Marine Management Organisation

Mapping of under 12m vessel fishing activity (MMO1264)






...ambitious for our seas and coasts

MMO1264: Mapping of under 12m vessel fishing activity, April 2023

Report prepared by:
Marine Management Organisation

Commissioned by: Defra's Marine Biodiversity Impact Evidence Group (IEG), established in March 2014 to co-ordinate evidence collection concerning impacts of human activities. Membership of the Group is:

- Department for Environment Food and Rural Affairs (Defra)
- Welsh Government
- Natural England
- Centre for Environment, Fisheries and Aquaculture Science (Cefas)
- Environment Agency (EA)
- Inshore Fisheries Conservation Authorities (IFCAs)
- Joint Nature Conservation Committee (JNCC)
- Marine Management Organisation (MMO)
- Natural Resources Wales (NRW)

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

Disclaimer:
This report contributes to the Marine Management Organisation (MMO) evidence base which is a resource developed through a large range of research activity and methods carried out by both MMO and external experts. The opinions expressed in this report do not necessarily reflect the views of MMO nor are they intended to indicate how MMO will act on a given set of facts or signify any preference for one research activity or method over another. MMO is not liable for the accuracy or completeness of the information contained nor is it responsible for any use of the content.

Unless otherwise stated, references in this document to EU, Council or Commission Regulations shall be read as part of retained EU law which, by virtue of the European Union (Withdrawal) Act 2018 now form part of UK domestic law and may subsequently be amended.

When referencing this publication, please cite as:
MMO (2023). Mapping of under 12m vessel fishing effort. A report produced for the Defra IEG, MMO Project No: 1246, April 2023, 43pp

Contents

Executive Summary

Commercial fishing vessel activity in England is regulated by the Marine Management Organisation (MMO). Reporting requirements vary, but generally the

reporting requirements increase as the catching capacity and the size of vessels increase. This means MMO has less data available for smaller vessels (under 12m) which comprise the majority of the fleet in England (88% of vessels).

An accurate understanding of inshore fishing vessel activity is important in terms of regulators and policy makers being able make the best decisions for fisheries management, as well as informing marine conservation, marine planning and licensing, as well as fishers themselves in matters such as proving historic track records to benefit from continued access.

This project investigated existing data sources accessible to MMO to enable the spatial mapping of under 12m fishing vessel activity, with each data source described in terms of its advantages and limitations.

The project initially intended to use a vessel sightings-based approach to create a current picture of activity around England. However, upon investigation there wasn't enough appropriate data to meaningful analyse. The next best source of data was judged to be the UK's annual return to the European Union (EU) Commission's Scientific, Technical and Economic Committee for Fisheries (STECF) Fisheries Dependent Information (FDI) call. This data set includes sales note data submitted by the buyers of the fish for under 10m vessels and paper logbooks for 10-12m vessels.

The main output from this project alongside a general review of datasets is a web-based mapping tool, where it is possible to choose to display one of three map types: fishing effort (in terms of days), the amount of fish landed from the area (in live weight tonnes) and the value of fish landed (in GBP). Effort data covers all UK vessels in UK waters and can be filtered by Nationality, vessel length group, gear type and year (2014-2020). Landing's data is restricted to the under 12m fleet in English waters and can be filtered by species, Nationality, vessel length group, gear type and year (2016-2020).

It is recommended that the new Inshore Vessel Monitoring System (iVMS) for under 12m vessels and the Record your Catch application (referred to here as Catch App) for under 10m vessels data sources should be investigated for data quality and utility. The aspiration is that they can be combined to form the most definitive spatial activity data for policy and scientific assessment. Catch App began full enforcement in Feb 2022 and the iVMS is being rolled out in 2023, MMO will be able to begin to draw down data for analysis, in the interim it would make sense to attempt to repeat this mapping exercise with the data gathered for the STECF data call on an annual basis to enable the most up to date data to be used, noting though that the UK no longer submits this data to STECF and conversations are ongoing about how fishing activity data is submitted to ICES.

1. Introduction

Impacts of fishing

Marine fish stocks provide significant socio-economic benefits to humans. Fish and shellfish can provide high protein, low carbon emission food security. Fisheries provide employment in coastal areas with otherwise limited opportunities and are an integral part of the culture and identify of UK as a maritime nation.

However, the exploitation of fisheries is associated with a range of impacts depending on when, where and how much fishing is being conducted. Impacts include significant direct and indirect effects on habitats, reduced biodiversity and changes to the structure and function of marine systems (Caveen *et al* 2014). Many fisheries were historically overcapitalised resulting in overfishing and the depletion of fish stocks, with a corresponding loss of stock productivity and profitability.

Changes in the distribution and intensity of fishing and the associated impacts are not new. In the North Sea for example, the problem of overfishing was recognised as far back as the mid 19th Century where from 1840 to 1860 the numbers of trawlers on the Dogger Bank increased considerably as fishermen depleted grounds closer to shore and the sailing fleet expanded (Royal Commission 1866). This was followed in the 1930s with rapid intensity, and offshore expansion of the post-war North Sea fleet powered by rapid technological advancement and modernisation (Russell, 1942). Throughout the 1950s management favoured efficiency restrictions, particularly mesh size. When, by 1960, management the efficiency restrictions proved ineffective, total allowable catch (TAC) approaches were introduced with catch-based perspectives of fisheries activity at the forefront. TAC approaches were in turn challenged as TAC-managed fisheries entered crises in the early 1990s requiring fishing effort reduction through limiting days-at-sea and vessel decommissioning programmes (Gezelius, 2008; Holden, 1994).

Need for fishing activity data

TAC based management is still central to fisheries management in the UK e.g. via the (European Union) EU–UK Trade and Cooperation Agreement (2020) and in implementing policy targets for attaining Maximum Sustainable Yield fisheries management. However, management is progressively becoming more holistic including for example Fisheries Act (2020) ecosystem objective to ensure that fisheries "*negative impacts on marine ecosystems are minimised and, where possible, reversed*".

The last century of fisheries management has shown different perspectives on, and descriptions of, fishing activity including as effort (first by efficiency and later by capacity) and catch (though introduction of stock quotas) and more recently as environmental pressures contributing to the impacts of fishing.

Knowledge about which human activities take place where, when, and how often, is essential for managing fisheries and assessing risk to marine systems. In combination with receptor sensitivity, activity pressure is essential for describing marine impacts. Further, activity data alone is often used as a proxy measure of impact in the absence of activity-pressure or sensitivity relationship.

Whereas the location, footprint and intensity of most licensed human activities are well known (e.g., aggregate extraction, wind farms, cables and pipelines), information on fishing activities remains more problematic. New evidence

requirements for marine planning and marine biodiversity conservation emphasises the need for a spatial understanding of fishing activity.

The under 12m activity evidence gap

Current English fisheries legislation divides commercial licensed fishing vessels into three main categories for management and regulatory purposes. Categories are based on vessel size; under 10m, 10m to 12m and 12m and over vessels. Vessels larger than 12m typically have an increased environmental impact and increased nomadicity. There are different regulatory processes associated with each of the three classifications that result in different data collection and submission requirements that can be used to provide an understanding of fishing activity in English waters.

To date robust data is collected on vessels 12m and over that contribute the majority of UK landings., Vessels 12m and over are required to report their activity to MMO through an electronic logbook which is submitted daily detailing their fishing activity including species retained, weight of species, gear used and location of capture. This information is combined with satellite based spatial Vessel Monitoring System (VMS) records of position every 2 hours. Together these data and linked datasets such as the fleet register can describe many dimensions of fishing activity.

However, most English registered fishing vessels are below 12m in length (88.11% - 2,224 of 2,524 vessels[1]), noting that registered vessels doesn't mean they are necessarily active vessels. Vessels under 12m have not historically had the same catch reporting and or vessel tracking requirements. The current lack of spatial activity data for under 12m fishing activity impacts on the policy makers or regulators decision making across wide policy objectives from fisheries management, biodiversity conservation, marine planning and marine licensing, as well as the fishers themselves where the lack of data may lead to a precautionary approach is adopted.

The Marine Biodiversity Impacts Evidence Group (MB-IEG) asked the Marine Management Organisation (MMO) to undertake work to enhance understanding under 12m fishing activity. The MB-IEG is a cross-organisational evidence group led by Department for the Environment, Food and Rural Affairs (Defra).

Aims and Objectives

This project aims to improve access to, and knowledge of existing under 12m fishing activity data in support of policy and regulatory decision making

This work is delivered through two objectives:

1. Review all available spatial fishing effort data for the under 12m fleet, identifying advantages and limitations of use, as well as the possibility of updating each data set
2. Analyse and present new spatial data for the under 12m fleet

Report Structure

[1] – Over 10m vessel list and under 10m vessel list.

This report is structured around 5 main sections:

- Section 1 – An introduction to the topic (this section)
- Section 2 – An overview of Fishing Activity data providing a definition of fishing activity and the different dimensions encompassed, fisheries regulation and how this impacts data availability, as well as categories of data. -
- Section 3 – Fishing Activity Data - both sources and products with strengths and weaknesses of each.
- Section 4 – Details of the mapping exercise for accessing existing data
- Section 5 – Forward look – this explores what data emerging that can further enhance our understanding of fishing activity and the timelines and requirements to maximise these opportunities.

2. Overview of Fishing Activity Data

Defining fishing activity

Understanding of the distribution and intensity of fishing activities is dependent on the dimension of how that activity is measured and visualised. Most commonly, fishing activity is expressed in terms of time (hrs) spent fishing, but this is only one specific element of fishing activity. It is therefore necessary to define fishing activity, which is defined here as:

Fishing activity: the transit to and from fishing grounds and ports, the search for fish, the deployment, soaking or towing and retrieval of fishing gear (active fishing), taking catch onboard, processing catch at sea, and transhipment.

Different organisations will have different interests in fishing activity and will seek specific perspectives informative to their needs. For example, those with interests in carbon emissions or safety of navigation may focus on vessel movements, nature conservation most often focuses on the location and intensity of pressure from fishing gears, quota management on catches by area, marine planning on the interaction of fishing activities with space, marine resources or other maritime activities at strategic scales and licensing on use of a particular area.

For example, interest in fishing activity can be expressed in terms of:

- What is the home range of vessels from port X?
- How does fishing activity redistribute when excluded from an area?
- How do fishing interests differ by nation?
- How many times is a location trawled?

These different interests in fishing activity could be informed by a range of individual or linked datasets to understand:

- What activity is occurring (usually transits, active fishing)
- When (time stamped)
- Where an activity occurs (see section below on spatial hierarchy, but also this can be depth)

- How is it occurring (e.g., gears, vessel sizes and other demographic descriptors) and how much
- Who (nationalities, individuals, communities), and to some extent,
- Why (catch data, economics)

Hierarchy of spatial fisheries data

Throughout this report, spatial aspects of fishing data are referenced to a range spatial of scales. These are described below.

FAO Major Fishing Areas: World-wide divisions of the Food and Agriculture Organization for fisheries reporting e.g., Area 27 - North-eastern Atlantic

ICES Statistical Areas / FAO sub-areas: The International Council for the Exploration of the Sea (ICES) Statistical Areas delineates the divisions and subdivisions of FAO Major Fishing Area 27. The ICES Statistical Areas are used as bounding areas for calculation of fish statistics, e.g., catch per unit effort (CPUE) and stock estimates e.g., Central North Sea (27.4.c (FAO) or 4.c (ICES)). Areas are of irregular size and shape e.g., 27.4.c; southern North Sea and 27.7.d; eastern English Channel. ICES areas are presented in Figure 1 below.

ICES Statistical Rectangles: ICES statistical rectangles are used for the gridding of data to make simplified collection, analysis and visualization of fisheries data. Regular in shape, ICES statistical rectangles are a grid of 0.5 degree of latitude by 1.0 degree longitude (ICES). Due to earth's curvature, the sea area encompassed within a rectangle is not uniform. In English seas, ICES statistical rectangles are 30nm north-south by approximately 38nm east-west (34.5nm-40.6nm) and thus encompass between 1,033nm^2 and 1,217nm^2, whereas in the far north of Scotland ICES rectangles cover only 940nm^2. The grid uses a two-digit latitude and alphanumeric longitude code combination for identification of specific rectangles e.g., 37F1 (located in the central North Sea). Figure 2 below displays ICES Rectangles around the UK.

ICES Statistical Sub-rectangles: For some activities more spatial precision is needed and ICES rectangles can be subdivided to sub-rectangle by dividing a statistical rectangle into nine (10' latitude x 20' longitude) sub-divisions. Sub-rectangles are designated by a fifth character (1-9) added to the rectangle code e.g., 28E59. ICES Statistical sub-rectangles are therefore also of variable size depending on their latitude.

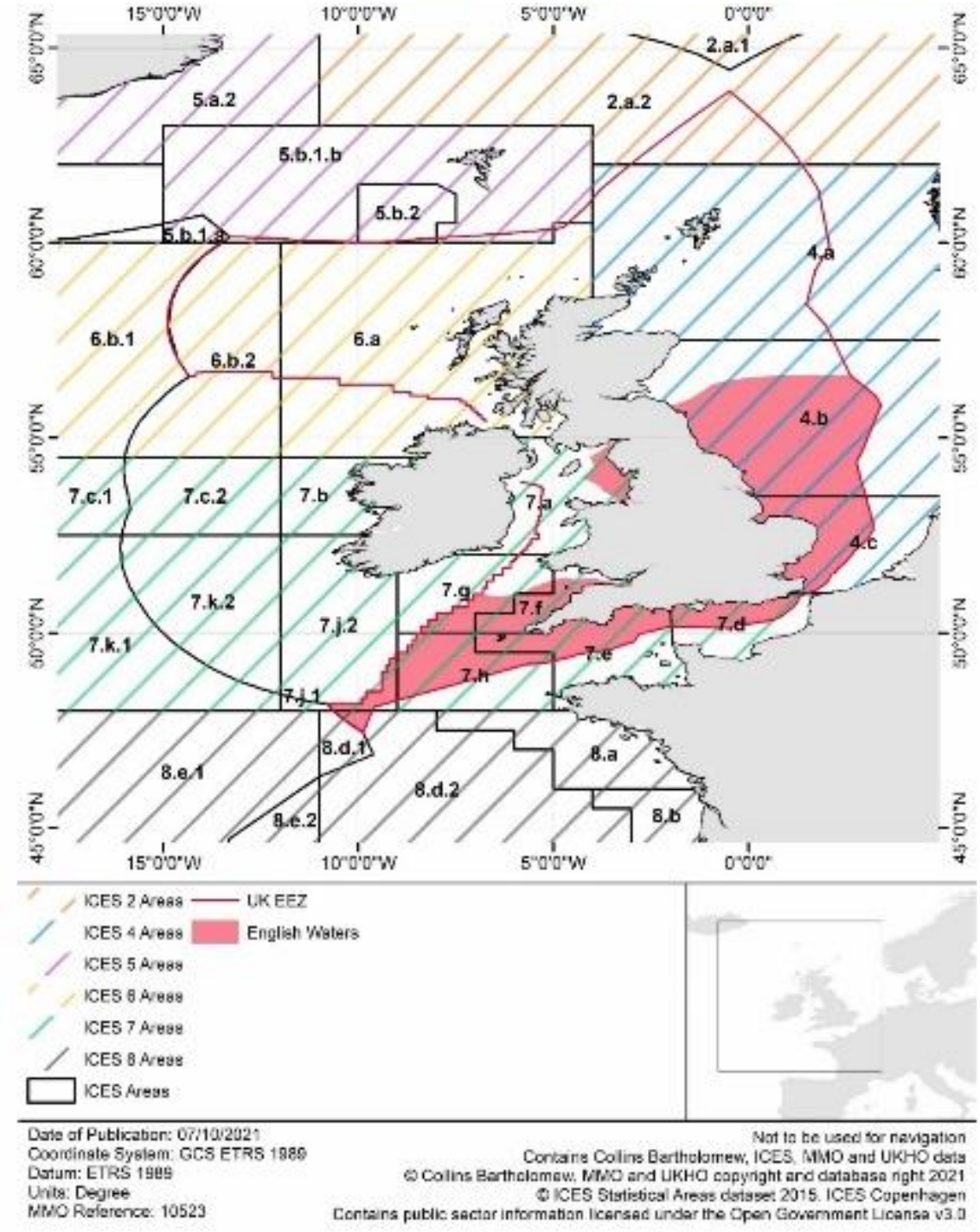
0.05 degree by 0.05 degree: The 0.05º by 0.05º grid is a common grid resolution to which fisheries data is represented. The grid has no basis in legislation or any requirements for catch reporting and is purely convenient for analysis and visualisation relative to common uses, data constraints and uncertainties (usually originating from VMS data). The grid has also been referred to as c-squares in some literature. In English waters the 0.05º by 0.05º grid is 3.0nm by approximately 1.9nm (or 5.6km by approximately 3.5km).

C-squares: C-square is an acronym for the concise spatial query and representation system, a system of spatially unique, location-based identifiers obtained by progressively subdividing 10º by 10º World Meteorological Organization squares into increasingly fine grids, including but not limited to the 0.05º by 0.05º grid above.

While a 0.05º by 0.05º grid seems to be the most common resolution in fisheries and is often interchangeably referred to only as “c-squares”, the grid resolution should always be stated. For example, a 0.5º by 0.5º c-square grid is the standard used by STECF for publishing EU landings and effort data spatially annually while fishing effort maps in ICES often use 0.05º by 0.05º c-square grid.

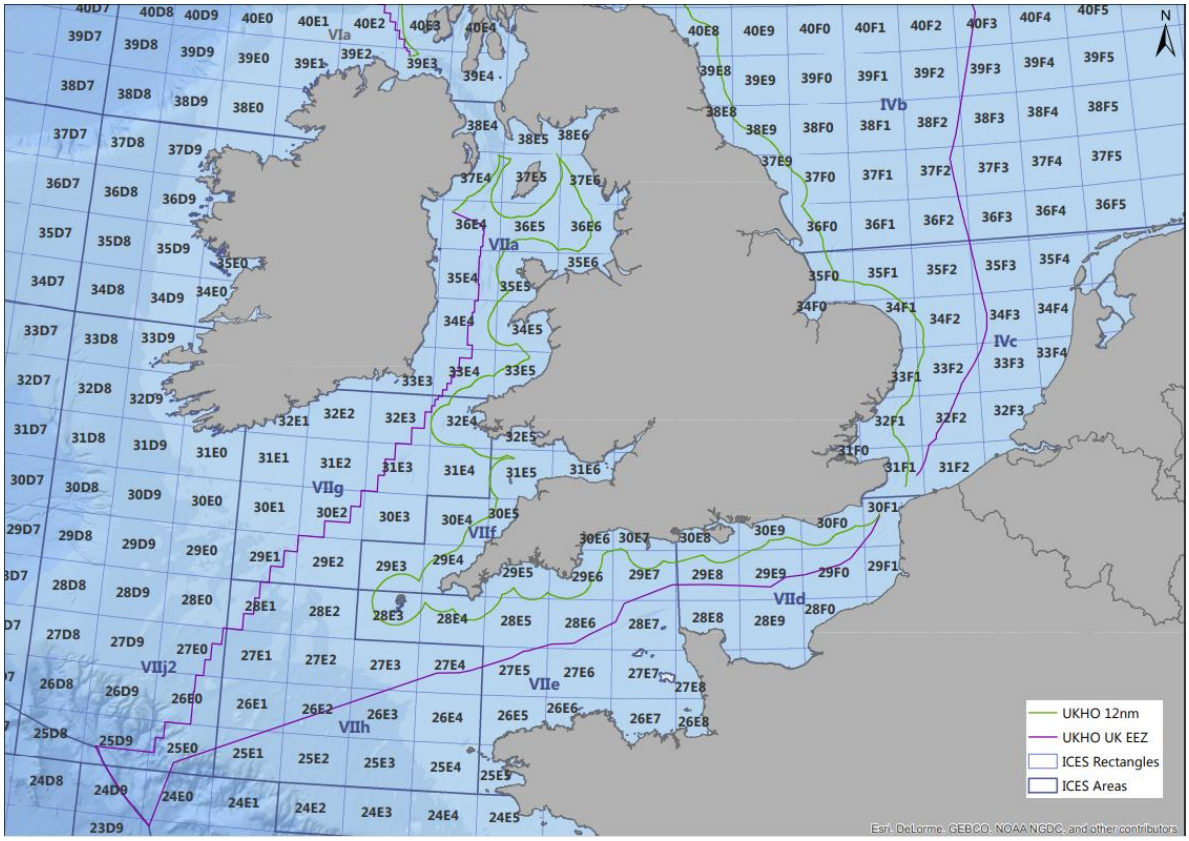
Other scales: While the above represent standard scales for different fisheries data products and statistics, depending on the analysis, fisheries data may be presented at other finer scales. Fine scales can include 1km or 500m grids, polygon, line(track) or point data and where resolution is determined by specifics of accuracy and precision of position data any subsequent analytical process.

Figure 1 – ICES Areas around the UK



Understanding the scale at which fisheries data and any associated products are given is important. Interpretation of the behaviour of vessels and fishing activity is scale dependant. For example, nominally simple questions like area fished differ with scale. Smaller spatial scales show increased perceived patchiness of the fishing intensity reducing the total fished area but increasing local fished intensity. Larger scales do the opposite (Piet and Quirijns 2009). Therefore, finer scale data does not always represent better data and some thought is required as to what is appropriate for the question in hand.

Figure 2 - ICES Rectangles and ICES areas around England and Wales



Types of under 12m fishing activity data

The main methods for gathering data on vessel location, what and how much fish is caught are summarised in Table 1. Although the definition of fishing activity given here includes transhipment, this component of activity was scoped out for this work given the focus on under 12m vessels.

Table 1 - Types of activity data

Methods	Data Source	Product
Automatic position	Inshore Vessel Monitoring System (iVMS)	iVMS
	Automatic Information System (AIS)	MMO1066, Global Fish Watch, European Marine Observation and Data Network (EMODNet)
	Remote Electronic Monitoring (REM)	N/A
Activity Observation	FishSum, AirSum, PortSum	Sightings per Unit Effort (Breen et al 2015)
	Inshore Fisheries and Conservation Authority (IFCA) Hand gathering	N/A
	Observer	N/A

Methods	Data Source	Product
Landing's data	Paper logbook and e-logs	Fisheries statistics, EU Commission's Scientific, Technical and Economic Committee for Fisheries (STECF) submission
	Sales notes	Official fisheries statistics, STECF submission
	Record your Catch (referred to here as Catch app)	Official fisheries statistics, STECF submission
	Shellfish returns	Official fisheries statistics, STECF submission
Fisher voluntary	Fishers' knowledge	FisherMap
	Fisher's data	Personal plotter data
Other	Various	Academic studies
	Various	Small scale fisheries review
	Various	CEFAS report

The following section explores each of the methods in turn, and within those, the data and products. The section explores the strengths and limitations of using the data and products for informing understanding of fishing activity and does so using a standardised framework that draws on MMO's quality assurance process. The details are outlined Table 2 below

Table 2 - Data Characteristics

1. Description	A data (or product) title and high-level overview / description
2. Data Collection	Links to documents describing collection [supplemented by subsequent analysis in the methodologies section later] and a list of key data involved
3. Purpose	The rationale / legal basis or end use for why data (or product) is collected or analysed, particularly where dictates either shape the data in a particular way or inform on reuse for other purposes
4. Fleet segment:	That component of the fishing fleet included in the data (or product) based on vessel demographics (usually size (length), gear, and nationality) and the comprehensiveness of that coverage e.g., % of vessels
5. Spatial Coverage	The geographic extent of the data (or product) and where appropriate reference to spatial, statistical, or administrative boundaries including latitude and longitude, national waters, territorial limits, fisheries statistical areas etc
6. Spatial Resolution	The spatial resolution of the data (or product) follows the hierarchy of spatial data outlined in the Introduction.
7. Temporal Coverage:	The temporal extent of the data (or product) particularly years, but also relevant where data only cover a particular season within the year or particular temporal sub samples e.g., every 4th week
8. Temporal Resolution	Temporal resolution expresses the finest temporal scale the data (or product) may be split into. This is often the biggest difference between a data source e.g., 2hr pings and the product (multi annual average across multiple years)

9. Data Access	This covers the following for data (or product) 1) provider, 2) holder/asset owner and contact 3) sensitivity restrictions and possibly privacy agreements 4) publication links etc
10. Methodologies	Links to method documents describing collection and subsequent analysis or a top line narrative
11. Use Caveats	While this will vary depending on the ultimate use data (or product) is put to, key caveats drawn from the above sections are highlighted

3. Fishing Activity Data

Automatic Position Reporting

Automatic reporting includes a range of electronic based vessel tracking technologies that collect vessel position (and other parameters) at intervals and report these to fisheries managers or data stations via satellite, radio or mobile phone infrastructure. It has been a legal requirement under the EU Control Regulation (2009) since 2012 for all 12m and over UK and EU fishing vessels to have a functioning Vessel Monitoring System (VMS) installed. In 2022 there will be a Statutory Instrument making it mandatory for all under 12m vessels fishing in England to install an inshore Vessel Monitoring System, it has been mandatory in Welsh waters for all commercial vessels since 15 February 2022.

Three technologies can provide automatic position data for under 12m vessels. These include:

- Inshore Vessel Monitoring System (iVMS) which is currently been rolled out across the English fleet and reports using mobile phone signal,
- Automatic Information System (AIS) introduced in 2002 is a radio-based technology that provides data for safety of navigation, though not mandatory on vessels less than 15m.
- Remote Electronic Monitoring (REM) is an electronic monitoring suite of sensors that includes global positioning system as well as cameras, sensors etc. These systems are only currently present on a small number of trial vessels.

Inshore Vessel Monitoring Systems

Data characteristics are outlined in Table 3.

Table 3 - Inshore Vessel Monitoring System

1. Description	iVMS reports data via mobile phone signal (GPRS), a cheaper alternative than satellite-based VMS signals. The data reporting frequency is significantly higher than VMS and when outside GPRS range, the device stores positional information for submission once GPRS coverages becomes available. Legislation is expected in late 2022 will make it a legal requirement for all vessels under 12 metres in length to have an

	iVMS installed and transmitting data to the MMO when they are at sea in English waters. Installation is being rolled out throughout 2022 in advance of legislation mandating the requirement. There has been an iVMS requirement on all Welsh scallop boats since 2012 under The Scallop Dredging Operations (Tracking Devices) (Wales) Order 2012. Devon and Severn Inshore Fisheries and Conservation Authority have had a Mobile Fishing Permit Byelaw requiring iVMS in their district since 2018.
2. Data Collection	iVMS in England will provide vessel data every 3 minutes that includes vessel: • Latitude and Longitude. • Course and Speed. • Date and Time • Devise diagnostics such as battery status, data stored etc.
3. Purpose	Data derived from iVMS will provide a more complete picture of all fishing in English waters. Combined with data on catch volumes, scientific evidence of stock levels and a range of other significant data, iVMS will enable more efficient decisions on local and national management measures and policies. iVMS is also expected to enable the MMO to continually improve its targeted assurance activities as the clearer picture of fishing activity will help highlight which vessels are consistently complying with regulations on where and what they can fish, and those that may introduce risk to sustainable sea fisheries.
4. Fleet segment:	When the legislation comes into force (currently expected in late 2023), iVMS will be required for all fishing vessels under12m transiting or fishing in England's water, regardless of where they're registered and what gear they operate.
5. Spatial Coverage	Spatial coverage will be variable – All vessels under 12m will be tracked in England. English vessels will also have to transmit iVMS data if/when operating outside of English waters, e.g., Scottish, EU waters and iVMS requirements already exist in Welsh waters providing wider insights on the English registered fleet.
6. Spatial Resolution	iVMS device design specifications require 95% of all reports to be accurate to +/-10m.
7. Temporal Coverage:	Devices began being installed in the first tranche of the roll out in February 2022 beginning with vessels over 10m and progressing to tranches of smaller vessels. Initial data collection can only be used for development purposes and would not be appropriate

	for fisheries activity description until legislation making iVMS mandatory is due late in 2023. Publicly accessible anonymised data products from iVMS would therefore not be available until a full year after legislations, potentially in early 2024.
8. Temporal Resolution	Positions generated every 3 minutes which allows a spatial understanding of vessel location. Gear impact, assumptions can be made based on vessel speed but for a precise understanding corroborative information is needed. Where mobile reception is unavailable, live tracks will not be available. However continuous positional data would be available retrospectively on reconnection.
9. Data Access	MMO is the data owner. Individual records are considered sensitive personal data. MMO expects to be producing anonymised annual aggregate data that are not subject to sensitive data issues and therefore open access in the future. Where appropriate raw data can be available subject to legitimate reasons and data sharing agreements
10. Methodologies	iVMS devices store positions for transmission when the device is within GPRS range as a more cost-effective solution. Data is passed via iVMS provider servers before being stored by MMO in the MMO strategic database where it can be checked for quality assurance purposes. Currently there is no established methodology in English fisheries management for the analysis of iVMS data. However, it is expected that a new method will be developed for example around speed rules, agreements on spatial resolution and establishing linkage to other database (e.g. catch data or vessel demographics).
11. Use Caveats	Initial methodology development is still ongoing and is expected to evolve as data volumes increase. Methodology standardisation across the UK has yet to be agreed, initial uses will be limited by the limited temporal coverage for many use cases.
12. Summary	It is unlikely MMO will have data available for analysis before late 2023 based on the experiences of the roll out of VMS to the 12-15m and the large number of vessels involved. In future this will be the key source in understanding where under 12m activity is taking place when combined with Catch app data.

Automatic Identification System

Data characteristics are outlined in Table 4.

Table 4 - Automatic Identification System

1. Description	AIS use global positioning system technology to record and broadcast vessel movements via VHF radio, approximately every 6 seconds. AIS was initially intended to improve ship safety by broadcasting and receiving AIS signals of movements to reducing collision risk between vessels. Legal requirements for AIS installation on vessels over a certain size length, or tonnage encompass fishing vessels and in the European Union (EU) and UK,all fishing vessels over 15m in length must operate an AIS system since the Control Regulation in 2009.
2. Data Collection	Class A AIS transceiver sends data every 2 to 10 seconds depending on a vessel's speed • Latitude and Longitude • Speed and course and turn and heading information • Date and Time • Vessel data including identification, type, size destination Smaller, simpler, and lower cost class B transceivers send a reduced number of parameters but still include speed, time, position and identity information and send at the same polling frequency.
3. Purpose	AIS is primarily for safety of navigation including collision avoidance, aids to navigation, search and rescue and maritime security although it has applications in monitoring and control of fisheries.
4. Fleet segment:	AIS vessel identification details such as the Maritime Mobile Service Identity (MMSI) and vessel name are yet to be fully crosschecked with MMO records of RSS/PLN. As such, it is not possible to accurately define AIS coverage of the under 12m fleet and it will be necessary to assess and verify the labelling of each vessel type to look for mislabelling or omissions. For this report AIS coverage of the under 15m English fleet is estimated at 36% based on calculations in Table 5 below, though this could be higher if considering some vessels being inactive. Vessels in the 12m-15m length category cannot be separated from the under 12m vessels at this time and AIS is likely concentrated in these larger vessel classes suggesting limited coverage of under 12m fishing vessels
5. Spatial Coverage	Data is available for all waters globally however there are limitations based on the detection ranges of receiver stations reception especially beyond 60nm offshore thus coverage is usually nearer shore. Typically, larger vessels can though transmit data through satellite AIS and therefore aren't limited as a smaller vessel would be to transmit.

6. Spatial Resolution	AIS positions have 3 levels of geolocation accuracy 1 : high accuracy (less than 10 metres), 0 : low accuracy (greater than 10 metres) or default.
7. Temporal Coverage:	AIS was introduced in 2002 for vessels of over 300t with the requirement expanding to smaller vessels incrementally since however there is still no requirement for under 12m vessels to carry AIS
8. Temporal Resolution	The rate of AIS transmissions varies by the transponder type and the movement of the vessel ranging from every 2 seconds to every 3 minutes (Marine Traffic).
9. Data Access	AIS data is freely available in near real time through many online sites, for example MarineTraffic.com or global fish watch. Historic data can be obtained commercially and MMO have previously purchased AIS data when specific information is needed.
10. Methodologies	MMO receives aggregated annual data from MCA of all activity in English waters reduced to the first 7 days of each month, this is then used primarily for Marine Planning and Licensing purposes. This data is stored online and currently covers 2011 to 2019, this is published to the Defra Data Services Platform by the MMO.
11. Use Caveats	Some areas will not have reception therefore will always show as no fishing activity falsely. The system isn't mandatory for under 15m vessels it is unlikely the trends identified will be relevant to under 12m vessels. The percentage of under 12m vessels covered in this fleet sector is currently not known to MMO definitively. The system is first and foremost an anti-collision safety system therefore understanding effort is not the intention and therefore raises data protection and ethical concerns. The system can be turned off or lose reception therefore some data will be missing – conversely VMS is tamper proof and MMO is notified if a vessel is not reporting.
12. Summary	At present AIS is best used as a corroborative data tool and due to the highlighted caveats isn't used for under 12m analysis.

Table 5 - Estimate of AIS coverage in the under 12m fleet

2,488	Vessels listed as fishing vessels on MarineTraffic.com vessels database at time of writing.

1,894	Removing 594 for the compulsory use in over 15m vessels by filtering on vessel length.
1,894 ÷ 5,189 (x100) = 36.50%	Percentage versus total number of Under 15m fishing vessels registered in 2020

There are currently a range of AIS based data products available that provide insight into fisheries activity. While these datasets can include under 12m vessels, their coverage is unknown as often vessel size data is omitted. Datasets include:

- MMO Anonymised AIS Derived Track Lines (2012-2019) and Shipping Vessel Density Grid (2012-2019)
- EMODnet Vessel Density Map (2017,2018) for fishing vessels
- Global Fishing Watch

Remote Electronic Monitoring

Although employed in other fisheries worldwide including on vessels under 12m, Remote Electronic Monitoring (REM) is not currently rolled out in England. MMO have conducted pilot studies, confirming the effectiveness of REM technology for monitoring fully documented fisheries, and improving accuracy of catch recording by fishers (MMO, 2016; 2017).

REM systems are a collection of monitoring technologies that include automatic vessel position tracking with comparable spatial (±10m) and temporal (under 10m polling frequency) resolution to AIS and iVMS. However, the suite of technology offers substantial advantages in describing fishing activity. For example, integrated winch sensors and or deck cameras improve accuracy of when fishing gear is deployed and retrieved removing the need for speed rules or algorithms to determine when “fishing” is occurring. Similarly, cameras that cover the fishing sorting areas provide information on catch and not just landings. Further systems may be designed to obtain landings data at a per haul level rather than per day improving the spatial resolution at which fish catch data may be defined and the confidence with which catch may be attributed to position.

Activity Observation

The data sources considered here have been restricted to those observational data sources specifically designed to inform on fishing activity. Sources are primarily records of sightings of vessels and vessel activities by observers conducting enforcement patrols on shore, at sea or from the air. However, observation data includes fisheries observers onboard fishing vessels.

Other observation sources may incidentally capture fishing activity insights e.g., earth observation and remote sensing satellites with sensor payloads including radar or visual spectrum photography. Similarly, more novel data does exist including acoustic monitoring. While such technologies may have value to describe fishing activity in specific areas, contexts or for specific questions, they are only acknowledged here but scoped out from detailed consideration and large-scale datasets are available and linking to further data (e.g. gear) is currently problematic.

Observation data examined below is of three types. A detailed consideration will be restricted to the first:

- MMO and IFCA at sightings data that consists of vessel activity reports recorded as part of control and enforcement. These may be sightings at sea (FishSum) sightings from overflight (AirSum), records taken during inspections (InReps)
- IFCA Hand Gathering data and MMO/IFCA in-port sightings.
- Observer data

MMO and IFCA sightings data

Data characteristics are outlined in Table 6.

Table 6 - MMO and IFCA sightings data

1. Description	Sighting information is recorded by MMO, IFCA and selected other agencies. MMO data is stored via the Monitoring Control and Surveillance System (MCSS). MCSS is primarily used to record fishing vessel inspection and sightings data, along with other more restricted details of prosecutions and offences. IFCAs have their own data observation repositories, however, IFCAs can submit sightings data to MCSS. This is relevant when considering activity for under 12m vessels as they are primarily active within the 0-6nm where IFCAs are the fisheries regulator.
2. Data Collection	Data are collected by various bodies including MMO, IFCAs, Royal Navy and other relevant agencies. Sightings are recorded by three methods; Inspection Reports (Inrep); At sea sighting (Fishsum) and Aerial sighting (Airsum). The data collected varies slightly by method. Inrep, Fishsum and Airsum all collect • Date/time • Position • Gear in use • Activity • Vessel name/Port Letter Number (PLN) and Inrep further collects • Date/time start and end of inspection • Master/Owner details • Fish retained onboard Some duplication between IFCA sightings and boardings can occur.
3. Purpose	Sightings data are collated primarily for fisheries monitoring, control and surveillance purposes. Providing a source of corroborative information on whether vessels are compliant with

	legislation, verifying the accuracy of industry submitted information etc.
4. Fleet segment:	All vessels at sea in English waters are subject to surveillance including those under 12m. Enforcement of both the IFCAs and MMO legislation is risk based, therefore surveillance effort is not uniform across the fleet segments or among areas
5. Spatial Coverage	English surveillance assets are generally tasked in English waters only. Observation coverage is not uniform. For example, effort for patrol vessels is usually greater near home ports that are patrolled more frequently.
6. Spatial Resolution	Vessels are recorded by their latitude and longitude and against the ICES sub-rectangle
7. Temporal Coverage:	MCSS is a long-term legacy system with decades of data available. IFCA data has been added to the system in the last 5 years which varies by IFCA.
8. Temporal Resolution	Surveillance data is a snapshot in time in the case of ship and aircraft sightings whereas inspections can be anywhere from 30 mins to 6 hours onboard with more information collected.
9. Data Access	Cefas host MCSS on behalf of MMO, sightings data can be extracted in a simple XML format by users, more complete analysis of outputs needs the Stats team and GIS team for spatial analysis.
10. Methodologies	A proforma exists for all data fields to be completed in MCSS to allow inspectors to gather information either in notebooks for later entry or more recently direct inputting into the database through mobile working in the field.
11. Use Caveats	There has been a decrease in the number and geographical spread of patrols and therefore sightings over the last decade to historic lows, although patrol effort is now increasing again after the UK's exit from the EU. Information on observer effort e.g., flight paths, patrol vessels tracks or observer hours are necessary to validate data and from their presence develop fishing activity to intensity estimates based on sightings per unit effort. Observer effort data is stored independently of sightings data and not centrally. Because sightings data are risk based, absence of information on fishing activity does not equate to an absence of fishing.
12. Summary	This source has a large amount of highly detailed spatial data over a long period which could potentially be useful however sightings data are highly variable round English waters means

	that it is difficult to draw conclusions on activity overall without noting the risks in an inaccurate picture.

Sightings per Unit Effort

Data characteristics are outlined in Table 7.

Table 7 - Sightings per Unit Effort

1. Description	Originally developed through Defra projects MB0106(3) and further in MB0117 and supported by a specific programme of work, this product utilised sightings data as described in Table 6 - MMO and IFCA sightings data. The products reviewed here are the resulting fishing intensity maps derived from effort normalised sightings data
2. Data Collection	The work draws on sightings data and had inclusion criteria to contain complete date, time, fishing vessel location (latitude and longitude), fishing method (gear type), and vessel name and registration (optional for privacy reasons to allow analysis stratified by vessel length and engine power). About 1/3 of sightings data could not be linked to vessel. Patrol tracks were derived from vessel and aircraft on-board navigation systems.
3. Purpose	To improve the evidence base on the location and intensity of inshore fishing activities and their link to the coastal fishing communities being sustained by the activity.
4. Fleet segment:	English and Welsh vessels of all sizes operating in the study area were included. Information on fishing activity could be attributed to the 94.1% of English and 98% of Welsh vessels not monitored using VMS (at that time under 15m in length)
5. Spatial Coverage	Fishing activity was estimated for areas within 20nm of the coast of England and Wales
6. Spatial Resolution	Resolution of 1/400th of an ICES rectangle, this equates to a resolution of 0.05 degrees in a longitudinal direction and 0.025 degrees in a latitudinal direction, or approximately 3x3km.
7. Temporal Coverage:	2007-2012 (MB0106(3) covering 2007-2009 and MB0117 adding 2009-2012)
8. Temporal Resolution	Data was consolidated to year to allow a temporal comparison
9. Data Access	The inshore fishing activity data presented in MB0117 are freely available from the Marine Environmental Data and Information Network (MEDIN) and Cefas. We have been unable to locate 2007-09 data.

10. Methodologies	Detailed methodologies are provided in the project reports of MB0106(3) and the associated academic paper Breen *et al* (2015), and also MB0117.
11. Use Caveats	Absence of information on fishing activity does not mean that no fishing is occurring. As sightings data have some inherent data collection biases (see above) some prominent local fisheries were not represented in the final data. Uses all vessel sightings including over 12ms so separation would be required.
12. Summary	While this product represents the most extensive analysis of sightings-based fishing activity data. However, the underpinning data is now over a decade old significantly reducing confidence in its outputs. Any use of the product should also be mindful of caveats inherent in the source data and subsequent analysis (e.g., patrol effort bias). Qualitative insights suggest understanding of these weaknesses has diminished through time.

For this project MMO explored whether it was possible to update inshore fishing activity maps using more recent data. However, this was not possible for three main reasons; 1) a reduction in sightings records in the most recent period limited the data available (noting a uptick since EU exit) 2) patrol track data required to normalise the sightings data by effort was in some cases inaccessible or absent limiting usable data further and 3) a lack of support for a refresh of this data among stakeholders.

While it was not possible to provide a nationally coherent data set, several IFCAs have undertaken localised updates using the methodologies and data described here in that can provide more recent insights locally. These include:

- Eastern IFCA (2018) Fisheries mapping project: Mapping inshore fishing activity in The Wash using vessel-based sightings information
- Sussex IFCA (2022) Sussex Inshore Fishing Effort 2017 – 2021

MMO and IFCA sightings data

Some IFCAs (for example Eastern IFCA) have extensive records of shellfish hand gathering activities in their areas. This data in not entered onto MCSS as the activities are not associated with a vessel.

MMO and IFCA Port Sum

This data is limited to vessels landing their catch therefore has limited use for assessing spatial fishing activity.

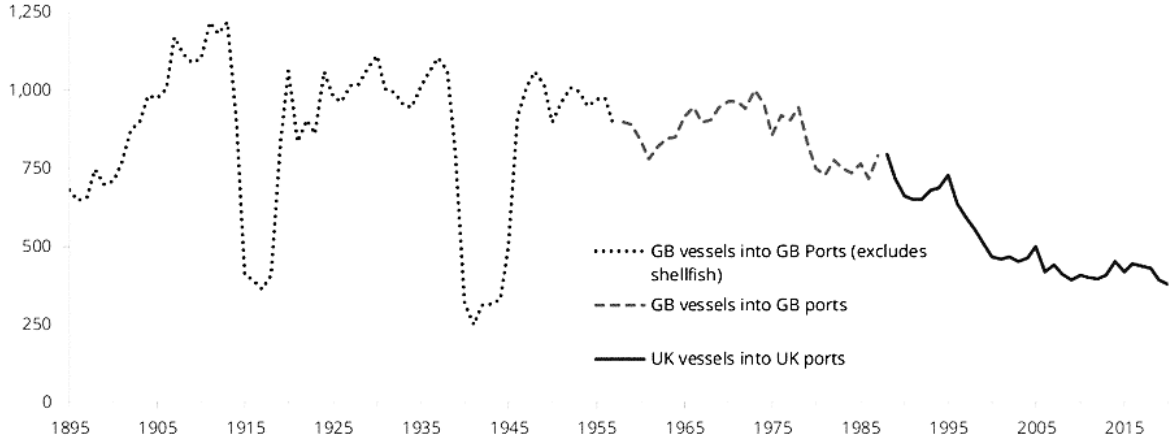
Observer data

Cefas conduct regular at sea observer trips so could potentially have additional data of use.

Landings Data

Landings data form some of the longest term records of fishing activity. Currently UK vessels land around 400,000 tonnes of fish each year into UK ports and between 200,000 and 300,000 tonnes abroad. Historically however, landings have been higher (up to 3x higher or approximately 1,200,000 tonnes just prior to the First World War (UK Parliament 2021). Figure 3 shows landings since 1895.

Figure 3 - Landings of fish in Great Britain/UK by home fishing fleet (in tonnes)



Sources: BR Mitchell, British Historical Statistics; OPCS, Annual Abstract of Statistics (variour years); Marine Management Organisation, UK Sea Fisheries Statistics (various years)

It is worth noting the distinction between landings and catch data. Landing data is an official record of fish brought ashore i.e. landed. It is used as a proxy for fish caught at sea although these data do not account for catches too small to require reporting, illegal, unreported and unregulated catch and landings or discarding. Landings data usually consists of direct estimates of landings from fishers themselves and then indirect verification from sales of those fish. Historically under 10m vessels have not been required to report landings data, sales notes were the only record since the 2005 Registration of Buyers and Sellers Regulation.

4 primary sources of landings data are examined here;

- Paper logbook (a requirement for 10m to 12m vessels)
- Catch App (a recent landing recording requirement for under 10m vessels)
- Sales notes (an indirect record of landings and historically the only source of data available for under 10m vessels)
- Shellfish Returns (a specific requirement for vessels targeting shellfish now replaced by Catch app)

Landings data from multiple sources can be integrated together in data products, one such example being the STECF data product the UK used to submit to the EU.

Information will be complemented over time with new information coming from REM based catch data. As more data is collected this will allow a more complete picture to emerge demonstrating more accurate estimates of amounts of fish being caught and removed from the sea.

10-12m fleet - Paper based Logbook data

Data characteristics are outlined in Table 8.

Table 8 - 10-12m fleet - Paper based Logbook data

1. Description	Vessels with an overall length between 10m and 11.99m were not subject to the implementation of electronic logbooks. They are required to complete a paper logsheet daily and submit on landing to the MMO.
2. Data Collection	Data is collected on vessel, trip, gear, area fished and catch specifically: • Vessel name • Trip start date • Trip finish date • Port start • Port end • Gear type • Gear number, mesh size, number of shots • ICES area of majority of catch • Species caught and live weight • Species retained and live weight
3. Purpose	Data collected meets statutory requirement on quantities and species of fish being taken from the sea, data is important for better management of stocks and supports a more profitable and sustainable fishing industry.
4. Fleet segment:	All 10-11.99m English vessels; 166 vessels in the English fleet see over 10m vessel list. 10-11.99m vessels from UK Devolved Administrations and EU vessels also submit paper logbooks which MMO has access to if they land into an English port.
5. Spatial Coverage	All areas fished.
6. Spatial Resolution	Catch is reported to ICES rectangle.
7. Temporal Coverage:	Paper logbooks in current form were first implemented in the early 90s and is maintained as a continual series to current date. Related historical data goes back to the 19th century although spatial allocation does not follow the same processes
8. Temporal Resolution	Daily breakdown of species in kg once the catch weight exceeds 50kg pre-processed weight.
9. Data Access	MMO is the data owner. Individual records are considered sensitive personal data. Annual anonymised data is published by MMO.
10. Methodologies	Latest guidance for fishers is available at Submission of paper logbooks and landing declaration data, for commercial fishing vessels of 10-12 metres length - GOV.UK (www.gov.uk). Processing guidance can be found here on Gov.uk.
11. Use Caveats	• 10m-11.99m vessels make up a small component of the fishing fleet (7.46% by vessel count) • Data is only available spatially down to ICES rectangle resolution and is not verified by VMS currently.

	• Masters are only required to report species caught more than 50kg liveweight and activity with catch under this limit remains unrecorded • There is a greater likelihood of misreporting of the area of capture at ICES rectangle level across a trip than for larger vessels as area of capture cannot be corroborated by direct tracking such as VMS and doesn't have to be submitted every day as an electronic logbook would be. • There is a slightly longer time lag on paper logs compared to elogs
12. Summary	This data was made available by MMO as an anonymised data set in the STECF FDI which is used in the final methodology (see Section 3). As a non-EU country the UK no longer submits this data to STECF and conversations are ongoing about how fishing activity data is submitted to ICES and how EU27 data is to be shared with the UK.

Catch Recording Application

Data characteristics are outlined in Table 9.

Table 9 - Catch Recording Application

1. Description	The Catch Recording Application (Catch App or Record your Catch) is a new requirement on under 10m fishing vessel masters to create and submit a catch record for everything caught on every fishing trip, mandatory from February 2022. Catch App replaces the need for under 10m vessel masters to submit a Nephrops (NEP1) form (under 10m vessels landing nephrops), Monthly Shellfish Activity Return (MSAR1) form or a logbook if fishing in 2 ICES areas.
2. Data Collection	Data is collected on vessel, trip, gear, area fished and catch specifically: • Vessel name • Trip start date • Trip finish date • Port start • Port end • Gear type • Gear number, mesh size, number of shots • Statistical sub area of majority of catch ICES sub rectangle (eg.29E6-9) • Species caught and live weight • Species retained and live weight The dataset can therefore inform on fishing activity by gear type, species and weight of capture using measures based on effort (expected as fishing days per sub-rectangle) and catch weight (expected as weight by species or total weight per sub-rectangle).
3. Purpose	To provide essential data on quantities and species of fish being taken from the sea by vessels under 10m, which is vital for

	better management of stocks and supports a more profitable and sustainable fishing industry.
4. Fleet segment:	All English and Welsh under 10m vessels are required to report. During the period of education up to 28th February 2022 uptake was still increasing to full compliance of all under 10m vessels. Under 10m vessels from other Scotland and Northern Ireland and non-UK vessels are not required to use the App.
5. Spatial Coverage	Catch app covers all UK waters but due the requirement being only on English and Welsh vessels, data is not appropriate as a measure of total fishing activity outside of English and Welsh waters.
6. Spatial Resolution	ICES sub-rectangle. As the location data of the record is defined "for the majority of the catch", unquantified fishing activity may occur in other ICES sub-rectangles. Early reports of catch location misallocation have been managed by reducing spatial choices for allocation based on phone GPS position although there is a legal requirement for catch location to be accurate. Catch is only allocated to one sub-rectangle. During the initial phases of roll out there was concerns about which port fishers should be using when the vessel was beach launched, advice was given to use the nearest port where an individual specific location is not selectable.
7. Temporal Coverage:	Introduced as a catch recording licence condition since 2020 and following an education period became fully enforceable from the 28 Feb 2022. Data prior to 1st March 2022 should be considered less robust. MMO expects to produce standardised anonymised data products alongside annual fisheries statistics reporting and will therefore lag by approximately 1 year.
8. Temporal Resolution	Data is collected at per day resolution. Catch records must be submitted to MMO before the fish is moved from the place of landing or transported to point of sale. MMO expects to produce standardised anonymised data products as annual averages although the data will allow much higher resolutions where data access consideration allows.
9. Data Access	MMO is the data owner. Individual records are considered sensitive personal data. MMO expects to produce anonymised annual aggregate data that are not subject to sensitive data issues and therefore open access.
10. Methodologies	The following provide sources describe data collection and processing • MMO (2022) Web guidance - Record your catch
11. Use Caveats	• Data is new and standardised analysis and reporting method have not been developed for these data yet. • Data prior to enforcement should be considered substantially less robust • Stakeholders have raised concerns about the ability to accurately estimate catch weight at sea.
12. Summary	The dataset represents a significant increase in the spatial resolution of data collection from the under 10m fishing fleet. Data collection is fairly new so how the data is analysed needs

	to be developed further. As the data collection is ongoing this dataset is likely to be the best source of data on contemporary fishing activity for the sectors encompassed. While it is possible that electronic vessel tracking, particularly iVMS in the near future, may provide greater positional accuracy for vessel movements and effort measures, the higher resolution catch data will remain valuable as a fisheries activity mapping measure. There are likely to be significant differences between insights that can be gains from public anonymised annual average datasets and detailed analysis of raw data available internally.

Sales Notes

Data characteristics are outlined in Table 10.

Table 10 - Sales Notes

1. Description	Landings by the under 10m section of the fleet are recorded via sales notes (catch data derived from point of sale). Sales notes are submitted to MMO within 48 hours of landing by the first buyer of the fish, generally by merchants or auction houses. Historically, sales notes were the only source of data for under 10m vessels, this information is now being supplemented by the new Catch App.
2. Data Collection	Because the data submitted is by the buyer of the fish rather than the fisher, less detail is obtained: • Vessel name • ICES area • Species sold in live weight Subsequently MMO staff add the following details based on local knowledge of the vessel: • Landing location • Gear type • ICES rectangle level
3. Purpose	Statutory requirement on buyers – to provide essential data on quantities and species of fish being taken from the sea, which is vital for better management of stocks and supports a more profitable and sustainable fishing industry.
4. Fleet segment:	All under 10m vessels; 2,058 vessels of 2,524 (81.54%) English vessels.
5. Spatial Coverage	All areas fished by under 10m vessels.
6. Spatial Resolution	Landings are given at ICES rectangle resolution but this is an assumption by the regulators local knowledge of the vessel refined down from the ICES area stated on the sales note. As vessels under 10m are assumed to have a restricted range,

	catch can usually only be drawn from a small subset of the total ICES rectangles in an area, this though may not always be the case.
7. Temporal Coverage:	A requirement since the 1993 Common Fisheries Policy. The latest requirement is under The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005.
8. Temporal Resolution	Data is only submitted after the landing and subsequent first sale so there is no temporal resolution bar the date of landing. This data is not published apart from yearly totals in the Annual Fisheries Statistics report.
9. Data Access	MMO is the data owner. Individual records are considered sensitive personal data. Anonymised annual aggregate data is not subject to sensitive data issues and therefore open access.
10. Methodologies	Latest guidance is available at Buyers and sellers of first-sale fish and submission of sales notes - GOV.UK (www.gov.uk)
11. Use Caveats	Not completed by the fishers themselves. Gear used is assumed and not reported. Only has date of landing whereas logbooks can be used to assess total time at sea. Resolution is at the ICES rectangle level but even that is based on an assumption made by MMO staff.
12. Summary	This data forms the basis of our current knowledge of under 10m landings. From Jan 2020 catch recording app digital submissions (see Catch app Section) are now required detailing the catch retained on board, gear and area fished. This data is included in the STECF FDI which is used in the final methodology (see Section 3).

Shellfish Returns

Data characteristics are outlined Table 11.

Table 11 - Shellfish Returns

1. Description	MSAR1 forms were a monthly submission for under 10m vessels that held a shellfish entitlement on their fishing vessel licence. The requirement to submit the forms has been replaced by the Catch app (see Catch App Section) although in some IFCA areas shellfish returns are still submitted at the request of the IFCA.
2. Data Collection	Completed monthly by the fisher if they have been active, giving the following details: • ICES area. • Gear - Pots/Nets. • Set Hauled times. • Edible Crabs (kg) – Cocks, Hens, Mixed. • Spider Crabs (Kg). • Lobster (Kg). • Other (Kg).

3. Purpose	In the absence of crab and lobster effort information on sales notes this licence condition was introduced to increase the understand potting effort.
4. Fleet segment:	Under 10m vessels.
5. Spatial Coverage	All waters where vessels are operating.
6. Spatial Resolution	ICES sub rectangle plus belt (A = 0-3nm, B = 3-6nm, C = 6-12nm, D = Outside of 12nm).
7. Temporal Coverage:	Nationally 2004 till 2020. Still completed to some IFCAs.
8. Temporal Resolution	Data is collected per day then submitted to the MMO/IFCA at the end of the month unless there was no activity.
9. Data Access	Cefas maintain a manually input database of all the shellfish returns submitted historically.
10. Methodologies	More detailed guidance is available online.
11. Use Caveats	The requirement to submit the forms has ceased where the catch app is being used therefore data will be reducing post 2020. Data quality is variable.
12. Summary	This could be a good potential source of spatial information on where under 12m shellfish activity is occurring until the catch app and iVMS data is available however coverage will be variable around the country, and we have been unable to gain access to the central data source in time for this report.

Regulatory data on landings

Data characteristics are outlined in Table 12.

Table 12 - Regulatory data on landings

1. Description	Data for the UK plus the EU 27 member states includes the under 12m fleets, and was available as part of a data collection framework data call collecting fisheries dependent information for STECF. Spatial effort and landings data are shown and selectable to a wide range of criteria, including gear, year, quarter, species, vessel length group and more. As noted we no longer submit this data through the EU and discussions are ongoing about how we submit this data to ICES.
2. Data Collection	The data utilised is sales notes for the under 10m vessels consisting of: • Vessel name • ICES area • Species sold in live weight

	Subsequently MMO staff add the following details based on local knowledge of the vessel: • Landing location • Gear type • ICES rectangle level and 10-12m logbooks consisting of: • Vessel name • Gear type • Gear number, mesh size, number of shots (10-12m) • ICES rectangle (under 10m) • Statistical sub area of majority of catch ICES sub rectangle (eg.29E6-9) (10-12m) • Species landed in live weight • Days at sea in KW
3. Purpose	Deciding annual quota limits for EU Member States and the UK.
4. Fleet segment:	All UK and EU vessels.
5. Spatial Coverage	All waters
6. Spatial Resolution	Data was supplied by the UK to STECF at C-Square level[2] which is around half an ICES rectangle, this involves the splitting of the supplied ICES rectangle data between them equally.
7. Temporal Coverage:	The dataset is available per year and covers the period 2015 to 2019.
8. Temporal Resolution	Data is collected per day in the case of logsheets. Sales notes are a snapshot of the date of sale.
9. Data Access	The English data was collated by MMO, the final data products are hosted by STECF. The UK does not expect to contribute to STFC data in the future.
10. Methodologies	Processing guidance can be found here on Gov.uk.
11. Use Caveats	The data is limited to ICES rectangle level, the final product is at a unique resolution (0.5^{o}*0.5^{o} c-square) with a process involving aggregation and splitting. Spatially the catch data is at ICES rectangle level rather than any finer resolution such as ICES sub rectangle or linked with VMS. Different member states have different approaches to converting ICES rectangles to c-squares.

[2] C-squares (acronym for the concise spatial query and representation system) is a system of spatially unique, location-based identifiers (geocodes) for areas on the surface of the earth, represented as cells from a latitude-longitude based Discrete Global Grid at a hierarchical set of resolution steps.

12. Summary	This dataset is the best available for under 12m activity by combining our two best sources – sales notes and 10-12m logbooks. This data will be used in the mapping exercise.

Remote Electronic Monitoring

While REM is not currently rolled out in England, REM data is considered here for completeness. Particularly of relevance here is that REM can encompass both catch data records (what is seen via cameras) as well as landings records (what is tracked into fish boxes in the hold and later landed). As a result of sorting of bycatch and discarding, legitimately or otherwise, catch data and landings data are expected to provide different perspectives on fishing activity. There is also the potential for per haul level (catch and landings) data rather than per day reporting via logbook improving the spatial resolution at which fish landings or catch data may be defined and the confidence with which landing / catch may be attributed to position.

Fisher's Data

Fisher's data is used here to encompass a range of information provided by fishermen outside of the structured reporting requirements. This information has historically been important in adding information to the gaps in our knowledge of the under 12m fleet where there is less statutory reporting. As such data is not a legal requirement there are no routine data collection and reporting of this type, only ad-hoc products This data can be quantitative such as fishing tracks recorded by the fisher in plotters and navigations systems or more qualitative annotations of maps

Here we focus primarily on a product from fishers' knowledge (FisherMap) although narrative is also provided to acknowledge the existence and value of other contributions.

FisherMap

Data characteristics are outlined in Table 13.

Table 13 - FisherMap

1. Description	FisherMap is the most recent iteration (in England) of a series of data products based on defining fishing activity through participatory Geographic Information approaches. Initially developed by Finding Sanctuary Marine Conservation Zone project as StakMap, data collection was expanded to cover all of England (Seafish 2010). Although a one-off project, similar activities have been conducted elsewhere in the UK that continue to expand are refine coverage e.g., ScotMap (Kafas *et al* 2014).
2. Data Collection	Qualitative data obtained from fishers included • Extent of fishing grounds (hand drawn and transposed into GI) from individual fishers followed by group validation sessions of summary maps, by area and gear type. • Essential fish habitats, features and species targeted. Individual grounds were then linked to percentage gross earnings.

3. Purpose	To help in the MCZ designation process to better understand the importance of different areas to local fishers.
4. Fleet segment:	Under 15m vessels
5. Spatial Coverage	The respondents were asked about English waters.
6. Spatial Resolution	Fishing activity is precisely geo-referenced by respondents leading to high spatial resolution. However, the precision with which initial fishing area polygons were defined limits confidence in fine scale observations.
7. Temporal Coverage:	2005-2010
8. Temporal Resolution	None - zones are indicative of importance.
9. Data Access	The final data layers are hosted by Defra on the Defra Data Services Platform.
10. Methodologies	The protocol collected through interviews with local fishers, a questionnaire and mapping survey. This data was then validated by focus groups.
12. Use Caveats	It does not give information on fishing effort in terms of the relative amount or intensity of activity on those grounds rather in terms of percentage contribution to their livelihood. The data has not been updated since 2010 so not likely to be representative of today's activity. There are perceptions in industry that only limited numbers of fishers were involved therefore trust in the results is low.
13. Summary	FisherMap is the current most comprehensive dataset of under 12m fishing activity in terms of the spatial location of fishing grounds and the economic value of those grounds however it is out of date and cannot be relied upon as representative of the current fishing patterns.

Other fishers' knowledge

Fishers' knowledge research has a relatively long history but generally failed to integrate with mainstream approaches such as regulatory data provision. Hind (2014) reviews the scope of the fishers' knowledge literature and how it has developed over the last century.

There are likely to multiple reasons for this lack of integration for example issues of scale (both temporal and spatial), the different attitudes and processes to handling quantitative and qualitative data and trust among parties including in the robustness of the data or in the uses to which such data may be put.

We have included FisherMap for example as fisheries knowledge in this report. However, FisherMap is a data product generated by scientists through a "participatory" process and not a deep integration of fisher's knowledge. Fisher' knowledge has been more readily adopted at a localised level where there are a range of mechanisms to collect knowledge all be it within often tight and defined parameters for example calls for evidence and consultation on marine licences or

legislation or engagement actions for example in marine plan development or the regional fisheries groups.

Other Data

Qualitative narrative of fishery activities – a series of papers generated by Cefas and the Sea Fishery Committees to define the primary fisheries in their area the most recent of which was 2007. These remain largely relevant according to IFCA representatives (Tim Smith and Rob Clark *Personal Communication*).

Small scale fisheries reviews – Such as this report done for the fisheries in Lyme Bay which contains catch data, VMS and Sightings.

4. Mapping Exercise

Methodology

The data chosen for the mapping exercise was information on fishing effort and landings provided by the UK to the Scientific, Technical and Economic Committee for Fisheries - Fisheries Dependant Information Expert Working Group in 2021 as discussed in Regulatory data Section. The method for calculating days at sea and fishing days from fishing activity data is set out in Castro Ribeiro, *et al.* (2016).

A series of data formatting steps were completed to clean and produce a final dataset appropriate for the mapping software. Due to the large size of the raw dataset, records were removed that fell out of the project scope. This included removing ICES rectangles that did not fall within the UK area of interest as well as records with an ICES rectangle of N/A as these could not be spatially defined.

Limitations of the mapping software capabilities meant that only a certain number of records could be mapped. For Landed Value (£) and Landed Weight (tonnes), records were limited to Under 12 metre vessels, years 2016 to 2020 and in ICES Rectangles within a 30 km buffer of English waters. This resulted in a data table of 161,277 records.

Fishing Effort was spatially restricted to ICES Rectangles within a 30 km buffer of the UK Exclusive Economic Zone resulting in 110,583 records. Species codes and Gear Types were converted to full or common names using the FDI Data Call 2021 Annex 1 for Gear Codes and the ASFIS list of species for fishery statistics. Landed values were reported in Euros and so using the average annual exchange rate listed by Eurostat, landed values were converted to Great British Pounds. The resulting data tables contained the following information:

Landed Value & Landed Weight:

- Date (Years 2016 to 2020)
- Vessel Nationality
- Vessel Length (Under 12 metre vessels only)
- Gear Type
- Species
- Total Landed Weight (tonnes)
- Total Landed Value (£)

- ICES Rectangle (spatially restricted to English waters)

Fishing Activity:

- Date (Years 2014 to 2020)
- Vessel Nationality
- Vessel Length (All lengths: Over 40 metres to Under 10 metre)
- Gear Type
- Fishing Effort
- ICES Rectangle (spatially restricted to UK waters)

These data were then imported into the Defra ArcGIS Online site where an Insights Dashboard was used to map the data. Filters were created to allow users to select specific variables e.g., gear types, species etc. which then automatically updates the map and graphs to show total values and time series. A separate web page was created for landed weight, value, and fishing effort to individually map each variable.

Results

The Insights Dashboard is available here at ArcGIS Insights. There are 3 fishing activity tools: Live Weight landed, Landings Value and Fishing Effort. These can be selected using tabs in the bottom left corner. By default, the data displayed in the dashboard is the total for all years, vessel lengths, gears, and vessel nationality.

Using the filter options the following can be individually selected:

- Vessel Length
- Vessel Nationality
- Fishing Gear Type
- Species (Live Weight and Value only)
- Year

The Dashboard also displays graphs of the data selected which summarises the total landed weight for each category as well as displaying the changes between 2016 and 2020. This data automatically updates based on the selection. Individual categories can be selected in the bar graphs to highlight the data over time.

The Dashboard has three components 1) an overview, 2) graphed outputs and 3) map and filters (Figures 4-6)

Figure 4 Dashboard overview illustrated for landings live weight

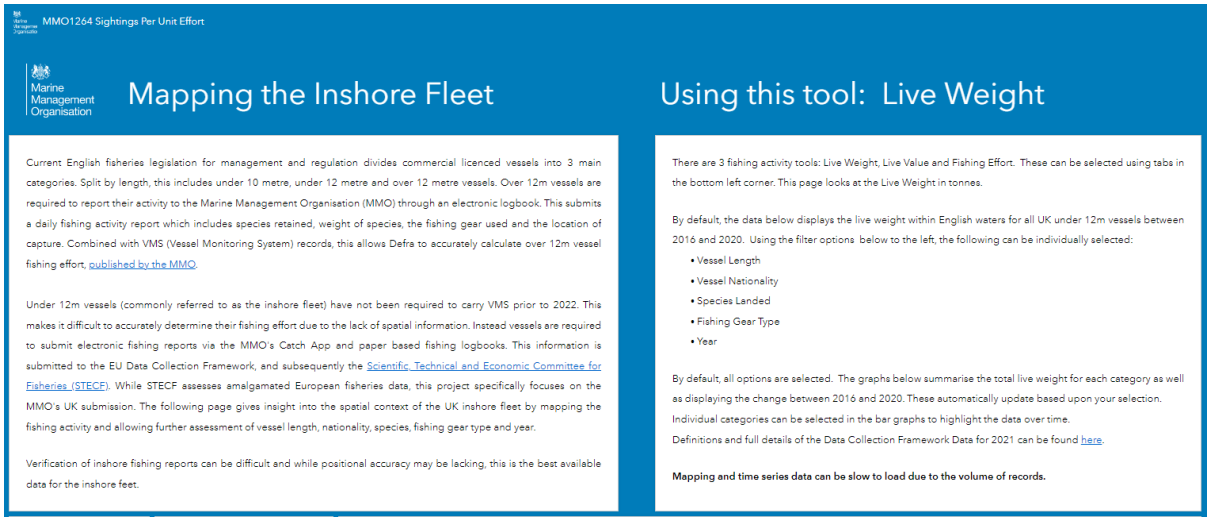


Figure 5 Dashboard graphed outputs illustrated for landings live weight

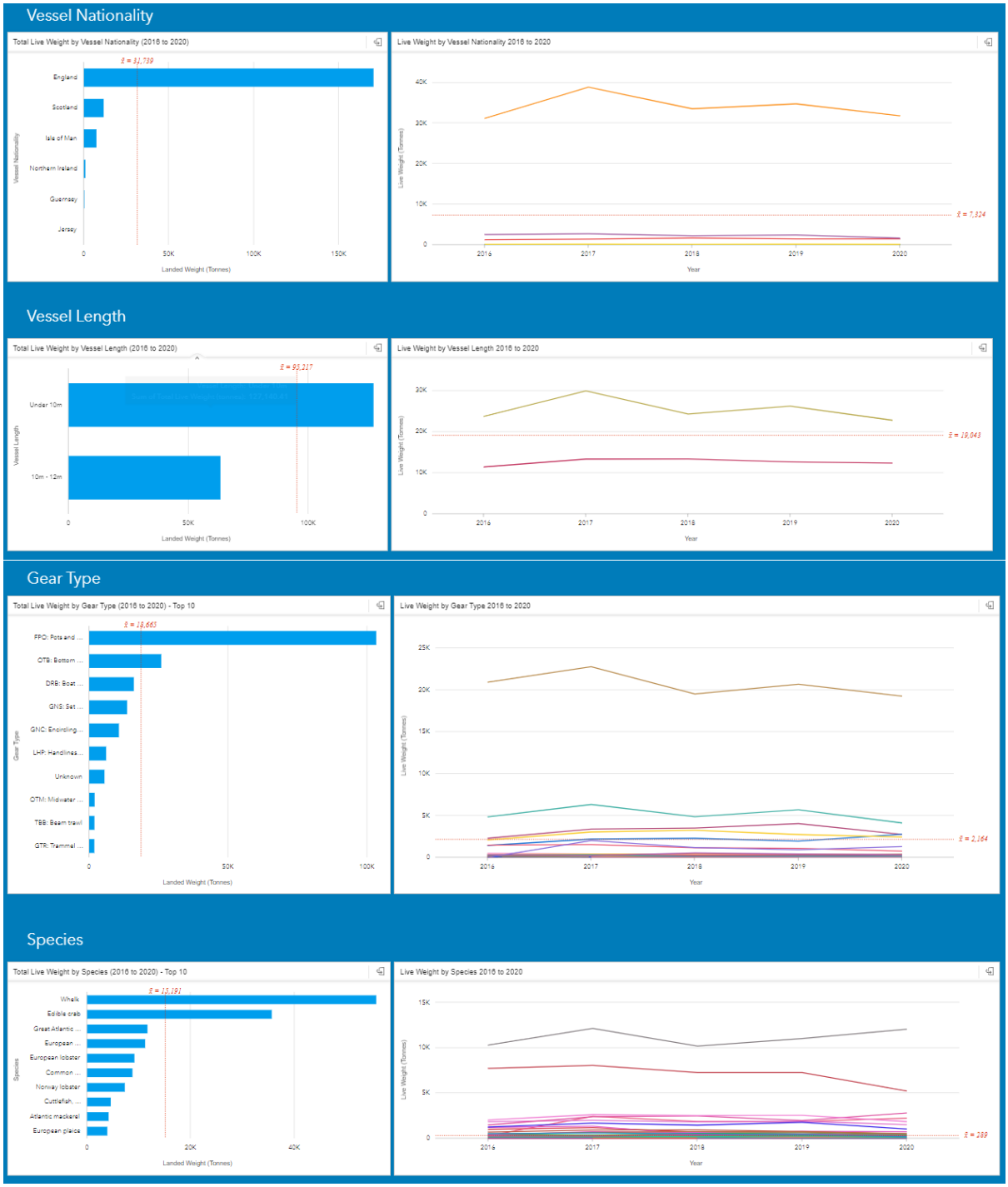
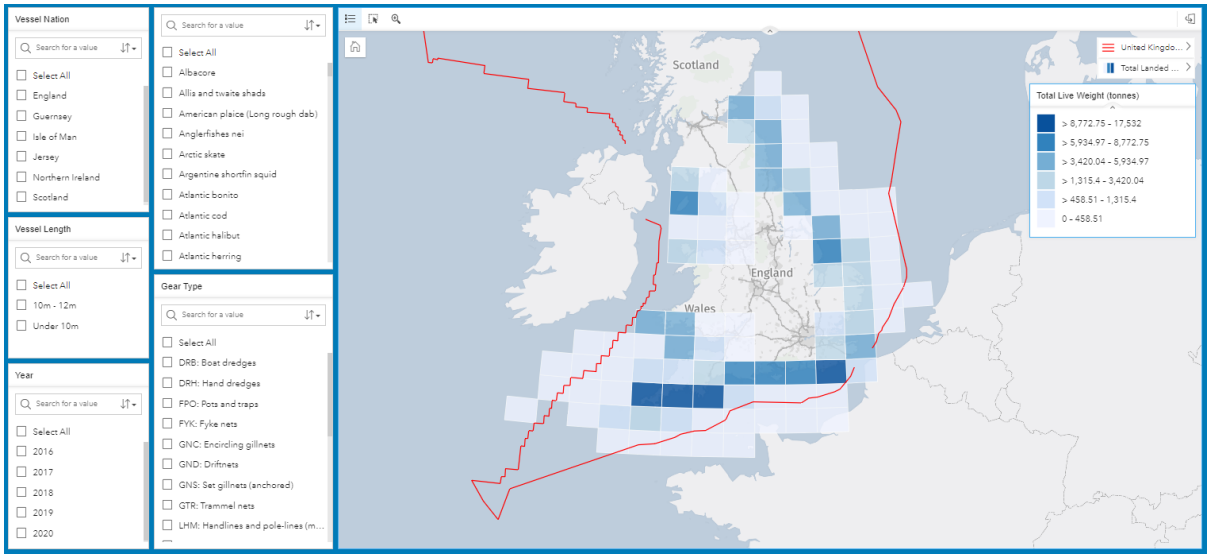


Figure 6 Dashboard map and filters illustrated for landings live weight



The web tool created here allows spatial assessment where under 12m fishing effort is taking place and what is getting caught and where. The inclusion of data on live weight landed and value means enables understanding of which areas are important to inshore smaller scale fishing. The data can be updated to include further years to allow comparison and keep up to date with the relatively current picture. This data set should ultimately be replaced by the direct fisher inputted catch app data which can be cross refenced and corroborated against iVMS data. This will provide greater resolution and allow evidenced informed decisions to be made in areas such as spatial prioritisation and MPA management.

5. Forward look and recommendations

While a range of data are available that describe fishing activity for vessels under 12m in length, there are significant restrictions in spatial-temporal resolution of these data. Temporal scale would be very useful to help understand seasonal variations in spatial fisheries activity, which would add greatly to any spatial prioritisation requirements for marine planning.

The high-resolution position data from AIS is particularly useful for corroborating pre-existing data. Connecting AIS data to vessel demographic data (particularly gear, vessel length and nationality) to understand fleet coverage and representation would be a beneficial next step on the viability of future use.

A combination of data from iVMS and Catch App are expected to provide a substantial improvement in the ability to describe under 12m fishing activity in English waters from late 2023. Some benefits may be realised relatively quickly after implementation of these technologies although more strategic uses including for example spatial planning are likely to require at least a complete annual dataset and would benefit from activity description over multiple years. Therefore, the utility of historic datasets in providing long-term context suggests these existing datasets and products discussed are likely to be relevant for the foreseeable future.

Emerging data sources such as AIS and iVMS will generate substantial volumes of high-resolution data. There would be opportunities in both big data analytics and

associated tools like artificial intelligence (AI) processing to describe fishing activity. AI applications are already applied for example in global fishing watch data to differentiate fishing activity and gear type from track data.

High resolution data would also enable many users to move from large scale aggregate datasets to more focus on individual vessel behaviours and micro distributions such as interactions with renewables infrastructure or impacts on protected features that may fundamentally change understanding of areas that may be important for fishing activity or questions of co-existence and displacement. This report's description of the data and data products in part draws attention to available data and aims to connect fishing activity data users with the caveats and use limitations of their sources of evidence. This report also serves to highlight the different ways fishing activity can be perceived through the different data sources.

6. References

Breen P., Vanstaen K., Clark R. (2015), Mapping inshore fishing activity using aerial, land, and vessel-based sighting information, ICES Journal of Marine Science, Volume 72, Issue 2, January 2015, Pages 467–479. Available online at https://doi.org/10.1093/icesjms/fsu115, last accessed on 11 March 2022.

Castro Ribeiro, C., Holmes, S., Scott, F., Berkenhagen, J., Demaneche, S., Prista, N., Reis, D., Reilly, T., Andriukaitiene, J., Aquilina, M., Avdič Mravlje, E., Calvo Santos, A., Charilaou, C., Dalskov, J., Davidiuk, I., Diamant, A., Egekvist, J., Elliot, M., Ioannou, M., Jakovleva, I. Kuzebski, E., Ozernaja, O., Pinnelo, D., Thasitis, I., Verlé, K., Vitarnen, J., Wójcik, (2016). Report of the 2nd Workshop on Transversal Variables. Nicosia, Cyprus. 22-26 February 2016. A DCF ad-hoc workshop; EUR 27897; doi:10.2788/042271. Available online at https://pureportal.ilvo.be/en/publications/eur-27897-en-jrc-101362-2016, last accessed on 11 March 2022.

Caveen, A., & Fitzsimmons, C., & Pieraccini, M., & Dunn, E., & Sweeting, C., & Johnson, M., & Bloomfield, H., & Jones, E., & Lightfoot, P., & Gray, T., & Stead, S., & Polunin, N., (2014). Diverging Strategies to Planning an Ecologically Coherent Network of MPAs in the North Sea: The Roles of Advocacy, Evidence and Pragmatism in the Face of Uncertainty. Advances in Marine Biology. 69. Available online at https://www.researchgate.net/publication/267623975_Diverging_Strategies_to_Planning_an_Ecologically_Coherent_Network_of_MPAs_in_the_North_Sea_The_Roles_of_Advocacy_Evidence_and_Pragmatism_in_the_Face_of_Uncertainty, last accessed on 6 June 2022.

Cefas (2007). The coastal fisheries of England and Wales, Part V: a review of their status 2005–6. Available online at https://www.cefas.co.uk/publications/techrep/tech140.pdf, last accessed on 8 June 2022.

Defra (2011). MB0106: Further development of marine pressure datalayers and ensuring the socio-economic data and datalayers are developed for use in the planning of marine protected area networks. Available online at http://sciencesearch.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=16415, last accessed on 7 June 2022.

Defra (2014). MB0117: Understanding the distribution and trends in inshore fishing activities and the link to coastal communities. Available online at http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=1&ProjectID=18126, last accessed on 25/04/22

Defra Data Service Platform. Available online at https://environment.data.gov.uk/, last accessed on 28/04/22

Devon and Severn IFCA (2014). Mobile fishing permit byelaw. Available online at https://www.devonandsevernifca.gov.uk/Resource-library/E-Legislation-and-management-relevant-to-functions, last accessed on 6 June 2022.

Eastern IFCA (2018) - Fisheries mapping project: Mapping inshore fishing activity in The Wash using vessel-based sightings information. Available online at: http://www.eastern-ifca.gov.uk/wp-content/uploads/2016/11/2018_04_Sightings_report_2017.pdf, last accessed on 28 April 2022.

European Commission (2009). Council Regulation (EC) No 1224/2009 of 20 November 2009 establishing a Community control system for ensuring compliance with the rules of the common fisheries policy. Available online at https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009R1224, last accessed n 7 June 2022.

European Commission (2022). Eurostat Exchange rates. Available online at https://ec.europa.eu/eurostat/web/exchange-and-interest-rates/data, accessed on 11 March 2022.

European Commission (2022). Fisheries Dependent Information data call 2021 - Annex 1. Available online at https://datacollection.jrc.ec.europa.eu/documents/10213/1385040/FDI2021-annex.pdf/6bb0a9b7-166c-48c8-ad12-48ea59a29ffe, accessed on 11 March 2022

European Commission (2020). Spatial effort 2015-2019 – EU level data. Available online at https://stecf.jrc.ec.europa.eu/dd/fdi/spatial-eff-map, last accessed on 11 March 2022.

European Commission (2020). Spatial landings 2015 to 2019 – EU level data. Available online at https://stecf.jrc.ec.europa.eu/d/fdi/spatial-land-map, last accessed on 11 March 2022.

European Commission (2022). STECF 21-12 - FDI - Fisheries Dependent Information. Available online at https://stecf.jrc.ec.europa.eu/reports/fdi/-/asset_publisher/5ZaD/document/id/17822251?inheritRedirect=false&redirect=https%3A%2F%2Fstecf.jrc.ec.europa.eu%2Freports%2Ffdi%3Fp_p_id%3D101_INSTANCE_5ZaD%26p_p_lifecycle%3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview%26p_p_col_id%3Dcolumn-2%26p_p_col_pos%3D1%26p_p_col_count%3D2, accessed on 11 March 2022.

Gezelius, S.S., (2008). The Arrival of Modern Fisheries Management in the North Atlantic: A Historical Overview. In: Gezelius, S.S., Raakjær, J. (eds) Making

Fisheries Management Work. Reviews: Methods and Technologies in Fish Biology and Fisheries, vol 8. Springer, Dordrecht. Available online at https://doi.org/10.1007/978-1-4020-8628-1_2, last accessed on 6 June 2022

Hind, E., (2015). A review of the past, the present, and the future of fishers' knowledge research: a challenge to established fisheries science, ICES Journal of Marine Science, Volume 72, Issue 2. Available online at https://academic.oup.com/icesjms/article/72/2/341/2801477?login=true, last accessed on 8 June 2022.

Holden, M., (1994). The building of a conservation policy or the marathon negotiation. In: The Common Fisheries Policy: Origin Evaluation and Future. Fishing News Books, UK.

International Council for the Exploration of the Sea. Available online at https://www.ices.dk/data/maps/Pages/ICES-statistical-rectangles.aspx, last accessed on 6 June 2022.

Kafas, A., McLay, A., Chimienti, M., Gubbins, M. (2014) ScotMap Inshore Fisheries Mapping in Scotland: Recording Fishermen's use of the Sea. Scottish Marine and Freshwater Science Volume 5 Number 17. Available online at https://data.marine.gov.scot/dataset/scotmap-inshore-fisheries-mapping-scotland-recording-fishermen%E2%80%99s-use-sea, last accessed on 8 June 2022.

Lyme Bay Reserve (2014). Appendix B: Fisheries Desk Review. Available online at https://www.lymebayreserve.co.uk/download-centre/files/LymeBay_AppendixB_DeskReviewFish_180914.pdf, last accessed on 28 April 2022.

Marine Management Organisation (2016). Catch Quota Trials. Available online at https://www.gov.uk/government/collections/catch-quota-trials-reports, accessed on 31 March 2022.

Marine Management Organisation (2017). Fully Documented Fishery scheme helping to reduce discards of quota species. Available online at https://marinedevelopments.blog.gov.uk/2017/03/20/fully-documented-fishery-discards-quota-fish-cctv/, accessed on 31 March 2022.

MarineTraffic: Global Ship Tracking Intelligence, AIS Marine Traffic, Vessels Database. Available online at https://www.marinetraffic.com/en/data/?asset_type=vessels&columns=flag,shipname,photo,recognized_next_port,reported_eta,reported_destination,current_port,imo,ship_type,show_on_live_map,time_of_latest_position,lat_of_latest_position,lon_of_latest_position,notes&ship_type_in|in|Fishing|ship_type_in=2&flag_in|in|United%20Kingdom|flag_in=GB, last accessed on 28 April 2022.

Marine Traffic Help. FAQs. About Reporting Positions. How often do the positions of the vessels get updated on MarineTraffic? Available online at https://help.marinetraffic.com/hc/en-us/articles/217631867-How-often-do-the-positions-of-the-vessels-get-updated-on-MarineTraffic-, last accessed on 12 July 2022.

M.G. Pawson, G.D. Pickett and P. Walker (2002). The coastal fisheries of England and Wales, part iv: a review of their status 1999-2001. Available online at https://www.cefas.co.uk/publications/techrep/tech116.pdf, last accessed on 11 March 2022.

G.J. Piet and F.J. Quirijns (2009). The importance of scale for fishing impact estimations. Canadian Journal of Fisheries and Aquatic Sciences. 66: 829–835. Available online at https://www.semanticscholar.org/paper/The-importance-of-scale-for-fishing-impact-Piet-Quirijns/d451322b6130bd2a54bea2de432ad35b8cf4f170, last accessed on 6 June 2022.

Royal Commission (1866). Report of the commissioners appointed to inquire into the sea fisheries of the United Kingdom. Vol. I. The report, and appendix. Session 1866. Vol. 152. pp. 8-355

Russell E.S. (1942). The Overfishing Problem. Cambridge University Press. Cambridge.

Seafish (2010) - Development of the FisherMap methodology to map commercial fishing grounds and fishermen's knowledge - Sophie des Clers. Available online at https://www.seafish.org/document/?id=8670F532-1D22-4872-9B92-9ED2C11A3466, last accessed on 25/04/22

Sussex IFCA (2022). Sussex Inshore Fishing Effort 2017 – 2021. Available online at https://secure.toolkitfiles.co.uk/clients/34087/sitedata/files/Research/SxIFCA-fishing-effort-2017-to-2021.pdf, last accessed on 7 June 2022.

UK Government (2005). The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 – Available online at https://www.legislation.gov.uk/uksi/2005/1605/regulation/2/made, last accessed on 28 April 2022

UK Government (2014). Fishing data collection, coverage, processing and revisions. Available online at: https://www.gov.uk/guidance/fishing-activity-and-landings-data-collection-and-processing#history, last accessed on 28 April 2022.

UK Government (2014). Vessel lists over 10 metres. Available online at https://www.gov.uk/government/statistical-data-sets/vessel-lists-over-10-metres, last accessed on 6 June 2022.

UK Government (2014). Vessel lists 10 metres and under. Available online at https://www.gov.uk/government/statistical-data-sets/vessel-lists-10-metres-and-under, last accessed on 6 June 2022.

UK Government (2018). Monthly Shellfish Activity Return (MSAR 1) guidance. Available online at https://www.gov.uk/government/publications/monthly-shellfish-activity-return-msar-1, last accessed on 11 March 2022.

UK Government (2019). Record your catch. Available online at https://www.gov.uk/guidance/record-your-catch, last accessed on 28 April 2022.

UK Government (2020). Fisheries Act 2020. Available online at https://www.legislation.gov.uk/ukpga/2020/22/contents/enacted, last accessed on 6 June 2022.

UK Government (2020). Submission of paper logbooks and landing declaration data, for commercial fishing vessels of 10-12 metres length - GOV.UK, Available online at https://www.gov.uk/guidance/submission-of-paper-logbooks-and-landing-declaration-data-for-commercial-fishing-vessels-of-10-12-metres-length, last accessed on 28 April 2022.

UK Government (2020). Trade and Cooperation Agreement between the European Union and the European Atomic Energy Community, of the one part, and the United Kingdom of Great Britain and Northern Ireland, of the other part. Available online at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/948119/EU-UK_Trade_and_Cooperation_Agreement_24.12.2020.pdf, last accessed on 6 June 2022.

Welsh Government (2012). The Scallop Dredging Operations (Tracking Devices) (Wales) Order 2012. Available online at https://www.legislation.gov.uk/wsi/2012/2729/contents/made, last accessed on 13 July 2022.

Welsh Government (2022). The Sea Fishing Operations (Monitoring Devices) (Wales) Order 2022. Available online at https://www.legislation.gov.uk/wsi/2022/70/made, last accessed on 6 June 2022.

UN Food and Agriculture Organisation (2022) Aquatic Sciences and Fisheries Information System (ASFIS) list of species for fishery statistics. Available online at https://www.fao.org/fishery/en/collection/asfis/en, last accessed on 11 March 2022.

Wikipedia - Automatic identification system - Available online at: https://en.wikipedia.org/wiki/Automatic_identification_system, last accessed on 28 April 2022.