewest (41, 7%). However, the South Inshore marine plan area had the highest estimated boat numbers with 45% of the total sum across all marine plan areas.

4. Discussion

4.1. Overview

The spatial extent of shore angling was successfully mapped at high, but variable, resolution. Data from open text were sufficient to provide strong indicators of value when data were disaggregated by season and species. Approximately 51% ±7.4 of all intertidal areas were assigned some activity (and species) angling value.

The Sea Angling 2012 site survey recorded species, spatial and temporal variables for 4,703 species catches (Armstrong and Hyder, 2013). In contrast, this methodology extracted 503,681 activity records (afloat and shore), but the two approaches have different limitations. The onsite survey of Sea Angling 2012 in which species and activity were recorded with spatial data is costly, but statistically sound whereas data mining such as this project can collect many more records per unit cost but may have unknown bias of the fisher.

Across the shore dataset, the volume of data allows us to have reasonable confidence in the monthly fluctuations in activity (Figure 2). The data suggests a high degree of variation at individual sites, as anglers switch between species, venues, fishing gears and strategies to meet changes in species availability throughout the year. These patterns match expectation from our personal knowledge; from research on seasonal changes in the distribution and migration of mature sea bass (Pawson and Pickett, 1987; Pickett et al., 2004; Pawson et al., 2007a, 2007b), and stock estimates (Pawson et al., 2007b).

Mined data is collected information from a subset of the population of anglers thus outputs are only suitable in making comparisons of relative value. The broad assumption made is that the population of anglers who publish open text to the source lists report values of sites in the same way that the wider general population of anglers would do for those areas.

It is also assumed that the population of anglers who contribute open text data is representative of the total angler population with no significant biases across the factors and factor levels reported. These assumptions are reasonable, but difficult to verify within the scope of this project. For instance, it may be the case that there are biases of enthusiasm and experience within those who report. Biases were examined using a qualitative ground-truthing validation.

Looking at species, it is apparent that biases in species reporting were present. ‘Prestige biases’ are particularly relevant to the data mining methods used (Campbell et al., 2001), which can result in the over-reporting of prestige, sport and rare species, and under-reporting of mundane trips where only common species, non-trophy specimens or no captures have occurred. This is most clearly seen in the comparatively high value of sea bass, cod and ray species, and to a lesser extent bream, plaice and smooth-hound species. This contrasts with the Sea Angling 2012 (Armstrong and Hyder, 2013) on-site survey results where whiting, mackerel and dab were the top three captured species (rays were 16^{th}) and in the North Wales Pilot Surveys (Goudge et al., 2009, 2010) where the ranking was whiting, mackerel and wrasses (mean shore catch percent; cod, rays, base = 0.2%). However, there is agreement with survey assessment of what anglers report as their target species, where combined data from four sources ranked sea bass (1), cod (2) and rays (4) in the top four targeted species (review, Monkman et al., 2015b). In addition, sea bass, cod and mackerel were ranked as the top three targets among both shore and private boat anglers in Sea Angling 2012 (Armstrong et al., 2013).

Marine spatial planning seeks to ensure that the right uses of the marine environment occur in the right place and at the right time, and that sustainable development underlies any decisions on what can or cannot take place. This includes consideration of social, environmental and economic factors in decision-making. Marine plans guide management of the marine environment and help inform an understanding of the interaction between commercial and recreational fishing in the marine planning context. This includes the benefits of marine planning in terms of promoting sustainable marine recreational activities, including sea angling, which is known to be an important economic sector in England, supporting many coastal communities and associated facilities.

The outputs from this research will also be used to inform decision-makers. For example, maps showing areas of relative high-intensity recreational angling will be of use when looking at development applications, to see if there would be any associated impacts on anglers; either on the fish resources, the access of recreational anglers to their typical fishing grounds, or businesses related to supporting angling, such as charter boats.

When assessing ecosystems services, a clear-cut measure of fishing effort and catch (by variables, such as angling method) is ideally required and should accompany assessments of impact by those variables. However, when making judgements about the relative importance of factors such as social, physical and mental wellbeing and environmental benefits, value (to fishers) is a more meaningful measure. In addition, the value outputs provided have been shown to correlate highly with angling effort measures (Monkman, 2013; Monkman et al., 2015a, 2018a, 2018b).

A limitation of the method is that we cannot, with absolute certainty, say a given location has no value for recreational sea angling. When considering the spatial distribution of shore angling, absence of evidence is not evidence of absence. However, with some confidence it would be possible to say that an area ranked with no data is not highly valued where value is defined as the count of visits near the location. The validation exercise showed that there is a high degree of confidence that highly ranked sites are accurately predicted.

There is, however, other limitations of count of visits near the location as a measure of value. Value cannot be assumed to be the same as some notional, all-encompassing value measure. For example, some areas may be highly valued but not rank highly because the site is under-reported. A highly pertinent example would be the pursuit of comparatively rare species (e.g. sting ray) at certain venues or during certain time of the year. Further evaluation would be required to determine if these methods could detect such activity patterns.

The validation proved to be invaluable in revealing exceptions in the output results showing the importance of utilising local knowledge when handling large volumes of fisheries data. The misidentification of sea bass as a target species in Isles of Scilly for example can be attributed to the comparatively low number of anglers within the Isles of Scilly IFCA. In an area with a low number of anglers small biases may increase the count of a particular species and are more likely to impact rankings – i.e. with fewer anglers contributing data, individual contributions carry more weight, so may influence changes in the results to a greater extent. This highlights methodological limitations in the reliability of accurate activity level for sites and species where there are few sources of open text.

Alternate approaches that could have been adopted to validate such data include recruiting a higher number of stakeholders, creating a more purposeful approach with definitions for the subjective rankings, or making the entirety of the data open source, with the ability to retrieve feedback online. Subjectivity, however, will always remain an issue in validation exercises, regardless of the approach type. Therefore, getting a large enough sample of sea anglers that are representative of the sea angler population is preferable to validate results.

The text mining approach here has advantages relative to other approaches. Data embedded in fisher knowledge reveals the preferences of participants without the biases which arise when soliciting a response directly. It is reasonable to assume that recall bias will be reduced in comparison to some survey instruments as posts will generally be made soon after the trip occurred. However, social media data are non-independent in space and time and the same users in a community will tend to provide repeated contributions (Lerman, 2007; van Mierlo, 2014; Nielsen, 2017). Clearly the locations frequented by participants in their recreational activity will not be randomly chosen. Social media posts are likely to influence others in the social network (Centola, 2010; Bond et al., 2012), will increase contributions and may stimulate recreational activity in other users.

The data mining method used is repeatable with some caveats. Repeatability in acquisition, classification georeferencing and reporting is intrinsic to the process. Given the same starting data, we end up with the same outputs. In fact, the process could be repeated at any time, and data compared as the time series continues to increase. Provided the code does not change, direct comparisons can be made between time points, assuming biases remain the same between years.

Certain elements of the whole process were non-deterministic. Choices were made on which sources were used to produce the gazetteers and data, and some open text samples will become unavailable and new ones will arise. Evidence does suggest there is a decline in the use of angling blogs and forums (Monkman, 2013) as the popularly of the large social networking sites (e.g. Facebook) continues to increase (Statista, 2018).

4.2. Afloat and Charter

The afloat and charter outputs are discussed together because the extent of data for both groups across England was poor. As detailed in the methods, both afloat and charter datasets included data-mined data, and the previous discussion points equally apply.

Determining the angling locations of private boat anglers and charter boats was problematic. Data coverage from survey sources was patchy and although open text samples were relatively numerous, named locations were very rarely used in open text (possibly to protect knowledge of fishing grounds which can be commercially advantageous) and the afloat gazetteer contained just 2% of the records contained in the shore gazetteer by count. This is despite the area available to afloat recreational sea angling being at least three orders of magnitude greater. All available sources of data had spatial coverages which were incomplete, with large areas with no recorded value. Where a value was assigned, the area polygon frequently covered an area over 10km^2.

The StakMap project (detailed in the full technical report) was successful in mapping high resolution spatial data for both afloat and charter platforms, particularly towards the south of the country. However, coverage was extremely poor in the offshore marine plan areas and in the more northerly marine plan areas. The StakMap project was also a non-randomised self-selecting survey sample. In addition, the lineage of the data is largely unknown as no detailed methodology or formal report could be found. The dataset also included point data which had been subsequently buffered to 300 meters. When standardising value by an area measure, these buffered areas will have a high value. This is an accepted limitation.

The estimated number of charter boats is similar to that in some previous studies (there were an estimated 399 in Sea Angling 2012 (Hargreaves et al., 2013)) although the estimated number of charter angler day trips (733,766) is much higher than in other studies: the ONS survey in Sea Angling 2012 estimated 370,825 angler days; and the charter boat survey in the same study was even lower at 105,871. It should be noted that the estimate of days in this research is a maximum value for both boat numbers and possible days and this does not take account of days lost to weather (not known) and there are no adjustments made for charters doing mixed trips. Poor data quality, survey methods and other factors may also account for differences.

Some of the data sources used are several years old and as such may be out of date. In addition it is a reasonable assumption that the same species retain their popularity through recent times. Species preferences demonstrate anglers' value size, fighting prowess and palatability and these will remain largely invariant except where availability is reduced through significant reductions in catchability (e.g. angel shark and common skate). The popularity of venues can also reasonably be assumed to not change markedly over time - except where venues become unavailable (e.g. piers) - because important predictors of site popularity will be accessibility, proximity to population centres and infrastructure, fish catchability and social influence (Carlin et al., 2012; Dabrowksa et al., 2017; Hunt et al., 2019). It is important to note that all methods which use data mining include contemporary sources.

The interpretation of the spatial charter and afloat values provided in the spatial layer may best be considered as similar to the chance of finding a boat within a fixed area.

4.3. Facilities

Improvements in the resolution of satellite imagery has made it easier to identify the extent of boat facilities and to count boat numbers. The resolution is of high quality to identify individual mooring buoys which can be counted to produce estimates of total capacity for a given mooring. The mapping exercise captured all on-water storage facilities in England's marine plan inshore areas.

The location of these facilities is highly correlated with the distribution of afloat effort. Angling boat numbers were a single point–in-time estimate of the relative distribution of boats potentially used for recreational sea angling across the sample extent. Only relative comparisons can be made and the reported boat numbers must not be interpreted as an estimate of total private angling boat numbers for any given spatial area.

Although recreational sea angling boats are relatively easy to identify, not all boats identified as used for recreational sea angling may be used for sea angling. Cruisers, ribs and powerboats may also be involved in angling activity, though undoubtedly at a reduced average activity level, but these were assigned into the 'other' category. The identification of recreational sea angling boats is open to observer interpretation although a single observer was used to make all estimates of recreational sea angling boat numbers. In addition, this was a point-in-time estimate, and that point-in-time was different across England as not all satellite imagery was captured at the same time. Variations in the time of day, month and year may bias the results however; dates and times were reviewed and satellite images were captured during spring and summer and during daylight hours and repeat studies could follow this approach to facilitate comparability. Each of these influences may serve to increase or decrease the estimates and it would be inappropriate to take the figures as a proxy quantitative indicator of the magnitude of recreational sea angling -centric vessels likely to be operating from the respective facilities.

4.4. Recommendations

Survey costs are directly proportional to sampling effort. The extent of the areas involved on the shore and at sea make it completely impractical to conduct a comprehensive site survey of the spatial extent of activity. This is particularly true of the afloat sector which covers a much larger area than shore and in addition private boat users are comparatively rare in the national population, making traditional low-cost survey methods ineffective.

In addressing environmental stewardship in marine spatial planning, it is important to undertake work to better understand the potential impacts of recreational sea angling on the ecosystems and associated habitats of high vulnerability or otherwise at risk. These habitats can then be prioritised to provide assessment of the potential impact of recreational sea angling. If significant impacts are possible, an appropriate spatial resolution needs to be determined to match predetermined risk levels of angling effort with the habitat in question. A suitable survey approach can then be decided to deliver outputs at the required resolution.

Other approaches to the validation could be undertaken to increase the input of stakeholders and individual sea anglers. This could include:

- a much more extensive survey involving angling clubs and IFCAs in each area, but this could have significant resource implications and require preparation of ‘packs’ for a wide range of sites for people to comment on.
- a more purposeful approach to ask stakeholders to select the sites they know about and then validate what we have at those sites with them (an approach ultimately adopted in this project).
- making the full dataset available and have an open, ‘crowd sourced’ online feedback mechanism for people to identify the sites and whether they agree with the grading of them. This could be accompanied by questions to assess respondent knowledge of the sites, to inform use of this input.

However, issues with accuracy and subjectivity will remain whatever approach is taken and developing a better understanding of the distribution of species will involve a more extensive catch survey. Although the Sea Angling Diary project records the activity and catches of 1,750 people in the UK, this is to produce annual estimates and does not produce data at the resolution required for this research. More extensive catch surveying might enable this.

Replication of the methods to estimate boat numbers should be repeated at the same time of year to ensure comparability. An alternative approach might be to commission satellite imagery within particular time windows to assess seasonal changes. Additional on-site surveys of anglers and facility managers could further help refine population estimators of boat numbers.

Other potential approaches could include adding to and expanding the data collected in the StakMap survey, for instance utilising online methods and existing angler databases; and targeted work in some areas to address poor data, such as the afloat data in the Northern marine plan areas.

5. References

Armstrong, M. and Hyder, K. (2013) ‘Sea Angling 2012 – a survey of recreational sea angling activity and economic value in England: Annex 4: An on-site survey of recreational sea angling catches from the shore and from private and rental boats in England in 2012. Report. Defra.

Armstrong, M., Brown, A., Hargreaves, J., Hyder, K., Pilgrim-Morrison, S., Munday, M., Proctor, S., et al. (2013). Sea Angling 2012 – a survey of recreational sea angling activity and economic value in England. Report. Defra.

Bond, R. M., Fariss, C. J., Jones, J. J., Kramer, A. D. I., Marlow, C., Settle, J. E., and Fowler, J. H. (2012). A 61-million-person experiment in social influence and political mobilization. Nature, 489: 295–298. Nature Publishing Group.

Campbell, D., West, L., Lyle, J., McGlennon, D., Coleman, A., Henry, G., and Reid, D. (2001). The Australian National Recreational Fishing Survey: 2000-01. Report. IIFET, Australia.

Campbell, G. (2015). Boatlaunch.co.uk Home Page. Available at: http://www.boatlaunch.co.uk/#/map

Carlin, C., Schroeder, S. A., and Fulton, D. C. (2012). Site Choice among Minnesota Walleye Anglers: The Influence of Resource Conditions, Regulations and Catch Orientation on Lake Preference. North American Journal of Fisheries Management, 32: 299–312. Taylor & Francis.

Centola, D. (2010). The spread of behavior in an online social network experiment. Science (New York, N.Y.), 329: 1194–7. American Association for the Advancement of Science.

Dabrowksa, K., Hunt, L. M., and Haider, W. (2017). Understanding How Angler Characteristics and Context Influence Angler Preferences for Fishing Sites. North American Journal of Fisheries Management, 37: 1350–1361. Taylor & Francis.

Defra. (2009). Designation of Marine Conservation Zones in English inshore waters and English and Welsh offshore waters. Marine and Coastal Access Act 2009. Statute Law Database.

European Commission. (2014). Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning. EC.

Food and Agriculture Organization of the United Nations. (2008). Report of the twenty-fifth session of the European Inland Fisheries Advisory Commission: Antalya, Turkey, 21-28 May 2008. Food and Agriculture Organization of the United Nations, Antalya, Turkey. Session 25: pp. 36 pp.

Giovos, I., Keramidas, I., Antoniou, C., Deidun, A., Font, T., Kleitou, P., Lloret, J., et al. (2018). Identifying recreational fisheries in the Mediterranean Sea through social media. Fisheries Management and Ecology, 25: 287–295.

Google. (2019). Google Earth Pro. Google.

Google Earth. (2019). Boat Layer Data. http://www.google.com/earth/index.html.

Goudge, H., Morris, E. S., and Sharp, R. (2009). North Wales Recreational Sea Angler (RSA) Pilot Surveys: Winter Results December 2007 to March 2008. Report. Marine Ecological Solutions. 67pp.

Hargreaves, J., Brown, A., Pilgrim-Morrison, S., Williamson, K., Armstrong, M., and Hyder, K. (2013). Sea Angling 2012 – a survey of recreational sea angling activity and economic value in England: Annex 3: A survey of charter boat sea angling catches in England. DEFRA. pp. 1–44.

Hind, E. J. (2014). Knowledge research: A challenge to established fisheries science. ICES Journal of Marine Science, 72: 341–358.

Hunt, L. M., Camp, E., van Poorten, B., and Arlinghaus, R. (2019). Catch and Non-catch-related Determinants of Where Anglers Fish: A Review of Three Decades of Site Choice Research in Recreational Fisheries. Reviews in Fisheries Science & Aquaculture: 1–26. Taylor & Francis.

Hyder, K., Weltersbach, M. S., Armstrong, M., Ferter, K., Townhill, B., Ahvonen, A., Arlinghaus, R., et al. (2018). Recreational sea fishing in Europe in a global context—Participation rates, fishing effort, expenditure, and implications for monitoring and assessment. Fish and Fisheries, 19: 225–243. Blackwell Publishing Ltd.

Johannes, R. E., Freeman, M. M. R., and Hamilton, R. J. (2000). Ignore fishers' knowledge and miss the boat. Fish and Fisheries, 1: 257–271.

Kenter, J. O., Bryce, R., Davies, A., Jobstvogt, N., Watson, V., Ranger, S., Solandt, J.-L., et al. (2013). The value of potential marine protected areas in the UK to divers and sea anglers. Cambridge, UK.

Lerman, K. (2007). User Participation in Social Media: Digg Study. In IEEE/WIC/ACM International Conferences on Web Intelligence and Intelligent Agent Technology Workshops, pp. 255–258. arXiv.

Monkman, G. G. (2013). Recreational bass angling in Wales: Approaches to data collection and the distribution of angling effort in the recreational European sea bass (Dicentrarchus labrax L.) fishery. Bangor University.

Monkman, G., Cambie, G., Hyder, K., Armstrong, M., Roberts, A., and Kaiser, M. (2015a). Socioeconomic and Spatial Review of Recreational Sea Angling in Wales. http://fisheries-conservation.bangor.ac.uk/wales/documents/52.pdf.

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

Monkman, G. G., Hyder, K., and Kaiser, M. J. (2018a). Text and Data Mining of Social Media to Map Wildlife Recreation Activity. Biological Conservation, 228: 89–99.

Monkman, G. G., Hyder, K., and Kaiser, M. J. (2018b). Heterogeneous public and local knowledge provides a qualitative indicator of coastal use by marine recreational fishers. Journal of Environmental Management, 228: 495–505.

Monkman, G. G., Kaiser, M., and Hyder, K. (2018c). The ethics of using social media in fisheries research. Reviews in Fisheries Science & Aquaculture, 26: 235–242. Taylor & Francis.

Nielsen, J. (2017). Participation Inequality: The 90-9-1 Rule for Social Features.
Pawson, M. G., and Pickett, G. D. (1987). The bass (Dicentrarchus labrax) and management of its fishery in England and Wales. Lowestoft. 1–37 pp.

Pawson, M. G., Pickett, G. D., Leballeur, J., Brown, M., and Fritsch, M. (2007a). Migrations, fishery interactions, and management units of sea bass (Dicentrarchus labrax) in Northwest Europe. ICES Journal of Marine Science, 64: 332–345.

Pawson, M. G., Kupschus, S., and Pickett, G. D. (2007b). The status of sea bass (Dicentrarchus labrax) stocks around England and Wales, derived using a separable catch-at-age model, and implications for fisheries management. ICES Journal of Marine Science, 64: 346–356.

Pawson, M. G., Glenn, H., and Padda, G. (2008). The definition of marine recreational fishing in Europe. Marine Policy, 32: 339–350.

Pickett, G. D., Kelley, D. F., and Pawson, M. G. (2004). The patterns of recruitment of sea bass, Dicentrarchus labrax L. from nursery areas in England and Wales and implications for fisheries management. Fisheries Research, 68: 329–342.

Radford, Z., Hyder, K., Zarauz, L., Mugerza, E., Ferter, K., Prellezo, R., Strehlow, H. V., et al. (2018). The impact of marine recreational fishing on key fish stocks in European waters. PLoS ONE, 13. Public Library of Science.

Richardson, E. A., Kaiser, M. J., Edwards-Jones, G., and Ramsay, K. (2006). Trends in sea anglers catches of trophy fish in relation to stock size. Fisheries Research (Amsterdam), 82: 253–262. Elsevier Science B.V., P.O. Box 211 Amsterdam 1000 AE Netherlands.

Statista. (2018). Number of social media users worldwide from 2010 to 2021.

The European Parliament and The Council of the European Union. (2014). Directive 2014/89/EU Of The European Parliament and Of The Council. Official Journal of the

European Union, 257: 1–11. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0089&from=EN (Accessed 7 October 2019).

The White House. (2010), July. Executive Order 13547 - Stewardship of the Ocean, Our Coasts, and the Great Lakes. The White House, Office of the Press Secretary.

Van Mierlo, T. (2014). The 1% rule in four digital health social networks: an observational study. Journal of medical Internet research, 16. JMIR Publications Inc.