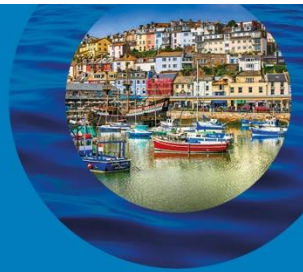**Marine Management Organisation**

Ad-hoc Statistical Release of Vessel Monitoring System (VMS) and Landings data, 2020-2022

...ambitious for our seas and coasts

AD-HOC STATISTICAL RELEASE OF VESSEL MONITORING SYSTEM (VMS) AND LANDINGS DATA, 2020-2022

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Introduction

Background

The Marine Management Organisation's (MMO) purpose is to protect and enhance our precious marine environment and support UK economic growth by enabling sustainable marine activities and development.

Following a call for evidence from the Crown Estate on the Future of Offshore Wind[1], the MMO has been asked to provide information on location and scale of fishing activity. The MMO has previously published spatial information on location of fishing activity[2], and routinely publishes statistics on landings of sea fish[3].

In order to provide information relevant to the call for evidence this ad-hoc statistical release draws in two main sources of data. Information on the location of fishing activity has been sourced from the Vessel Monitoring System (VMS), and information on the scale of fishing activity has been sourced from landings declarations. Both data sources are discussed in the Methodology section of this document.

Purpose of this document

This document provides supporting information for the data tables and spatial files that are included within the ad-hoc statistical release.

This document provides background information on why the ad-hoc statistical release has been published, as well as description on how the statistics have been prepared, and limitations on the use of the statistics.

The results section of this document provides an overview and description of the data tables and spatial representation; however, it does not provide detailed statistical commentary on the statistical outputs.

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[1] The 'call for evidence' has been sent directly to stakeholders; however, a published report on the project can be found here.
[2] An example of published spatial information on location of fishing activity can be found here.
[3] Monthly UK sea fisheries statistics can be found here.

Results

The outputs of this ad-hoc statistical release are two data tables which provide information on location of fishing activity (derived from VMS data) and scale of fishing activity (derived from Landing declarations). The data tables have been prepared so that they represent the same population of vessels and are aggregated in the same way, so that they can be matched.

The geographical scope of the VMS data has been focused on English waters. Landings data has been provided for all landings made to UK ports and abroad, by UK and Crown Dependency vessels.

Data have been prepared for the years 2020 to 2022 and represents UK and Crown Dependency[4] vessels that are 12 metres and over. Foreign vessels are not included in either dataset.

A description of the data tables and illustration of the spatial representation are presented below.

Vessel Monitoring System (VMS) and Landings data tables

Table 1 – Format of VMS and Landings data tables, 2020-2022

VMS data table (English waters)	Landings data table (All waters UK and abroad)
Measured variables	
Time spent (in area, hours)	Landed Weight (tonnes)
	Live Weight (tonnes)
	Value (£s)
Common variables in each of the datasets	
Fish Producer Organisation	
Year Activity	
Month Activity	
Vessel Length Group	
Gear Category	
ICES (statistical) Rectangle	
Food and Agriculture Organization Subarea Division	

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[4] Jersey, Guernsey and Isle of Man

Table 2 – Description of variables contained within VMS and Landings data tables

Variable	Description
Time Spent (in area, hours)	This is the sum of estimated time spent in an area by all UK and Crown Dependency 12m and over vessels. This variable has been measured by summing the time difference between all VMS recordings ('pings') in an area. VMS recordings ('pings') usually provide location information for the vessel every 2 hours; however, the frequency can differ such as 3 minute or 1 hour ping intervals.
Landed Weight (tonnes)	This is the sum of all recorded landings of sea fish. The landed weight refers to the weight of the product in the state (e.g. fresh, frozen) or presentation (e.g. whole, gutted, filleted, etc.) is landed.
Live Weight (tonnes)	This is an estimate of the 'live', or whole, weight of the sea fish. This variable is derived from the landed weight by multiplying landed weight by conversion factors that are unique to the state and presentation of the product, for each species. This is the primary quantity metric used for most analysis.
Value (£s)	This is the total sum of value (£s) of landings. The value of landings is generated from the recording of the first sale of landings, reported via submission of sales notes. Any sales recorded in a currency other than Sterling (GBP) are converted to GBP for consistency.
Producer Organisation	Producer Organisations (POs) or Fish Producer Organisations (FPOs) are officially recognised bodies set up by fishery producers. PO has been presented as published in the vessel lists available on the MMO website: https://www.gov.uk/government/collections/uk-vessel-lists POs which are registered in England were consulted with prior to publication of this statistical release to understand whether there were disclosure concerns with publishing data at PO level. Due to the varying size and scale of PO membership, at least one PO asked for their members information to not be identified in the statistical release; therefore, Producer Organisation ID does not include all English or UK Producer Organisations.

	Activity of vessels that are not members of the named Producer Organisations in the landings data table have been aggregated into the 'other' category, along with Scottish, Welsh, Northern Irish, and Crown Dependency vessels.
Year Activity	Year based on activity date which corresponds with the time of the trip[5].
Month Activity	Month based on activity date which corresponds with the time of the trip[5].
Vessel Length Group	All vessels are recorded as '12 meter and over' due to the availability of location information being fully available for 12 meter and over vessels only. No further breakdown has been provided to mitigate against risk of disclosing sensitive information.
Gear Category	Gear type represents the category of gear used. More information on fishing gear can be found here: http://www.fao.org/fishery/topic/1617/en
ICES (Statistical) Rectangle	The International Council for the Exploration of the Sea (ICES) uses sub-divisions of the sea surface area each approximately 30 nautical miles by 30 nautical miles in size; although more detailed landings data exists ICES Rectangle remains the highest resolution of reported spatial landings data available for every UK commercial fishing vessel. See here for more information: https://www.ices.dk/data/maps/Pages/ICES-statistical-rectangles.aspx
Food and Agriculture Organization (FAO) Subarea Division	The Food and Agriculture Organization (FAO) divides the sea up into major fishing areas (such as major fishing area 27 - the Northeast Atlantic), then subareas (such as subarea 27.4 - the North Sea) and then divisions (such as 27.4.c - the Southern North Sea). See here for more information: https://www.fao.org/fishery/en/area/27/en
C-square	The 'Concise spatial query and representation system' (c-squares) is used to divide the globe into a standardized grid. Further information about c-squares can be found in Table 3. This release uses the 0.05-degrees c-squares resolution. This has been used to aggregate VMS positions from point data into a standardized grid.

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[5] Within Sea Fisheries Statistics[3], landings are usually recording against the landed date, which is the date recorded in the landing declaration; therefore, the landings dataset within this ad-hoc statistical release will not necessarily align with Sea Fisheries Statistics.

Ping Type	This variable represents an estimation of whether a vessel is undertaking 'fishing' activity or 'non-fishing' activity, such as transits. This categorisation has been estimated based on the recorded speed from the VMS ping. Speeds between one and six knots are categorised as 'fishing' activity, and speeds less than one knot or greater than six knots are categorised as 'non-fishing' activity.

Spatial representation of VMS data

In addition to the VMS data table a spatial representation will be published on the Defra Data Services Platform as a direct follow up to this release. This layer will provide a spatialised version of the VMS data released alongside this report by attaching to a 0.05 degrees c-square spatial grid, which is described below. The purposes of publishing a separate spatial layer variant of the dataset is to provide an alternative route to access the data, avoid the need for users to spatialise the data themselves (which may require specialist knowledge of VMSTools R package for example[6]) and add additional functionality via the DEFRA Data Services Platform such as viewing online, downloading an area of interest only and providing Open Geospatial Consortium (OGC) compliant spatial services.

Table 3 – Description of c-square spatial grid

| Variable	Description
C-square	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 10° by 10° World Meteorological Organization squares into increasingly fine grids. There are numerous spatial resolutions possible using c-square (10 degree grid, 5 degree grid, 1 degree grid etc.), however, this release used 0.05 degrees resolution. This resolution has been selected for the purposes of aggregating and anonymising VMS point data as well as to harmonise with the temporal resolution available for UK vessels of 12 meters and over VMS data (ping intervals of 2 hours or less). In English waters a 0.05 grid is 3.0 nautical miles by approximately 1.9 nautical miles (or 5.6km by approximately 3.5km). For comparison ICES statistical rectangles are approximately 30 by 38 nautical miles in English waters. The selected resolution is in line with previous MMO VMS publications[7]. More information on c-squares can be found here.

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[6] Vmstools R package
[7] Fishing Activity for over 15 metre United Kingdom Vessels

Figure 1 – Vessel location by c-square, UK and Crown Dependency vessels of length 12m and over, English waters

Vessel location by C-square, UK and Crown Dependency vessels of length 12m and over
Total time spent (hours) from 2020 to 2022

Marine Management Organisation
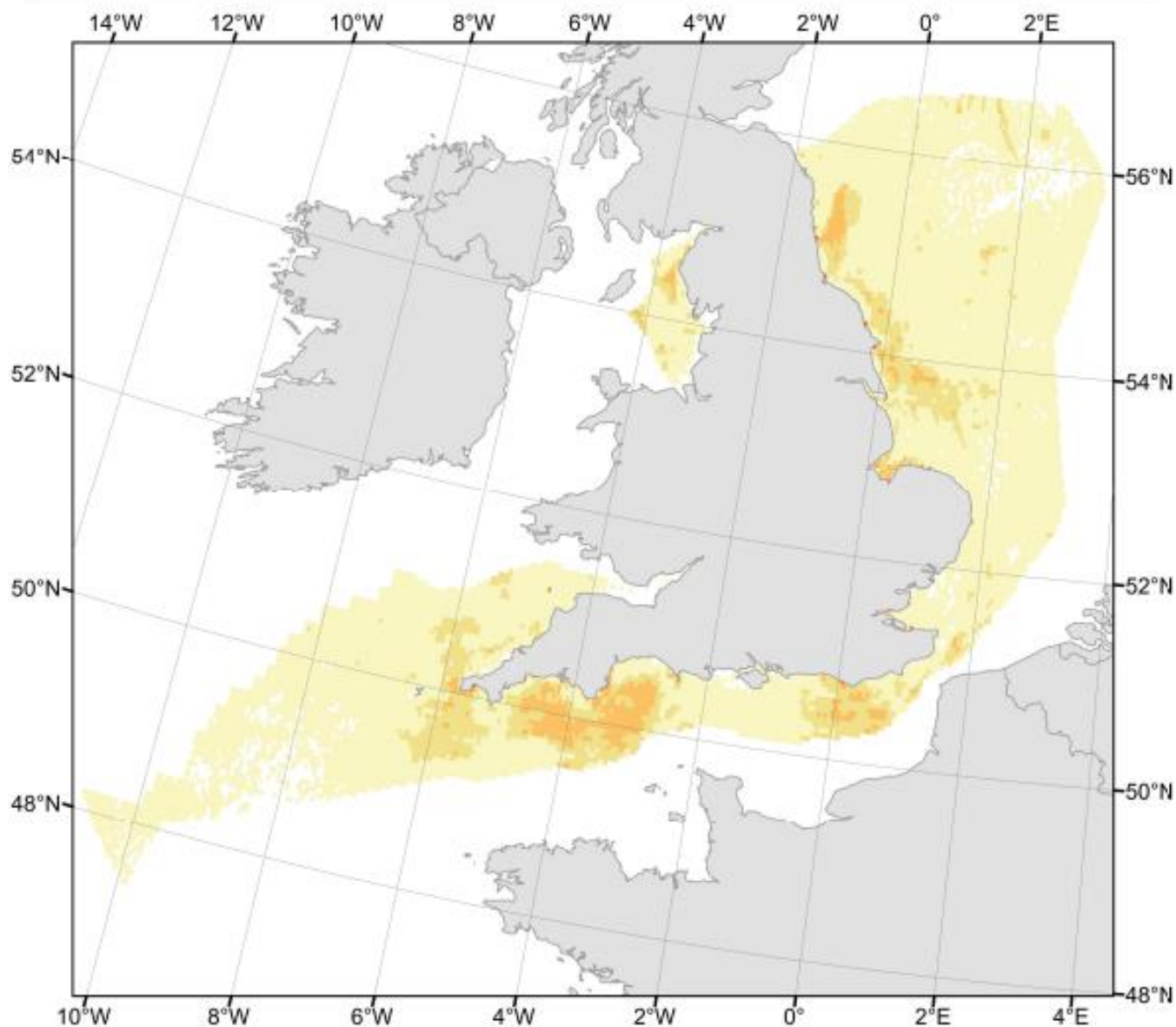
Time Spent (Hours) by C-square

- >0 to 275
- >275 to 850
- >850 to 4250
- >4250 to 13000
- >13000 to 25000
- >25000 to 75000
- >75000 to 235238

Date of Publication: 25/10/2024
Coordinate System: CRS ETRS 1989
Projection: Lambert Azimuthal Equal Area
MMO Reference: 10833

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Methodology

Data sources

Data have been collected from two main data sources, which are described in the sections below.

Vessel Monitoring System (VMS)

Since 2013, it has been a regulatory requirement for UK 12 metre and over vessels to transmit their position when at sea at least every two hours using Vessel Monitoring System (VMS). The Vessel Monitoring System (VMS) is a system of satellite tracking using transmitters on board fishing vessels and records the location, speed and heading of a vessel.

Currently, plans to fit under-12 meters commercial vessels operating in English waters with Inshore Vessel Monitoring Systems (i-VMS)[8] are subject to parliamentary process. Therefore, with certain exceptions, it is not currently a legal requirement for i-VMS to be fitted on vessels below 12 meters.

This statistical release focuses on UK and Crown Dependency vessels that are 12 meters and over, as these data are complete.

Logbooks, landing declarations and sales notes

Retained European Council legislation[9] requires skippers to keep and submit logbooks and provide landing declarations electronically for vessels 12 metres and over, which includes all vessels included within this statistical release.

Landing declarations provide information on the weight and presentation of fish landed by species. Logbooks provide information on reported fishing activity such as activity dates, gear used and area of fishing. Data from sales notes, submitted by buyers and sellers of the first sale fish, have been used to provide information on the value (£s) of the landing.

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[8] Inshore Vessel Monitoring (I-VMS) for under-12 metre fishing vessels registered in England - GOV.UK
[9] The basic legislation that sets out the measures under the EU Common Fisheries Policy: Council regulation (EU) No. 1380/2013. The legislation that sets out the control system for ensuring compliance with the rules of the common fisheries policy: Council regulation (EU) No. 1224/2009.

A further methodology note that describes the process of collecting fisheries data can be found here: Fishing data collection, coverage, processing and revisions - GOV.UK (www.gov.uk)

Methodology

Data have been prepared for the years 2020 to 2022 and represents UK and Crown Dependency vessels that are 12 metres and over.

The geographical scope of the VMS data is focused on English waters. Landings data have been provided for all landings made by UK and Crown Dependency vessels irrespective of waters.

Methodology for preparing Vessel Monitoring System data table

Vessel Monitoring System data have been prepared in four stages:

1) VMS data have been extracted from several tables within SQL databases to create a single table with the required variables for the VMS data table.
2) The data in this table have been cleaned, using R software, to improve the accuracy of the data. This process has been described in greater detail in table 4 below.
3) The VMS data have been clipped to the boundaries of the UK Exclusive Economic Zone (EEZ) using UK Hydrographic Office (UKHO) data[10] and then clipped further to just the extent of English waters using ArcGIS Pro. VMS positions on land have also been excluded.
4) The data have then been aggregated according to the fields listed in table 1.

Table 4 - Data cleaning for the VMS extract

Data cleaning steps that have been applied	Description of methodology
Removing onshore 'pings'	A small number of registered locations ('pings') from VMS have coordinates that are on land. A high-resolution polygon of the UK coastline from Ordnance Survey data has been used to identify points that are on land, which have been subsequently removed from the dataset. A publicly accessible version of this polygon can be found at: https://osdatahub.os.uk/downloads/open/BoundaryLine

[10] UK Hydrographic Office Maritime Limits and Boundaries | ADMIRALTY Marine Data Portal

Checking for erroneous 'pings'	All VMS 'pings' recorded had valid latitude and longitude readings. No further action has been taken.
Removing duplicated 'pings'	A very small number of VMS readings are duplicate readings. Therefore, only one incident of duplicated data points has been retained in the dataset.
Removing 'pings' relating to non-fishing vessels	Not all vessels with VMS fitted are registered fishing vessels; therefore, these vessels have been removed from the dataset. This includes Fishery Patrol Vessels (FPVs).
Apportioning 'time spent' to VMS positions	Each VMS report was allocated associated estimates of time spent derived from date and time information from the VMS reports immediately before and immediately after it. All intervals are divided in two at their midpoint and assigned to the VMS positions either side. For example, consider a VMS report timed at 10:00, with a previous report having been sent at 08:00 and the next report sent at 11:00. The VMS report for 10:00 is allocated a total of 90 minutes (half the time between 08:00 and 10:00 (60 minutes) plus half the time between 10:00 and 11:00 (30 minutes)). The VMS point data have subsequently been aggregated into 0.05-degree c-squares to better match temporal resolution of the VMS data, as well as provide anonymity of positional data.

The table below sets out proposed measures to improve the quality of the dataset, which were not possible to implement within the timescales. It is likely that omission of the following data cleaning step will not affect the key focus of this statistical release. This step would have removed some data points around the edge of English waters, which are unlikely to represent fishing activity.

Data cleaning steps that have <u>not</u> been applied	Description of methodology
Removing 'pings' within harbours	Vessels may transmit their location whilst within a harbour or leaving or departing a harbour area. Due to imprecise point data for harbours held on IT systems, and differing sizes and shapes of harbour areas, it has not been possible to create a buffer zone for all English harbours of sufficient robustness to remove VMS pings in harbours with confidence at this stage. This will be assessed in future.

For further information, please see the Quality Assurance and Limitations of Use sections.

Methodology for preparing Landings data table

Landings data have been prepared in three stages:

1) Landings data have been extracted from the MMO Sea Fisheries Statistics underlying landings dataset[11]. To ensure consistency with the VMS dataset the landings are presented by year and month of activity date. As landings are reported using landing date in the annual Sea Fisheries Statistics publication, the landings figure in this release will differ slightly when compared to data previously published for UK and Crown Dependency vessels of 12 meters and over.
2) To ensure consistency with the VMS data table, only landings from UK and Crown Dependency vessels that are 12 metres and over have been included in the landings data table.
3) The data have then been aggregated into the fields listed in Table 1. Aggregation has been applied due to the potential sensitivity of the measured variables from landing declarations. The aggregation of data has been carefully applied to mitigate risk of disclosure of sensitive information.

The landings dataset excludes fish caught in 2022 but not landed until 2023. This includes approximately 1,100 tonnes, predominately from non-English waters

Disclosure control

As discussed in the methodology section, disclosure control measures have been applied to mitigate the risk of new or sensitive information being disclosed through the data tables or through cross referencing these data tables with other sources.

The method of applying disclosure control has been to aggregate the data by the variables listed in Table 1. In addition, the variable vessel length has been restricted to one level, ('12 metres and over') and UK Fishing Authority (UKFA) nationality has been excluded to mitigate identification of individual vessels.

The number of vessels represented by each segment/row has not been included as a measured metric.

VMS data have been aggregated from point data to 0.05 degrees c-squares data and applied the same aggregation rules as the landings data.

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[11] UK Sea Fisheries Statistics – Unscheduled Corrections - GOV.UK

Quality Assurance

Quality assurance of data has been applied in three main phases:

1) At the point of data collection, such as when landing declarations are submitted, initial validation checks of data are applied. Some further commentary on this stage of quality assurance can be found here: Fishing data collection, coverage, processing and revisions - GOV.UK
2) During manipulation of data to produce desired outputs, data and code have been quality assured to ensure that data are accurate and have been manipulated effectively. There is some commentary on data cleaning processes that have been applied in the methodology section.
3) Post-hoc quality assurance on outputs has been applied. Data tables have been quality assured by cross referencing totals and breakdowns with Sea Fisheries Statistics[3]. It has not been possible to directly match Sea Fisheries Statistics[3] due to use of differing date fields and geographical areas, however, proxy variables have been used to ensure coherence. The effectiveness of disclosure control has also been investigated by conducting intruder testing.

Limitations of use

The main limitations of use of the data tables are summarised below:

- The data in both the VMS and Landings dataset includes UK and Crown Dependency vessels of 12 metres and over. The release does not contain information on under 12-meter vessels. Smaller vessels are likely to conduct fishing activity in locations that are inshore compared to larger sized vessels. Landings for under 12-meter vessels are included in other publications[12].

- The scope of the geographic coverage for the VMS and Landings dataset are different. The VMS data table only covers activity in English waters, whereas the Landings dataset covers landings of all UK vessels irrespective of waters. For this reason, care should be taken when drawing comparison between the datasets. The data tables are directly comparable by geography when matching on ICES Statistical Rectangle or Food and Agriculture Organization (FAO) Subarea Division.

- The landings data table is not directly comparable to the Sea Fisheries Statistics[3], as different date variables have been used in this release (activity date).

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[12] UK Sea Fisheries Statistics – Unscheduled Corrections - GOV.UK

- The 'Ping type' variable within the VMS dataset is a simple categorisation of activity based exclusively on recorded instant speeds of the vessel from VMS pings. There is likely to be some outliers to the categorisation – an example may be fishing activity which takes place whilst a vessel is static which is marked 'non-fishing' or vessels returning to harbour at slow speed which is marked as 'fishing' due to travelling at a speed between one and six knots. This approach matches the spatial resolution of MMO's previously published VMS datasets[13.] Although a very simplistic approximation there is evidence to support the use of this speed range to provide an overview of fishing activity. For example, Lee et al., 2010 stated in their report using UK VMS data; "The data indicated that the use of a 1–6-knot speed filter could provide an effective means of distinguishing most of the fishing activity for all gears"[14]. This method will be reviewed and improved in future methods and publications, but it is sufficient to provide a realistic view of overall activity in most cases. It is likely more robust for mobile gear activity such as bottom otter trawling compared to static gear fishing such as potting.

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[13] Fishing Activity for over 15 metre United Kingdom Vessels
[14] Developing reliable, repeatable, and accessible methods to provide high-resolution estimates of fishing-effort distributions from vessel monitoring system (VMS) data | ICES Journal of Marine Science | Oxford Academic